Petrological and monitoring insights into the mechanisms driving eruptions of Kelud volcano, Indonesia

Utami, Sri Budhi

2021

Utami, S. B. (2021). Petrological and monitoring insights into the mechanisms driving eruptions of Kelud volcano, Indonesia. Doctoral thesis, Nanyang Technological University, Singapore. <https://hdl.handle.net/10356/153288>

<https://hdl.handle.net/10356/153288>

<https://doi.org/10.32657/10356/153288>

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**Petrological and monitoring insights into the mechanisms
driving eruptions of Kelud volcano, Indonesia**

Sri Budhi Utami

Asian School of the Environment

A thesis submitted to the Nanyang Technological
University in partial fulfilment of the requirements
for the degree of Doctor of Philosophy

2021

Candidate Statement of Originality

I hereby certify that the work embodied in this thesis is the result of original research, is free of plagiarised materials, and has not been submitted for a higher degree to any other University or Institution. I confirm that the investigations were conducted in accord with the ethics policies and integrity standards of Nanyang Technological University and that the research data are presented honestly and without prejudice.

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Authorship Attribution Statement

This thesis does not contain any materials from papers published in peer-reviewed journals or from papers accepted at conferences in which I am listed as an author.

This thesis contains material from three papers, one is currently in press, another is in review, and one more will be submitted to peer-reviewed journals, where in all cases I am the first and corresponding author.

Chapter 2 is currently in press as S. B. Utami, F. Costa, P. Lesage, P. Allard, H. Humaida. *In press*. Fluid fluxing and accumulation drive decadal and short-lived explosive basaltic andesite eruptions preceded by limited volcanic unrest. *Journal of Petrology*. <https://doi.org/10.1093/petrology/egab086>

The contributions of the co-authors are as follows:

- Dr. Hanik Humaida provided samples and fieldwork assistance.
- I co-designed the study with Prof. Fidel Costa. I analyzed and interpreted the data, conducted fieldwork to sample pumices, and performed statistical and diffusion modelling.
- I conducted analyses on the scanning electron microscope (SEM) at the Earth Observatory of Singapore (EOS) and electron microprobe (EPMA) in the Facility for Analysis, Characterization, Testing and Simulation (FACTS).
- Prof. Costa provided guidance on data interpretation and manuscript writing.

- Dr. Allard assisted modelling using rhyolite-MELTS and provided guidance on volcanic systems.
- Dr. Lesage provided guidance on geophysics and Kelud and the original seismic data from the 1990 eruption.
- I prepared the manuscript drafts under the guidance of Prof. Costa, which was revised by Drs. Humaida, Patrick Allard, and Philippe Lesage.

Chapter 3 is under review as S.B. Utami, J. Andújar, F. Costa, B. Scaillet, and H. Humaida. In review. The role of magmatic storage conditions and excess fluids in the effusive to explosive eruption styles. *Geochemistry, Geophysics, Geosystems*.

The contributions of the co-authors are as follows:

- I designed the study and applied for funding from the Stephen Riady Geosciences Scholarship under the guidance of Dr. Costa.
- I prepared the starting materials and capsules for experiments and performed initial experimental charge characterization at ISTO-Orléans, France under the guidance of Dr. Joan Andújar.
- Drs. Andújar and Bruno Scaillet assisted me in conducting experiments by operating the IHPV, as well as discussions on experimental petrology approach.
- All microscopy and chemical analyses were conducted by me using the SEM and EPMA in the EOS and FACTS.

- I prepared the manuscript under the guidance of Dr. Costa, which was revised by Drs. Costa, Andújar, Scaillet, and Humaida.

Chapter 4 is being prepared for submission as S. B. Utami, F. Costa, J. Herrin, H. Humaida. Contrasting magma ascent rates of explosive eruptions and dome emplacement at Kelud volcano, Indonesia. In preparation, *Earth and Planetary Sciences Letters*.

The contributions of the co-authors are as follows:

- I co-designed the study with Prof. Fidel Costa.
- I conducted chemical and spectroscopic analyses on apatite on the SEM in EOS, and EPMA in FACTS under the guidance of Dr. Jason Herrin.
- Dr. Herrin conducted analyses on plagioclase on the EPMA in FACTS.
- I analyzed and interpreted the data, performed diffusion modelling, and performed statistical and modeling for ascent rate calculations.
- I prepared the manuscript drafts, under the guidance of Dr. Costa. The manuscript was revised by Drs. Costa, Herrin, and Humaida.

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ACKNOWLEDGEMENTS

First and foremost, endless gratitude to my advisor Fidel who supported me through thick and thin during this thesis. Thank you for believing in my ideas when many people did not and recognizing my value when I could not. With your support and guidance, I learned to trust in my own abilities as a scientist, and to have the confidence to move onward in science.

Thank you to my thesis committee members Susanna Jenkins, Patrick Allard, Philippe Lesage and my faculty mentor Janice, I am grateful that you all played an integral part of my academic journey. Thank you to Benoit, Emma, Christina Tee, Jacqueline Koh, Wong Chun Yu, Rohaya, and the faculty and staff at EOS and ASE who have been kind and supported me during my stay here, especially during an unforgiving global pandemic.

Thank you to Hanik Humaida, BPPTKG, and CVGHM for your generosity in providing samples, fruitful discussions in the field, and guidance the topic of Kelud volcano.

Thank you to Joan Andújar, Bruno Scaillet, and colleagues (especially Ida, Morganne, Jonas, and Maria) at ISTO-Orléans for two memorable visits to France and for introducing me to experimental petrology. Thank you to the late Dr. James D. Webster, may you rest in peace.

Thank you to current and former colleagues in the Volcano Group, or otherwise: Jason, Jeff, Ying-Jui, Helena, Gareth, Ira, Yuti, Alex, Dini, Riko, Lilu, Yang, Nang, Brian, Tarsílo, Corentin, and many others, your generosity and kindness have been invaluable to me.

I would like to thank my two closest friends in Singapore, Christina Widiwijayanti and

Anna Perttu for your steadfast friendship for the past five years. Your encouragement, kindness, and support enabled me to heal from the past and to thrive against all odds. Thanks to all my teammates in the Canadian Dragons Singapore who taught me the value of grit, camaraderie, friendship, and team spirit on and off the water.

Finally, unconditional love and gratitude to Bapak, Ibu, Riri, Wahyu, and Gaby who celebrated my successes with me, who supported me through the challenges, and who fill me with joy and laughter every day.

Table of Contents

CANDIDATE STATEMENT OF ORIGINALITY.....	1
SUPERVISOR DECLARATION STATEMENT.....	2
AUTHORSHIP ATTRIBUTION STATEMENT	3
ACKNOWLEDGEMENTS	7
TABLE OF CONTENTS.....	ERROR! BOOKMARK NOT DEFINED.
ABSTRACT	11
INTRODUCTION	12
OBJECTIVES.....	15
CHAPTER 2: FLUID FLUXING AND ACCUMULATION DRIVE DECADAL AND SHORT-LIVED EXPLOSIVE BASALTIC ANDESITE ERUPTIONS PRECEDED BY LIMITED VOLCANIC UNREST	17
ABSTRACT	19
2.1. INTRODUCTION	19
2.2. GEOLOGICAL SETTING.....	21
2.2.1 <i>Kelud volcano and lake</i>	21
2.2.2 <i>Historical eruptions and hazards from Kelud</i>	22
2.2.3 <i>The 1990 eruption</i>	23
2.3. METHODOLOGY	25
2.3.1 <i>Sampling Strategy</i>	25
2.3.2 <i>Analytical Methodology</i>	27
2.3.3 <i>Geothermobarometry and magma storage conditions</i>	29
2.3.4 <i>Pyroxene diffusion modeling and calculations of timescales</i>	31
2.3.5 <i>Calculation of exsolved fluid using SO₂ mass balance</i>	32
2.4. RESULTS	32
2.4.1 <i>Petrology, mineralogy, and geochemistry of main- and late-stage pumices</i>	32
2.4.2 <i>Pre-eruptive Magma storage conditions</i>	54
2.4.3 <i>Dissolved water content, saturation pressures, and exsolved fluids</i>	58
2.4.4 <i>Timescales of magmatic processes</i>	59
2.5. DISCUSSION	59
2.5.1 <i>A range of pre-eruptive storage conditions and Kelud's plumbing system</i>	59
2.5.2 <i>Magmatic processes and timescales related to the 1990 eruption</i>	64
2.5.3 <i>Time scales of processes and relation to monitoring data</i>	68
2.5.4 <i>A general model for Kelud eruptions and their relation to other volcanoes</i>	72
2.6. CONCLUSION	72
2.7. SUPPLEMENTARY MATERIAL	74
CHAPTER 3: THE ROLE OF MAGMATIC STORAGE CONDITIONS AND EXCESS FLUIDS IN THE EFFUSIVE TO EXPLOSIVE ERUPTION STYLE	103
ABSTRACT	106
3.1. INTRODUCTION	107
3.2 GEOLOGICAL SETTING.....	108
3.2.1 <i>Kelud volcano</i>	108
3.3 MATERIALS AND METHODS	109
3.3.1 <i>Selection of experimental conditions</i>	110
3.3.2 <i>Preparation of experimental charges</i>	110
3.3.3 <i>Experimental equipment</i>	112
3.3.4 <i>Calculation of fO₂ and dissolved water content in experimental charges</i>	113
3.3.5 <i>Analytical techniques</i>	113
3.4 RESULTS	115
3.4.1 <i>Petrological observations and geothermobarometry of the 1990, 2007 and 2014 magmas</i> ...	115
3.4.2 <i>General observations from the experimental results</i>	123
3.4.3 <i>Phase relation, crystallinities, and mineral assemblages</i>	124

3.4.4 Mineral and glass compositions.....	134
3.5 DISCUSSION	149
3.5.1 Geothermobarometry and experimental constraints on magma storage conditions of sub- Plinian eruptions and dome extrusions	149
3.5.2 The importance of excess volatiles in determining eruption style.....	150
3.5.3 Relating pre-eruptive processes to unrest signals.....	153
3.6 CONCLUSIONS	154
3.7 ACKNOWLEDGMENTS	155
3.8 REFERENCES	155
3.9 SUPPLEMENTARY MATERIAL	164
CHAPTER 4: CONTRASTING MAGMA ASCENT RATES OF EXPLOSIVE ERUPTIONS AND DOME EMPLACEMENT AT KELUD VOLCANO, INDONESIA.....	175
ABSTRACT	177
4.1 INTRODUCTION	178
4.2 SUMMARY OF THE 1990, 2007, AND 2014 KELUD ERUPTIONS, UNREST, AND PREVIOUS PETROLOGICAL STUDIES	179
4.3 METHODOLOGY	180
4.3.1 Chemical Analyses of Apatite	181
4.3.2 Modelling timescales and ascent rates from apatite	181
4.3.3 Viscosity calculations.....	183
4.4 RESULTS	184
4.4.1 Apatite textures and composition	184
4.5 DISCUSSION	191
4.5.1 Interpretation of the volatile zoning patterns in apatite.....	191
4.5.2 Apatite timescales and their relation to unrest.....	192
4.5.3 Magma ascent rates for explosive eruptions and dome emplacements.....	197
4.5.4 Relating ascent rates to eruption styles.....	198
4.6 CONCLUSIONS	200
4.7 ACKNOWLEDGEMENTS.....	201
4.8 REFERENCES	201
4.9 SUPPLEMENTARY MATERIAL	210
CONCLUSIONS AND FUTURE WORK	213
BIBLIOGRAPHY.....	218
THESIS APPENDIX.....	234
TABLE S2.2: MAJOR ELEMENT COMPOSITIONS OF WHOLE ROCKS, GLASSES, AND MINERALS	235
Table S2.2.1: Major element compositions of minerals (Cpx)	235
Table S2.2.2: Major element compositions of whole rocks, glasses, and minerals (Opx)	263
Table S2.2.3: Major element compositions of whole rocks, glasses, and minerals (Plag).....	329
Table S2.2.4: Major element compositions of whole rocks, glasses, and minerals (Mag).	345
Table S2.2.5: Major element compositions of whole rocks, glasses, and minerals (Ilm).....	348
Table S2.2.6: Major element compositions of whole rocks, glasses, and minerals (Amph)	350
Table S2.2.7: Major element compositions of whole rocks and glasses.....	351
TABLE S3.2 NATURAL GLASS AND MINERAL COMPOSITIONS ANALYZED BY EPMA AND XRF FOR KELUD, 1990-2014.....	355
Table S3.2.1 Natural glass compositions analyzed by EPMA and XRF for Kelud, 1990-2014.....	355
Table S3.2.2: Natural orthopyroxene compositions analyzed by EPMA for Kelud, 1990-2014	356
Table S3.2.3: Natural clinopyroxene compositions analyzed by EPMA for Kelud, 1990-2014	361
Table S3.2.4: Natural plagioclase compositions analyzed by EPMA for Kelud, 1990-2014.....	365
Table S3.2.5: Natural olivine compositions analyzed by EPMA for Kelud, 2014.....	371
Table S3.2.6: Natural amphibole compositions analyzed by EPMA for Kelud, 1990-2014.....	372
TABLE S3.3: PLAGIOCLASE TRAVERSE CHEMISTRY FROM 2007 DOME ROCK.	373
TABLE S3.4: WHOLE ROCK TRACE ELEMENT COMPOSITION OF 2007 AND 2014 SAMPLES.....	393
Table S3.4.1: Transition metals, semi-metals, immobile elements, alkaline (earth) elements	393
Table S3.4.2: REE, HFSE, Th, U, Pb, (semi-) metal elements	394
FIG. S3.4: COMPILATION OF BSE IMAGES OF PLAGIOCLASE TEXTURES, PLAGIOCLASE TRAVERSE ANALYSES, AND ELEMENTAL MAPS OF PLAGIOCLASE AND CRISTOBALITE FROM THE 2007 DOME	395

ABSTRACT

Our capacity to anticipate volcanic eruptions depends on accurate interpretation of unrest signals coupled with understanding of the magmatic system and processes. This is challenging for most volcanoes, including Kelud (Indonesia), that erupts effusively and explosively. In this thesis, I address some unknowns to this topic by quantitatively determining the magmatic processes, storage conditions, timescales, and ascent rates of three eruptions at Kelud (1990, 2007, 2014). I relate these variables to the time series of monitoring data for the same events. I show that explosive eruptions are likely driven by fluid accumulation and degassing that began months before eruption. I performed experiments to find that magma storage conditions for explosive and effusive eruptions were similar, and I demonstrate that ascent rates and viscosity vary with eruption style. These results can be used to improve volcanic hazard assessment and monitoring through robust petrology-based conceptual frameworks for different eruption styles.

INTRODUCTION

Active volcanoes are phenomena of outstanding natural beauty and provide abundant natural resources, but are also responsible for some of the most devastating catastrophes that have occurred in human history. For example, the eruption of Vesuvius in 79 CE devastated the Roman cities of Herculaneum and Pompeii and provided the first detailed narrative of a volcano's eruptive process by Pliny the Younger (Sigurdsson et al., 1982). Nevertheless, the very existence of population centres around an active volcano such as Vesuvius indicates that humans have long exploited resources provided by volcanoes. Despite the many hazards associated with volcanoes and their eruptions, there is an increasing trend in the concentration of human population living close to active volcanoes (Freire et al., 2019).

Southeast Asia, which sits on the 'Pacific Ring of Fire' subduction zone, is home to ~750 active volcanoes as well as densely populated cities near them, including Jakarta (Java, Indonesia), Manila (Luzon, the Philippines), and Padang (Sumatra, Indonesia) (Whelley et al., 2015) (Fig. 1.1). Therefore, volcano hazard mitigation is essential towards reducing risk to the general populations from volcanic eruptions. Examples of past successes in mitigating volcanic hazards from eruptions in this region has been the result of synergy between the community, civil protection agencies, and the local government (e.g. Andreastuti et al., 2016; Leone and Gaillard, 1999), as well as improvements in monitoring techniques and approaches towards eruption forecasting (e.g. Boué et al., 2016; Nakamichi et al., 2017a; Sparks, 2003). Still, anticipating eruptions from many volcanoes is challenging, with issues that include limitations in the existing monitoring network, sparse past monitoring records, unknown eruption history, or a lack of understanding in the magmatic processes and timescales behind volcanic eruptions. For the latter case, petrologic studies of erupted rocks are crucial in illuminating relevant aspects of the magmatic system, including its structure, magma dynamics, and the relationship between pre-eruptive processes and the recorded unrest.

Figure 1.1: Map of Southeast Asia, adapted after Whelley et al. (2015), showing the major cities of Jakarta, Padang, and Manila (turquoise stars) and their location relative to active volcanoes.

Erupted rocks preserve the textural and geochemical information on the magmatic sources, trajectories of geochemical evolution, and the magmatic processes leading up to the eruption. Most petrologic studies of volcanic eruptions are conducted sometime after the eruption has ended, focusing on the retrospective interpretation of the pre-eruptive processes leading up to that eruption, for example in Merapi, Pinatubo, and Calbuco (e.g. Costa et al., 2013a; Namur et al., 2020; Scaillet and Evans, 1999). The aim of these studies is to use the knowledge gained from past eruptions to provide information on the structure of the magmatic system and the possible scenarios of a future eruption. In rare cases where a volcano is already erupting, such as in the 2018 Kilauea Lower East Rift Zone eruption (Gansecki et al., 2019) near real-time ‘petrologic monitoring’ of erupted lavas can be done in as rapidly as hours after the eruption. Information gathered reveals significant changes in magma system as the eruption progresses; the magmatic sources feeding the eruption; the geochemical evolution of erupted lavas over time; and the

changes in temperature and viscosity of the lava. Deciphering the “petrologic puzzle” behind eruptions can provide the necessary context in assessing whether a volcanic system with unrest could culminate in an eruption, or how it proceeds once the eruption commences.

The precursory unrest before an eruption reflects the magmatic system’s response from fluid movement and magma ascent through the crust prior to eruption. Unrest signals manifest as heightened seismicity, deformation, gas emissions, gravity changes, and changes in the chemistry and temperatures of lakes and springs close to the volcano, among others (Newhall et al., 2017). To capture these signals, an integrated monitoring network of geodetic, geophysical, geochemical instruments are commonly installed on the volcano. Interpretation of the resulting time-series of monitoring data provide key insights into the possible shallow subsurface activity during periods of repose and unrest prior to eruptions. Different types of unrest patterns have been identified from a global survey of volcanic unrest data (Newhall et al., 2017; Phillipson et al., 2013), which includes reawakening unrest, prolonged unrest, pulsatory unrest, and sporadic unrest. Volcanoes have also been classified as having “slow” (up to decades-long) and “fast” (up to month-long) volcanic activity according to their volatile content, ascent rate, timescale, and the possibility of a separate pre-eruptive volatile phase, which can control parameters such as overpressure, explosivity, and magma extraction process (Stix, 2018). Positive correlations have been observed between factors such as the whole rock silica content, repose time – the longer the repose time is associated with more evolved, and higher, whole rock silica content (Passarelli and Brodsky, 2012). For processes involving exsolution of volatiles, precursory activity can migrate faster than magma movement, meaning that precursory unrest can arise long before magma moved towards the surface (Menand and Tait, 2001).

Some volcanoes are preceded by months-long unrest, but intriguingly underwent short escalation time before eruption. Volcanoes such as Kelud in Indonesia spend most of its inter-eruptive period in quiescence (e.g. Arzilli et al., 2019; Hidayati et al., 2018a; Maeno et al., 2019a; Matoza et al., 2018), but enters into unrest phase up to three months before eruption. By contrast, the escalation time between the onset of unrest to a Plinian-style eruption last a mere few hours. This eruption pattern alone makes Kelud volcano one of Southeast Asia’s most hazardous volcano, with a historical record of > 30 explosive eruptions since 1000 CE, giving a recurrence

interval of ~23 years (Global Volcanism Program, 2013a; Maeno et al., 2019a). In addition to explosive eruptions, Kelud has also extruded rare lava domes, which adds to the enigmatic nature of its magmatic system and its relation to eruption styles. The combination explosive and effusive eruptions with the short escalation time preceding explosive eruptions at Kelud means anticipating eruptions is especially challenging. Thus, further investigation into the relationship between petrology and volcanic unrest is critical, with implications towards improving monitoring approaches and hazard assessment for Kelud and volcanoes with similar eruption histories.

Objectives

This PhD thesis aims to improve our understanding of the magmatic processes of volcanoes with explosive eruptions that are preceded by short unrest escalation times, but also “slower” dome extrusions. I focus primarily on the three most recent eruptions at Kelud volcano in Indonesia as a case study. To address the overarching aim, I focus on three main issues related to Kelud volcano: 1) the relationship between processes and timescales to unrest signals; 2) magmatic storage conditions of explosive and effusive eruptions; and 3) the relationship between ascent rates and eruption styles. I expect that the implications of findings from this thesis will aid in hazard assessments, eruption forecasting, and evaluations of existing monitoring network at Kelud and volcanoes that exhibit similar eruption styles, such as Calbuco in Chile (Arzilli et al., 2019), Galeras in Colombia (Stix et al., 1993), and volcanoes around the western Mexican Volcanic Belt (Waters and Lange, 2013) .

The first study (Chapter 2) aims to correlate petrology and monitoring records for a typical explosive eruption at Kelud. The 1990 eruption was a typical Plinian style (VEI 4) eruption preceded by limited unrest signals, and many unknowns persist concerning the pre-eruptive processes and timescales related to this eruption style. I evaluate both the petrologic and monitoring records to determine the processes and role of volatiles in driving explosive eruptions at Kelud. I also estimate diffusion timescales from zoned orthopyroxenes and correlate them with unrest preceding the 1990 eruption. My findings show that explosive eruptions at Kelud are driven by fluid accumulation from degassing and fluid flushing from deeper to shallower parts of

the system, and diffusion timescales from zoned orthopyroxenes reflect this process.

The second study (Chapter 3) aims to constrain the storage conditions of explosive and effusive eruptions using phase equilibrium experiments to explore the role of whether the magmatic storage conditions (temperature, pressure, water content) in controlling eruption styles. I use phase equilibria experiments to derive the storage conditions for the three most recent eruptions (1990 Plinian, 2007 dome, and 2014 Plinian) at Kelud to compare the storage conditions between explosive and effusive eruptions. I show that effusive and explosive eruptions share similar pre-eruptive storage conditions. However, I find that explosive eruptions at Kelud have an excess fluid phase, whereas lava domes have re-equilibrated and outgassed most of its water content in the melt.

Finally, the third study (Chapter 4) aims to constrain magma ascent rates of effusive and explosive eruptions, as they have been shown to control eruption styles at many volcanoes. Yet the relationship between ascent rates and eruption styles have not been investigated in detail for Kelud volcano. I use the mineral apatite to constrain timescales of ascent and ascent rates for the 2007 dome magma, and for the 1990 and 2014 explosive eruptions. I show that the timescales estimated from apatite can be correlated with unrest signals and show that the different eruption styles imply very different magma ascent rates.

**CHAPTER 2: Fluid fluxing and accumulation drive decadal and short-lived
explosive basaltic andesite eruptions preceded by limited volcanic unrest**

Fluid fluxing and accumulation drive decadal and short-lived explosive basaltic andesite eruptions preceded by limited volcanic unrest

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Running Title: Fluid fluxing and accumulation at Kelud Volcano

Keywords: volcano monitoring; magma storage conditions; diffusion timescales; Kelud; Kelut

ABSTRACT

Some volcanoes are known for repeatedly producing explosive but short-lived eruptions (< half a day) every decade or so. These eruptions are often preceded by limited unrest signals and short run-up times to eruption (a few hours to months), and thus they are difficult to anticipate. Some well-documented examples are the 1990 and 2014 eruptions of Kelud volcano in Indonesia, or the 2015 Calbuco eruption in Chile. Here we interrogate the rock record and obtain insights into the processes and pre-eruptive conditions that led to the 1990 Kelud eruption, which we integrate with monitoring data (seismicity, lake temperature and hydro-acoustics, sulfur emissions) towards a conceptual model for this type of events. Mineral-melt geothermobarometers indicate that the basaltic andesite magma carried a crystal cargo from as deep as 15-19 km, and reached volatile saturation at 4-9 km with 2-4 wt. % water in the melt. The textures and compositional zoning of orthopyroxene and plagioclase do not support intrusion of more primitive magma as the driver for the eruption, and we instead propose that pre-eruptive fluid accumulation at the and high-temperature fluid fluxing from depth (likely dominated by CO₂) played a major role in priming the eruption to occur. Such pre-eruptive gas accumulation is also supported by mass balance calculation of the emitted excess SO₂ gas. Mg-Fe diffusion profiles in reversely zoned pyroxenes constrain timescales of weeks to months before eruption for fluid addition to the shallow reservoir, and such events may be recorded in the monitoring signals, especially in the change of hydroacoustics and water lake temperature, and probably in the seismic swarms. We propose that fluid exsolution and accumulation in the shallow reservoir plays a crucial role in modulating and triggering short-lived explosive eruptions with brief unrest at Kelud and probably other volcanoes worldwide.

2.1. Introduction

Explosive eruptions can generate lethal hazards, and thus special attention is needed to monitor and properly interpret the signs of unrest in anticipation of the eruption (Jolly and de la Cruz, 2015). Yet for many eruptions, dedicated volcano monitoring efforts are not enough to anticipate their explosivity, when the eruption will occur, and how it will progress with time. This is partly because the relationship between the magmatic processes controlling the eruptions and

associated unrest patterns are poorly understood. Explosive eruptions can often be preceded by a wide range of unrest patterns, from abrupt to gradual to progressive changes in precursory signals over timescales varying from a few days to years before eruption for example in Merapi 2006 vs 2010 (Indonesia) (Ratdomopurbo *et al.*, 2013; Surono *et al.*, 2012). Some explosive eruptions are preceded by exceptionally short run-up times (a few hours to a few weeks), which makes it extremely challenging for civil protection authorities to advise communities, given the limited time to activate mitigation plans.

Kelud volcano, located in East Java (Indonesia) is part of the Sunda arc volcanoes, and a good example of a volcanic system that has produced two explosive eruptions that were preceded by short unrest in 1990 and 2014. For example, before the event in 2014, volcano-tectonic earthquakes abruptly spiked starting from 3rd February, dissipating until 10 February, before a final spike in seismicity occurred a couple of hours before the eruption at 22:50 on 13 February (e.g. Cassidy *et al.*, 2019; Hidayati *et al.*, 2018; Maeno *et al.*, 2016). Such a pattern is observed at other subduction zone volcanoes in the world (Passarelli and Brodsky, 2012, and references therein) such as Calbuco volcano in Chile, which erupted explosively in 2015, and had very short run up times of seismicity a few hours before its first explosive phase that produced a volcanic cloud column > 20 km tall (Arzilli *et al.*, 2019; Morgado *et al.*, 2019a, 2019b; Pardini *et al.*, 2018).

The link between magmatic processes, unrest signals and the explosive dynamics of these eruptions can be elucidated by combining various types of information: the whole-rock, mineral compositions, and textures combined with timescale indicators (e.g. Albert *et al.*, 2016; Kahl *et al.*, 2013; Rasmussen *et al.*, 2018); thermobarometric constraints and geophysical models (Chiarabba *et al.*, 2004; Patané *et al.*, 2003; Widiyantoro *et al.*, 2018); petrological estimates of magma degassing compared to satellite measurements of volatile emissions (Caricchi *et al.*, 2014; Jay *et al.*, 2014); petrological indicators of magma volume, timescales and processes compared to unrest signals from monitoring records (Cheng and Costa, 2019; Kahl *et al.*, 2011). Such integrative approaches have been applied to investigate the processes and mechanisms that lead to different eruptions at a variety of volcanoes (e.g. Costa *et al.*, 2020), including Mt Etna (Kahl *et al.*, 2013), Eyjafjallajökull (Pankhurst *et al.*, 2018), Mt. St. Helens (Saunders *et al.*, 2012),

Ruapehu (Kilgour *et al.*, 2014), Shishaldin (Rasmussen *et al.*, 2018), Piton de la Fournaise (Albert *et al.*, 2019), or Kilauea. For many of these examples renewed mafic magma injection is proposed to be the main driving mechanism for the eruption.

Here we provide new constraints on the pre-eruptive conditions and the driving mechanism of the 1990 explosive eruption of Kelud, based on detailed investigations of its eruption deposits, minerals, and glass. We also obtain timescales for the magmatic processes which we combine with the instrumentally recorded unrest signals to propose a conceptual model for the eruption. We show that fluid accumulation in the upper parts of the reservoir during years of repose and fluxing of deep fluids that are likely CO₂ dominated may play a key role in promoting and driving the recurrent, short-lived explosive eruptions at Kelud. Such fluid accumulation and fluxing may be recognized in the monitoring signals recorded in the crater lake before the eruption. Our findings may thus be of importance towards a better understanding of future eruptions at Kelud and of analogous events other volcanoes worldwide.

2.2. Geological Setting

2.2.1 Kelud volcano and lake

Kelud is a basaltic andesite stratovolcanic complex located in East Java (Indonesia) as part of the Sunda Arc subduction zone volcanoes, and has been classified as semi-plugged as there is no significant degassing during repose periods (Whelley *et al.*, 2015) (Fig. 2.1). The current edifice consists of two highly excavated craters (Kawah Dargo being the main one) with a westward opening, surrounded by four crypto-domes (Sumbing, Lirang, Gajah Mungkur, and Umbuk) (Wirakusumah, 1991). The location and age of the nearest crypto-domes indicate a clockwise shift of eruptive centres over time, from the earliest crypto-dome (Gunung Lirang, 238 ky) to the current crater (Global Volcanism Program, 2013; Wirakusumah, 1991). More distal parasitic domes, such as the Gunung Umbuk show evidence for flank volcanic activity at ~39 kya (Wirakusumah, 1991). The valleys around the volcano are highly incised and steeply dipping, showing that the edifice is being actively eroded. Kelud hosts one of the few neutral pH volcanic lakes in the world, whose volume averaged $\sim 2.5 \times 10^6 \text{ m}^3$ prior to the 1990 eruption (Bourdier *et al.*, 1997). Bernard and Mazot (2004) identified two hydrothermal systems feeding the pre-1990

crater lake: a deep Li-B-enriched alkali-chloride hydrothermal system, and a shallow Ca-Mg sulfate dominated hydrothermal system. The neutral pH indicates that an impermeable barrier exists somewhere between the magma reservoir and the shallow conduit of Kelud. After the devastating 1919 eruption (5,160 casualties), a drainage tunnel system was constructed to drain the lake level and reduce the hazards from lahars during future eruptions. This drainage system was further deepened after the 1966 eruption (Caudron et al., 2012).

Fig. 2.1: Map of 1990-2014 volcanic deposits at Kelud volcano showing the distribution of the 1990 deposits from tephra fall and pyroclastic density currents (PDC) as documented by Bourdier et al. (1997). These are overlain by pyroclastic density flows from the 2014 eruption (defined as Stage 1 and 3). Regions of flattened trees were digitized from Maeno et al. (2017). The Lirang seismic station was the single station with interpretable seismic data in 1990 (Lesage & Surono, 1995). Inset map shows the location of Kelud in the island of Java, Indonesia.

2.2.2 Historical eruptions and hazards from Kelud

Kelud has erupted around 34 times since 1000 CE and all events were highly explosive

except for two dome extrusions in 1920 and 2007 (Global Volcanism Program, 2013). Most eruptions generated a range of hazards, including lahars, landslides, ash fall, ballistics, and pyroclastic density currents (Global Volcanism Program, 2013). Lahars generated by the mixing of eruptive deposits with lake water have caused most of the fatalities, killing 5160 people in 1919, and up to 10,000 people in 1586 (Global Volcanism Program, 2013). Ashfall has produced widespread damage to the surrounding villages and cities (e.g. Blake *et al.*, 2015; Bourdier *et al.*, 1997; Pardyanto, 1990; Williams *et al.*, 2020), with roof collapse due to ash accumulation killing 32 people in 1990. Ash also forms unconsolidated deposits that become washed down the flanks and the steep-sided valleys by heavy rains, forming cold lahars (Thouret *et al.*, 1998). Pyroclastic density currents usually remain confined to inside the crater or proximal areas (Bourdier *et al.*, 1997; Maeno *et al.*, 2016). The last eruption in 2014 generated a 17-km high volcanic column, promoting ash circulation within the troposphere for several months (Kristiansen *et al.*, 2015; Vernier *et al.*, 2016) and causing extensive damage to infrastructure networks across multiple cities in Java (Blake *et al.*, 2015). Despite its suddenness and widespread impact more than 160,000 people were evacuated in less than two hours, thanks to the high level of preparedness and coordination by the Centre for Volcanology and Geological Hazard Mitigation (CVGHM) (Andreastuti *et al.*, 2016).

2.2.3 The 1990 eruption

This eruption ejected a total volcanic volume of 0.13 km³ dense rock equivalent (DRE) (Bourdier *et al.*, 1997), and released a total of ~170 kt of SO₂ into the troposphere according to satellite data (Global Volcanism Program, 2013). The unrest period leading up to the February 1990 eruption of Kelud was characterized by changes of the crater lake, hydroacoustics anomalies, and seismic swarms. According to Vandemeulebrouck *et al.* (2000) the unrest might have started in April 1989 with an increase in baseline of low frequency hydroacoustics signals, probably due to the onset of gas rising up and early boiling of the lake water. Four main stages can be recognized in the sequence of events that led to the 1990 eruption of Kelud (Table S2.1). All reported times refer to local time (GMT+7):

1. Main unrest phase (November 1989 - January 1990): this was marked by an increased

number of daily earthquakes and the appearance of two seismic swarms in December 1989, and then January 1990. Lesage & Surono (1995) attributed these swarms to fracturing of a brittle plug blocking the volcano conduit. Changes were also observed in the chemistry, pH, and color of the lake (Badrudin, 1994; Kadarsetia *et al.*, 2006). The lake bottom and surface temperature increased from 30°C to 60°C and from 30°C to 48°C, respectively (Pardyanto, 1990). Vandemeulebrouck *et al.* (2000) interpreted the increasing hydroacoustic signals in the high-frequency band as due to increased gas bubbling in a convective column, and signals in the ultrasonic frequency bands as related to pressure variations in the hydrothermal system.

2. Temporary quiescence (January - 9 February 1990): this lasted about three weeks and both seismic and hydroacoustic signals decreased to their background levels.
3. Escalation (9-10 February 1990): Renewed unrest suddenly started after midnight on 9th February with > 400 low magnitude earthquakes recorded until 9:00 am on 10th February, the day of the eruption (Lesage & Surono, 1995). In response, the Volcanological Survey of Indonesia ordered an evacuation at 10:00 am (Pardyanto, 1990).
4. The eruption (10 February 1990): The eruption started at 11:41 am, with seven phreatomagmatic explosions in one hour. From 12:35 pm, it then rapidly developed as a sub-Plinian magmatic phase with a 10-km high column and lasted until 5:00 pm and its collapse generated pyroclastic flows, (Global Volcanism Program 1990; Pardyanto 1990; Lesage & Surono 1995). Tephra of lapilli size fell on Margomulyo Volcano Observatory, about 7 km west of the crater, until 5:00 pm, and ash continued to fall during the night. After this major phase, smaller discrete explosive outbursts occurred on the 11th and 12th February, which produced incandescent tephra and lightning (Global Volcanism Program, 1990). The main phase of the eruption ended around March 1990 (Global Volcanism Program, 2013), having completely emptied the crater lake and generated syn-eruptive hot lahars.
5. Heavy tropical rainfalls subsequently remobilized the fresh pyroclastic deposits to produce 33 cold lahars episodes until 28th March (Thouret *et al.*, 1998). After the eruption, a new magmatic plug had solidified in the excavated crater and a new lake gradually reformed

(Bourdier *et al.*, 1997). According to the Volcano Survey of Indonesia, the eruption ended at the end of March 1990 (Global Volcanism Program, 1990).

2.3. Methodology

2.3.1 Sampling Strategy

The studied rock samples were taken from a vertical outcrop in the southwestern part of Kelud's main crater that provides access to deposits from the 1951 to 1990 eruptions (Fig. 2.2). The studied outcrop was protected by dense vegetation before the 2014 eruption, and afterwards, by trees blown down by that eruption (Maeno *et al.*, 2016).

Fig. 2.2: (a) Photograph of the main 1990 outcrop sampled for this study, overlying the previous deposits from 1966 and 1951 eruption deposits. (b) schematic diagram of the 1990 stratigraphic units showing our sample distribution and names (adapted from Bourdier *et al.*, 1997). All samples except for PL2 derive from the main eruption stage in the pumice flow and fall deposits, while PL2 (in bold) representing the late eruption stage is found embedded in the pumice fall deposit. Only the pumice fall (P) and pumice flow (PF) units are shown in the outcrop photograph.

The 1951 deposit is made of beds of ash and blocks, gently dipping downward from the edifice, and contains both unaltered white pumices (> 64 mm), oxidized red pumices, and dark ones partially covered by soil and organic matter. Entrained lithic clasts (< 64 mm) and charcoal are minor components. A paleosol horizon separates the 1951 eruption deposit from the overlying 1966 eruption deposit. The latter deposit consists of massive to weakly bedded ash and block layers, containing bomb-sized pumice blocks and lithic clasts of comparable sizes. The 1966 pumices are light grey to white porphyritic blocks. Another paleosol horizon separates products from the 1966 and 1990 eruptions. The 1990 deposit gently dips downward from the crater and consists of a mixture of ash and poorly to moderately-sorted grey to white pumice blocks, together with entrained charcoal and lithics. Pumice clasts range from sub-rounded lapilli to bomb-sized pumices blocks (up to 15 cm), embedded in a mixture of ash and smaller pumice fragments. Lithic ejecta are sub-rounded to sub-angular porphyritic andesites. We interpreted this lens as the *pumice flow layer* previously described by Bourdier *et al.* (1997). This layer is overlain by an upward dipping, clast-dominated bed containing sub-rounded to rounded lapilli- to bomb-sized pumice clasts, as well as lithics. We interpret this upper bed as the *pumice fall layer* described by Bourdier *et al.* (1997) in their composite stratigraphy.

We found two types of pumices within the 1990 deposits: (i) a volumetrically prevalent, light and vesicular pumice, and (ii) a volumetrically minor, relatively dense but frothy and vesicular pumice. Combining our observations with the composite stratigraphy of Bourdier *et al.* (1997), we consider the prevalent pumice component as representative for the main eruption stage, whereas the minor pumice component represents the late eruption stage. Thereafter, we refer to these samples as “main-stage” and “late-stage”. We studied six pumice samples from the main-stage and one from the late-stage. Our samples were collected from the outcrop described above during a field campaign in October 2017 and were complemented by samples previously collected by Humaida (2013), which has been ascribed as being coeval to the . Lithic clasts are fragments of either past lava flows excavated during the eruption or fragments of the plug that blocked the conduit (Lesage & Surono, 1995). The 1990 deposit stratigraphy closely resembles that of the subsequent 2014 eruption, compiled by Maeno *et al.* (2017) and Goode *et al.* (2018). We did not find scoriaceous pumice clasts in the 1990 deposit, but Bourdier *et al.* (1997) found scoria

deposits in other outcrops, which were included in their composite stratigraphic column. Scoria was also produced during the 2014 eruption and lapilli-sized clasts were found around the crater floor.

2.3.2 Analytical Methodology

2.3.2.1 Bulk sample characterization

Point counting was conducted on standard polished petrographic thin sections to determine the areal proportions of minerals and groundmass (> 1400 point per thin section), using a Pelcon mechanical point counting stage, and the JMicrovision software on optical images of the thin sections. Whole-rock major and trace element compositions were analyzed using X-Ray Fluorescence (XRF) with fused lithium methaborate/tetraborate discs – and inductively coupled plasma mass spectrometer (ICP-MS) at the Activation Laboratory in Ancaster, Ontario (Canada) following the approach outlined in Norrish and Hutton (1969). There was no alteration on the samples, and thus no additional steps were taken other than cutting the pumices into small 50 x 40 mm billets needed for whole rock analyses. All other preparation steps, including crushing and powdering, was done at Activation Laboratory.

2.3.2.2 Textures, mineral and glass chemistry

Minerals and textures of interest were characterized and imaged using the JEOL JSM-7800F field emission scanning electron microscope (SEM) at the Asian School of the Environment, Nanyang Technological University (NTU), Singapore. We used an accelerating voltage of 15 kV, 20nA current to obtain back-scattered electron (BSE) images of various parts of the sample. Minerals and glasses were analyzed in both spot and traverse modes using a JEOL-JXA 8530F field emission EPMA at the Facility for Analysis Characterization Testing & Simulation (FACTS) at NTU. We determined the major element composition of plagioclase (Plag, $n = 388$), orthopyroxene (Opx, $n = 1628$), clinopyroxene (Cpx, $n = 639$), Fe-Ti oxides (magnetite – Mag, $n = 53$; ilmenite – Ilm, $n = 35$), and amphibole (Amph, $n = 20$). Quartz (Qz) was identified but not analyzed. Point and traverse analyses of Opx and Cpx were made with a focused beam of about 1 mm, accelerating voltage of 15 kV and a current of 20 nA. The relative errors for pyroxene

analysis are 0.2-6% for Si, Al, Ca, Mg, Fe, and Mn; and 1-64% for Na, Ti, and K. For plagioclase, Mag, and Ilm analysis we used the same beam size and accelerating voltage, but with a 10 nA beam current. Relative errors for Fe-Ti mineral analysis are 0.2-7% for Fe, Ti, and Mg; 2-24% for Mn, Al and Si; and 8-99% for Cr. For Plag analysis, the relative errors are 0.4-4% for Si, Al, Na, Ca, and Fe, whereas for Mg and K, the relative errors are 1-55%. Amph was analyzed with a beam of 1 to 5 mm, a 15 kV accelerating voltage, and a 10nA beam current. The relative errors are 0.4-6% for all major element oxide contents in Amph, except for Cr₂O₃, where they are 13-62%. The relative error for halogens in Amph are 32-56% for Cl and 19-58% for F. The EPMA standard reference materials for pyroxene and Amph analyses came from P & H (diopside – Si, Ca, Mg; corundum - Al, albite – Na, rutile - Ti, specularite - Fe, rhodonite - Mn, Chromium oxide - Cr, and orthoclase – K, fluorite – F, halite - Cl). The standard reference materials for Plag, came from P & H (albite – Na, Al, Si; wollastonite - Ca, orthoclase - K and olivine - Mg) and Astimex (olivine – Mg, Fe, plagioclase - Ca). The standard reference materials for Fe-Ti oxides came from Astimex (Almandine - Al, Si; titanium – Ti, diopside – Mg, chromium oxide – Cr; magnetite – Fe, rhodonite – Mn).

Chemical indicators used to characterize the minerals were calculated from standard structural formulae (Deer *et al.*, 1992). Pyroxenes are characterized by Mg-number ($Mg \# = 100 \times Mg / [Mg + Fe^*]$ in mol, where Fe* is total iron as Fe²⁺), and their proportions of wollastonite ($Wo = 100 \times Ca / [Ca + Mg + Fe^*]$ in mol), enstatite ($En = 100 \times Mg / [Ca + Mg + Fe^*]$ in mol), and ferrosilite ($Fs = 100 \times Fe^* / [Ca + Mg + Fe^*]$ in mol). Plag composition is described with the anorthite content ($An = 100 \times Ca / [Ca + Na]$ in mol). For magnetite we computed the *ülvöspinel* component, $X_{usp} = 3 \times Ti / (Ti + Fe^*)$, and for ilmenite, $X_{ilm} = 2 \times Ti / (Ti + Fe^*)$, following Sauerzapf *et al.* (2008). For amphibole, we used the structural formulae of Leake *et al.* (1997) as included in Ridolfi *et al.* (2010).

Glass inclusions hosted in Cpx and interstitial glass were analyzed using a defocused beam of 10 mm, an accelerating voltage of 6 kV and a current of 5 nA. The following elements were analyzed: Si, Al, Ca, Na, K, Fe*, Mg, Mn, Ti, P, Cl, and S, with Na analyzed first to account for Na migration during analyses. Melt inclusion compositions were corrected for post-entrapment crystallization of the host mineral along the melt inclusion walls by adding back the weighted

pyroxene composition to the melt inclusion composition (e.g. Bucholz *et al.*, 2013; Esposito *et al.*, 2014; Gaetani & Watson, 2000). A hypothetical groundmass composition of each sample was obtained by subtracting the median major oxide compositions of the phenocrysts (Plag + Opx + Cpx + Mag), weighted to their modal abundances, from the whole-rock composition. For a few samples whose whole rock compositions was not available (samples 90-2 and 90-20), we used the average composition of all 1990 samples reported by Humaida (2013). Such composition was used where appropriated to calculate some intensive variables of the magma.

2.3.3 Geothermobarometry and magma storage conditions

2.3.3.1 Mineral geothermobarometers

The pre-eruptive conditions of magma storage (temperature, T; pressure, P; oxygen fugacity, fO_2 , and melt water content) were inferred using a combined approach of rhyolite-MELTS thermodynamic software (Gualda *et al.*, 2012), nine mineral/melt geothermobarometers, oxybarometers, and a hygrometer, as described below. Reliable application of these geothermobarometers and volatile calculations require assessment of equilibrium. For mineral-mineral pairs, calculations were done using the core-core or rim-rim compositions of touching grains, where available. For mineral-melt pairs from the main-stage pumices, crystal core compositions were paired with the whole-rock compositions, and crystal rim compositions were paired with the measured interstitial glass composition. For late-stage samples, rim and microlite compositions were paired with the calculated groundmass composition rather than the measured interstitial glass, because we found that the latter was too evolved to be in equilibrium with the phenocrysts.

Pyroxene-melt equilibrium was tested using the Mg/Fe* distribution coefficient (Kd) defined as:

$$Kd_{crystal-melt} = \frac{X_{Fe}^{crystal} X_{Mg}^{melt}}{X_{Mg}^{crystal} X_{Fe}^{melt}} \quad (1)$$

where X is the mol fraction for the relevant mineral-melt and mineral-mineral pairs using

$Kd_{cpx-melt} = 0.28 \pm 0.08$ and $Kd_{opx-melt} = 0.29 \pm 0.06$ (Putirka 2008). For Opx- and Cpx-melt

geothermometers (equations 28a and 33 in Putirka (2008), respectively), we fixed the $\text{Fe}^{2+}/\text{Fe}_{\text{total}}$ of the melts at the $f\text{O}_2$ reaction buffer constrained by Fe-Ti oxides equilibria as determined in late-stage pumices (Sauerzapf *et al.*, 2008). We also added 3 wt. % water into the melt according to hygrometer results (see below). Varying the water content in the melt by ± 1 wt. % changes the calculated temperature by $< 15^\circ\text{C}$ for pyroxene-melt geothermometers. The standard errors on temperatures estimated from the Cpx-melt and Opx-melt geothermometers are $\pm 42^\circ\text{C}$ and $\pm 48^\circ\text{C}$ (Putirka, 2008), respectively. For all pyroxene-based geothermometers, the pressure was fixed at 100 MPa. A pressure change of ± 100 MPa results in a temperature change of $\pm 5^\circ\text{C}$. No adjacent Opx-Cpx crystals appear to be in equilibrium using the Kd criterion of Putirka (2008). Instead, we used the QUILF algorithm of Andersen *et al.* (1993) and we only report the temperatures for which the calculated and expected pyroxene compositions are similar within analytical uncertainty and give T errors $< 25^\circ\text{C}$.

For the amphibole-melt geothermobarometry, using the Mg-Fe* $Kd_{\text{Amph-melt}}$ of Putirka (2016) resulted in a very wide range of possible equilibrium melts. We thus used an additional equilibrium test based on the exchange of Si/Al (mol) ($Kd_{\text{Amph-melt}} = 0.96 \pm 0.04$; Li *et al.*, 2021), from which we verified the Amph phenocrysts to be in equilibrium with the whole rock. We also applied the Amph geothermobarometry formulations of Ridolfi & Renzulli (2012) and Ridolfi *et al.* (2010) and we accepted all results that fulfilled the structural formulae of Ridolfi *et al.* (2010).

The $f\text{O}_2$ and temperature for the late-stage pumices were calculated from co-existing Mag-Ilm pairs and the oxybarometers calibrations of Sauerzapf *et al.* (2008), and Ghiorso & Evans (2008). We also used the Plag-melt hygrometer of Waters & Lange (2015) to determine the pre-eruptive water content of the melt. For this, we considered the compositions of the crystal rims, and of the interstitial glass, together with the temperatures given by the Opx-melt geothermometer for the main-stage pumices, and by Fe-Ti oxides for the late-stage pumices. The calculated water content, temperature, and interstitial glass compositions were then combined with the $\text{H}_2\text{O}-\text{CO}_2$ saturation model of Ghiorso & Gualda (2015) in the MagmaSat application to estimate volatile saturation pressures. For some computations we considered the maximum CO_2 concentration (336 mg/kg) measured by Cassidy *et al.* (2016) in plagioclase-hosted melt inclusions of the 2014

products. We recognize that this may not be directly applicable to the 1990 eruption, and that is likely a minimal value for the melt, since no corrections was made for the potential CO₂ present in the bubble (e.g. Bucholz *et al.*, 2013; Gaetani *et al.*, 2012; Lloyd *et al.*, 2013).

2.3.4 Pyroxene diffusion modeling and calculations of timescales

The timescales of Fe-Mg re-equilibration in Opx and Cpx were obtained from our measured crystal zoning profiles and the diffusion model approaches described in Costa *et al.* (2008) and Flaherty *et al.* (2018). A total of 38 reversely zoned crystal profiles were used: 22 in the main-stage samples (Opx = 20, Cpx = 2), and 16 in the late-stage samples (Opx = 14, Cpx = 2). We used the zoning in Mg-number of rim-to-core profiles approximately perpendicular to the crystal *c*-axis (along *a* or *b* axis) since this is deemed to be the slowest diffusion direction and the least affected by 2D or 3D diffusion (cf. Krimer & Costa, 2017). For initial profile geometries, we used sharp step functions across two well-defined compositional plateaus that are close to the observed zoning profile shape and thus have less uncertainty (Costa & Morgan, 2010). We performed independent checks of the geometry and position of initial Mg-number distributions by comparing to Al₂O₃, which is a slower diffusing component and thus likely closer the initial profile that would be related to growth. As a boundary condition we assumed a constant composition at the crystal rim. We thus obtained a range of diffusion timescales around a best fit for each profile with the analytical uncertainty and diffusion coefficients determined following Flaherty *et al.* (2018).

For profiles in Opx crystals we used the Fe-Mg diffusion coefficient formulations of Dohmen *et al.* (2017) including the correction for composition, as well as the formulations of Ganguly & Tazzoli (1994) which give 2-3 times shorter diffusion timescales at the range of composition, temperature, and *f*O₂ values at Kelud. Fe-Mg zoning in Cpx crystals was modeled by using the diffusion coefficient of Müller *et al.* (2013), assuming isotropic diffusion. A mean rim temperature of $T = 979 \pm 48^\circ\text{C}$ was used for modeling according to Opx rim-melt temperatures we have obtained (see below), with the *f*O₂ buffered at NNO +1 ($\log f\text{O}_2 = -9.60$) according to the formulation of O'Neill & Pownceby (1993). For the late-stage Opx, we used a mean temperature of $T = 972 \pm 48^\circ\text{C}$ calculated from the rim and calculated melt pairs, also with *f*O₂ at the same

buffer ($\log fO_2 = -9.70$). The late-stage interstitial glass is too evolved to be in equilibrium with the pyroxenes. Data for modeling the Cpx crystals is from one sample (90-23) for which Cpx-melt temperatures average $1023 \pm 42^\circ\text{C}$ for the main-stage and $976 \pm 42^\circ\text{C}$ for the late-stage, all according to our geothermobarometry results presented in further sections.

2.3.5 Calculation of exsolved fluid using SO_2 mass balance

We computed the mass of fluid exsolved from the melt by using the petrologic method (Devine *et al.*, 1984). The highest sulphur concentration in Cpx-hosted melt inclusions was taken to represent the pre-eruptive S content of the melt and the sulphur concentration of the interstitial glass to represent the degassed melt. The total amount of sulphur (as SO_2) outgassed during the 1990 eruption is given by the sulphur loss per unit mass of magma normalized to the residual melt proportions and multiplied by the DRE volume of the eruption. We compared our petrologic estimate of the outgassed amount of SO_2 with the total SO_2 emissions measured from space (0.17 Mt; TOMS, Global Volcanism Program, 2013) to evaluate the presence of an exsolved fluid phase prior to eruption (e.g. Costa *et al.*, 2003; Costa *et al.*, 2013; Jay *et al.*, 2014).

2.4. Results

2.4.1 Petrology, mineralogy, and geochemistry of main- and late-stage pumices

2.4.1.1 Whole rock and glass chemistry

The whole rock composition of both, the main- and late-stage pumices is basaltic andesite (Table 2.2 and Fig. 2.3a), with 54-56 wt. % SiO_2 , a total alkali silica ($\text{Na}_2\text{O} + \text{K}_2\text{O}$) of ~4 wt. %, and a K_2O content that straddles the boundary between the low- to mid-K series (Fig. 2.3b). Other major oxides show limited compositional variability (8-9 wt. % CaO , 2-4 wt.% MgO , 18-19 wt.% Al_2O_3 , and 9-10 wt.% FeO^*) (Table 2.2, Fig. 2.3c-f). Interstitial glass and melt inclusions from the main-stage samples are more evolved than the corresponding whole rock, ranging in composition from dacite to rhyolite (Fig. 2.3a). The late-stage pumices are slightly more evolved than the main-stage ones, and the interstitial glasses contain <1 wt. % of MgO , FeO^* and CaO . The calculated groundmass melts obtained by subtracting phenocrysts from the whole rock are

also dacitic (Table S2.3), and are compositionally intermediate between the whole rock and the measured interstitial glass or melt inclusions. Compositional trends in Harker diagrams of other major oxides (CaO, MgO, FeO, and Al_2O_3) versus SiO_2 are broadly linear and with a negative slope (Fig. 2.3c-f) which can be due to crystal fractionation and/or mixing between the crystals and melts of different origins (see Fig. S1).

Fig. 2.3: Normalized major element oxide compositions (versus SiO_2) of whole rocks and glasses from the 1990 Kelud eruption analyzed in this study. (a) total alkali content ($\text{Na}_2\text{O} + \text{K}_2\text{O}$); (b) K_2O ; (c) CaO ; (d) MgO ; (e) Al_2O_3 ; (f) FeO . Greyscale domains represent sample compositions from other eruptions of Kelud (1919 – Sjarifudin & Claproth (1989), 1951 – Sjarifudin and Claproth (1989), this study; 1966 – this study; Pre-1990 – Bernard (unpub. data); 2007 – Humaida (2013), Jeffery et al. (2013); 2014 – Cassidy et al. (2016), Goode (2018)). Although we acknowledge that there is an apparent correlation between the compositional domains of other Kelud eruptions, this trend is the result from combining whole rocks and glasses together. Whereas the whole rock is consistently basaltic andesite and completely overlaps for all eruptions, the different glass compositions are more evolved and thus form a trend within each respective eruption.

Table 2.1: Summary of sample description of 1990 samples used in our study. Asterisks (*) refer to the 1990 samples previously studied in Humaida (2013).

Sample ID	KELUT90B*	1990-PL1	1990-BR	90-2*	90-20*	90-23*	1990-PL2
Stage	Main	Main	Main	Main	Main	Main	Late
Latitude	-8.0	-7.9	-7.9	-7.9	-7.9	-7.9	-7.9
Longitude	112.0	112.3	112.3	112.3	112.3	112.3	112.3
Origin	Pumice fall	Pumice fall	Pumice flow	Pyroclastic flow*	Pyroclastic flow*	Pyroclastic flow*	Pumice fall
Hand specimen observations	light gray to gray porphyritic pumice	light gray to gray porphyritic pumice	light gray to gray porphyritic pumice	Thin section only	Thin section only	Thin section only	gray dense porphyritic pumice
Microscopic textures	Glom of plag + opx + cpx + mag. Overgrowth of cpx around rounded opx. Amph pseudomorphs and ol symplectites. Zoned and unzoned opx, cpx phenocrysts.	Glom of plag + opx + cpx + mag. Overgrowth of cpx around rounded opx. Contains partially reacted amph, amph pseudomorphs, and symplectite. Zoned and unzoned phenocrysts	Glom of plag + opx + cpx + mag. Overgrowth of cpx around rounded opx. Ol symplectite. Zoned and unzoned phenocrysts. Amph pseudomorph.	Glom of plag + opx + cpx + mag. Amph pseudomorph. Overgrowth of cpx around rounded opx. Sieve-textured plag.	Glom of plag + opx + cpx + mag. Sieve textured plag. Zoned and unzoned phenocrysts.	Glom of plag + opx + cpx + mag. Overgrowth of cpx around rounded opx. Ol symplectite. Zoned and unzoned phenocrysts	Glom of plag + opx + cpx + mag. Overgrowth of cpx around rounded opx. All phenocrysts are zoned. Large (>500um) amph pseudomorphs. Ol symplectite. Contains abundant qz bearing enclaves.

Sample ID	KELUT90B*	1990-PL1	1990-BR	90-2*	90-20*	90-23*	1990-PL2
Matrix texture	vitric vesicular interstitial glass with variable vesicles. Rare microlites of plag + opx + cpx + mag	vitric vesicular interstitial glass with abundant fragments and microlites of (skeletal) plag + opx + cpx + mag. Opx microlites can be reversely zoned.	vitric vesicular interstitial glass with small vesicles. Rare microlites of plag + opx + cpx + mag	vitric vesicular interstitial glass	vitric vesicular interstitial glass	rare microlites of plag + opx + cpx + mag. Glass is partially devitrified.	vitric vesicular interstitial glass with thin, highly vesicular groundmass and thin (<10um) vesicle walls. Microlites consist of normally zoned plag.
Other observations			One of oikocryst of opx surrounding plag + mag				Qz is anhedral and interstitial, crystallizing around phenocrysts.
Zoned Minerals	Plag, Opx, Cpx	Plag, Opx, Cpx	Plag, Opx, Cpx	Plag, Opx, Cpx	Plag, Opx, Cpx	Plag, Opx, Cpx	Plag, Opx, Cpx
Zoning type							
<i>Plag</i>	oscillatory, normal rim	oscillatory, normal rim	oscillatory, normal rim	No observations	oscillatory, normal rim	oscillatory, normal rim	oscillatory, normal rim
<i>Opx/Cpx</i>	normal, reverse, multiple	normal, reverse, multiple	normal, reverse, multiple	No observations	normal, reverse, multiple	normal, reverse, multiple	normal, reverse, multiple
Modal Mineralogy # (vol.%)							
<i>Glass</i>	57.6	69.1	68.3	59.5	66.9	52.8	50.7
<i>Plag</i>	29.8	14.1	22.4	30.4	19.6	37.6	31.4
<i>Opx</i>	4.6	6.6	2.4	3.8	4.6	3.3	8.7
<i>Cpx</i>	5.2	5.4	3.9	4.2	5.3	3.9	3.3
<i>Mag</i>	2.9	4.8	3.0	1.9	3.6	2.4	4.3
<i>Amph</i>	<0.1**	0.12	0.18**	0.12**			1.6**

Sample ID	KELUT90B*	1990-PL1	1990-BR	90-2*	90-20*	90-23*	1990-PL2
<i>Apa</i>	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
<i>Ol</i>	< 0.1	< 0.1	< 0.1				< 0.1
<i>Ilm</i>							< 0.1
<i>Total</i>	100	100	100	100	100	100	98
<i>Phenocryst content (vol. %)</i>	42.4	30.9	31.7	40.4	33.1	47.3	47.7
Analyses Conducted	XRF, SEM (WDS/EDS), EPMA	XRF, SEM (WDS/EDS), EPMA	XRF, SEM (WDS), EPMA	SEM (WDS)	SEM (WDS)	XRF, SEM (WDS/EDS), EPMA	XRF, SEM (WDS/EDS), EPMA

Plag = plagioclase; Opx = orthopyroxene; Cpx = clinopyroxene; Mag = magnetite; Amph = amphibole; Apa = apatite; Ol = olivine; Ilm = ilmenite. Glom = glomerocrysts.

*Samples from H. Humaida's unpublished doctoral thesis (Humaida, 2013)

**Amph is pseudomorph

*** Ol has been turned to symplectite

Sample ID	KELUT-90B	KELUD-1990-PL1	KELUD-1990-BR	KELUD-1990-PL2
Stage	Main	Main	Main	Late
<i>Major elements (wt. %)</i>				
SiO ₂	56.15	54.17	54.6	54.42
Al ₂ O ₃	18.42	18.95	18.36	17.88
FeO*	8.74	9.35	9.65	9.26
MnO	0.2	0.2	0.21	0.2
MgO	3.65	3.66	3.81	3.81
CaO	9.1	9.05	9.2	9.08
Na ₂ O	2.99	2.9	2.82	2.89
K ₂ O	0.7	0.69	0.67	0.67
TiO ₂	0.64	0.69	0.67	0.65
P ₂ O ₅	0.13	0.16	0.14	0.13
Total	100.7	99.8	100.4	99.0
<i>Trace elements (mg/kg)</i>				
La	5.82	6.05	6.0	5.96
Ce	13.2	13.5	13.3	13.3
Pr	1.82	1.76	1.74	1.78
Nd	8.34	8.34	8.01	8.23
Sm	2.55	2.37	2.24	2.36
Eu	0.873	0.854	0.817	0.902
Gd	2.84	2.32	2.52	2.4
Tb	0.46	0.44	0.43	0.41
Dy	2.72	2.78	2.60	2.74
Ho	0.55	0.56	0.53	0.58
Er	1.72	1.67	1.64	1.7
Tm	0.287	0.251	0.248	0.256
Yb	1.89	1.71	1.71	1.7
Lu	0.29	0.27	0.25	0.27
Y	15.7	15.3	15.6	15.3
Zr	44	39	38	38
Nb	1.2	0.9	0.8	0.9
Hf	1.5	1.1	1.1	1.2
Ta	0.11	0.04	0.02	0.05
Th	0.93	0.86	0.83	0.85
U	0.38	0.34	0.33	0.35
Rb	13	12	12	12
Cs	1.0	0.8	0.8	0.8
Sr	577	605	580	575
Ba	484	479	463	465

Sample ID	KELUT-90B	KELUD-1990- PL1	KELUD-1990-BR	KELUD-1990- PL2
Sc	20	19	20	19
V	183	179	180	179
Cr	30	< 20	< 20	80
Co	19	19	20	20
Cu	40	60	30	20
Pb	9	8	8	8
Zn	60	60	70	60
Sn	4	3	< 1	1
W	1.9	2.3	2.5	0.5
Ga	16	15	16	16
Ge	1.4	1.3	1.3	1.3
Tl	0.49	< 0.05	< 0.05	< 0.05
Sb	0.8	< 0.2	0.3	0.4
Eu*	0.99	1.12	1.05	1.16
CI Chondrite normalized				
REE				
(La/Yb) _n	2.21	2.54	2.52	2.52
(La/Sm) _n	1.48	1.65	1.73	1.63
(Dy/Yb) _n	0.96	1.09	1.02	1.08
V/Cu	4.58	2.98	6.00	8.95

$Eu^* = Eu / (Sm \times Gd)^{1/2}$, with all compositions are normalized to primitive mantle.

FeO^* = total iron oxide, converted to Fe^{2+} .

See data on glass inclusions and calculated matrix in supplementary data.

Table 2.2: Major and trace element composition for the 1990 whole rocks analyzed in this study. Sample compositions denoted with ** were used the sample composition chosen for modeling using MELTS. $Eu^* = Eu / (Sm \times Gd)^{1/2}$, with all compositions are normalized to primitive mantle.

Trace element concentrations in the whole rocks show a pattern typical of island arc magmas (Fig. S2). Primitive mantle-normalized trace element patterns reveal a relative enrichment in fluid mobile large ion lithophile elements (Cs, Rb, Ba, Sr), with a pronounced spike

in Pb, and depletion in Nb. Chondrite-normalized rare earth elements (REE) concentrations show a relative enrichment in light REE ($(\text{La}/\text{Sm})_n = 1.48\text{-}1.73$) and an almost flat pattern for the heavy REEs ($(\text{Dy}/\text{Yb})_n = 0.96\text{-}1.09$). The main-stage pumice does not show significant Eu^* anomalies ($\text{Eu}^* = \text{Eu}/(\text{Sm} \times \text{Gd})^{1/2} \sim 0.99$ to 1.12), whereas the late-stage pumice has the highest positive Eu^* anomaly ($+1.16$). Differences in moderately volatile trace elements between main-stage and late-stage pumices involve a higher V/Cu ratio in the late-stage pumice (~ 9 vs. $3\text{-}6$) indicating a shift in oxidation state of the late-stage erupted magma.

2.4.1.2 Textural relations, mineralogy and mineral chemistry

The main-stage pumices are light gray to gray, with a porphyritic texture set in a vesicular, glass-rich, but microlite-bearing groundmass (Fig. 4a-j, Table 2.1). The phenocryst (crystals $> 100 \mu\text{m}$) assemblage consists of $\text{Opx} + \text{Cpx} + \text{Plag} + \text{Mag} + \text{Amph}$ and its pseudomorph (Amph^*) $\pm$ olivine symplectite (Ol^*) along with accessory apatite (Apa). The samples show a significant range of phenocryst content, from about 30 to 47 vol. %; plagioclase is the most abundant (< 14 to 38 vol. %), followed by Opx (< 9 vol. %), Cpx (< 5 vol. %), Mag (< 5 vol. %), and Amph (< 0.2 vol. %). Phenocrysts of Plag , Opx or Cpx , are subhedral to euhedral or angular fragments of larger crystals.

Fig. 2.4 (below): Plane-polarized (PPL) and backscattered electron (BSE) images of representative mineral textures pumices from the main eruptive stage. (a) Type 2 Plag phenocryst with a partially resorbed core mantled by spongy-sieve textured growth zone with a normal rim. Light grey inclusions are apatite (Apa). (b) Cpx phenocryst with glassy inclusions (MI), Plag inclusions, and post-entrapment daughter minerals (PEM). (c) Euhedral reversely zoned Opx phenocryst with Apa and Mag inclusions. (d) Normally zoned Cpx and reversely zoned Opx . The normally zoned Cpx hosts many irregular melt inclusions. (e) Groundmass texture with plagioclase and pyroxene microlites surrounded by quenched interstitial glass. (f) Glom of $\text{Opx} + \text{Cpx} + \text{Mag}$ showing both unsutured and sutured grain boundaries. (g) PPL image of Cpx overgrowth mantling rounded Opx core with Mag phenocrysts along boundaries. Orange dashed line shows the Opx - Cpx boundary (h) Partially reacted Amph grains with anhedral Mag phenocrysts attached. (i) Pseudomorph after Amph breakdown, filled with fine-grained assemblage of $\text{Opx} + \text{Cpx}$

+ Plag + Mag. (j) Symplectitic texture after olivine breakdown showing anhedral pyroxenes surrounded by stringy magnetite.

Plag phenocrysts show a wide range of textures, including oscillatory zoning, sieved cores, and are typically broadly normally zoned with lower An at their rims than interiors (Fig. 2.4a). Unzoned Opx and Cpx phenocrysts (34% of the pyroxenes) are typically subhedral to euhedral and may host mineral and melt inclusions in their cores (Fig. 2.4b). Chemically zoned Opx phenocrysts (23% of the population) are typically reversely zoned, with a higher Mg-number rim mantling a rounded core (Fig. 4c). The compositional step from core to rim is sharp, even though some phenocrysts show more complex zoning at their rims (Fig. 2.4c). Normally zoned Opx phenocrysts (3%) are rare. Cpx phenocrysts are less commonly zoned; 18% show normal zoning in Mg-number, and about 1% reverse zoning (Fig. 2.4d). The cores of reversely zoned crystals are rounded or embayed, indicating a partial dissolution before rim regrowth. Mineral inclusions embedded in most phenocryst cores are commonly Fe-Ti oxides or apatite.

Gloms (13% of the total population) are made of $\text{Opx} \pm \text{Cpx} \pm \text{Plag} \pm \text{Mag}$, with grain boundaries that can be rounded and sutured, or sub-rounded and partly exposed to the surrounding melt (Fig. 2.4f). We also found euhedral Cpx overgrowths over rounded and resorbed Opx phenocryst cores (3% of the total population), with inclusions of Mag outlining the core-overgrowths boundaries (Fig. 2.4g). Rare amphibole occurs as partially reacted phenocrysts (Fig. 2.4h). The pseudomorph reaction assemblage comprises anhedral fine-grained $\text{Cpx} + \text{Opx} + \text{Plag} + \text{Mag}$. Pseudomorphs after Amph breakdown consists of aggregates of $\text{Opx} + \text{Cpx} + \text{Plag} + \text{Mag}$ in the original shape of the amphibole (Fig. 2.4i). Symplectites after olivine breakdown (Ol^* , 1 % of the total population) are made of $\text{Cpx} + \text{Opx} + \text{Mag}$ (Fig. 2.4j). Microlites (< 100 μm) are mainly Plag, Cpx, Opx, Mag, and Apa, varying in habit from euhedral or skeletal to angular zoned fragments of larger crystals (Fig. 2.4e). Cpx microlites may have hourglass twinning, indicating rapid growth.

The late-stage pumices are light grey, with a porphyritic texture set in a vesicular and porous, glass-rich groundmass. They share the same rock-forming mineral assemblage as the main-stage pumices, but have higher phenocryst content (49 vol. %) and contain both quartz (Qz) and ilmenite. Opx, Cpx, and Plag phenocrysts can be chemically zoned. Plagioclase shows progressive, normally zoned rims (Fig. 2.5a). Opx phenocrysts are typically normally zoned (44% of the total) rather than reversely zoned (2%) (Fig. 2.5b). Phenocryst edges are serrated or show

reaction rims, likely from partial melting of evolved interstitial glass. Gloms are common (39% of the total population surveyed in this study) and with the same mineralogy as those in the main-stage pumices (Fig. 2.5c). Cpx can be found as overgrowths on Opx (5%) and are more abundant than in main-stage pumices (Fig. 2.5d). The groundmass is highly porous with thin vesicle walls ($< 10 \text{ mm}$) and rhyolitic interstitial glass (Fig. 2.5e). Microlites are mainly Plag plus some Cpx, Opx, Mag, and Apa (Fig. 2.5f). Fe-Ti oxides are Mag and Ilm, with Mag partially surrounded by frayed Ilm rims wherever Mag edges are exposed to melt (Fig. 2.5g). Quartz crystals commonly fill the interstices surrounding phenocrysts of $\text{Plag} \pm \text{Opx} \pm \text{Cpx} \pm \text{Mag}$ in enclaves, indicating that the magma cooled enough to evolve to high SiO_2 content and crystallize Qz (Fig. 2.5h). Amphibole is completely reacted to pseudomorphs (7%) that are considerably larger than the main-stage pseudomorph ($> 500 \text{ mm}$) and appear as fine-grained $\text{Cpx} + \text{Opx} + \text{Plag} + \text{Mag}$ assemblages in the shape of the original Amph crystal (Fig. 2.5i). Olivine symplectites (2% of the total population) are similar in morphology and mineralogy to those in main-stage pumices (Fig. 2.5j).

Fig. 2.5: PPL and BSE images of representative mineral textures in the pumice from the late eruption stage. White and grey scale bars indicate 100 μ m scale. (a) Normally zoned Plag phenocryst with glassy inclusions. (b) Multiply zoned Opx phenocrysts attached to partially reacted Mag glom, featuring reverse mantling growth zone followed by normal rim. (c) Glom comprising anhedral to subhedral Opx + Cpx + Plag + Mag. (d) PPL image of Cpx overgrowth mantling rounded Opx core. Orange dashed line marks the Opx-Cpx boundary. (e) Groundmass textures with Fe-Ti oxides, pyroxenes, and Plag microlites. (f) Magnified view of Opx + Apa + Plag + Cpx microlites; (g) Mag phenocryst with Ilm rims. (h) Quartz bearing enclaves, where Qz forms an interstitial phase around the pyroxene and plagioclase phenocrysts. (i) Pseudomorph of Amph, with Plag inclusions. (j) Symplectitic texture surrounded by Mag, Plag, and pyroxene phenocrysts.

2.4.1.3 Mineral compositions and traverses

The main-stage Plag ranges from An = 58 to 90 (Fig. 2.6a, Table 2.3), with cores showing a bimodal distribution at An₅₈₋₇₅ and An₇₅₋₉₀, whereas rims are mainly unimodal at An₅₈₋₇₅. Plagioclase phenocrysts can be classified into two main textural types (Fig 2.6b-d): Type 1a Plag has a spongy, sieved core ($\sim$ An₈₆) mantled by a zone at An = 70-90, which is in turn surrounded by a lower-An rim (58-70), some crystals can also have an intermediate sieved zone, which we call Type 1b. Type 2 crystals do not show significant zoning or textures aside from oscillatory zoning, with cores fluctuating between An₆₀₋₇₅ and An₇₅₋₉₀ and surrounded by lower An rim (An₆₀₋₇₀) (Fig. 2.6d). Plagioclase microlites are zoned, with cores of An₆₀₋₈₅ mantled by rims of An₆₀₋₆₂ that are similar to Type 2 Plag phenocrysts. Compositional profiles in Type 1b crystals show one plateau that coincides with a light grey zone in BSE images (An₈₀) and darker rim (An₆₀). The outer zones of these crystals show multiple compositional fluctuations, from about An 62 to 75 (Fig. 2.6e-f). We have few Plag analyses from the late-stage pumice. These have similar phenocryst types and compositions as the main-stage pumices, but a major difference is the presence of a more evolved rim population at about An₄₀. Such a low-An rim population is consistent with the more evolved compositions of the interstitial melt in late-stage pumice.

Fig. 2.6: Histograms, false color BSE images, and representative traverses of plagioclase (Plag) compositions from the main and late eruption stage. (a) Histogram of Plag population, divided into type 1a, 1b, and 2 phenocrysts, microlites, and enclaves. (b) Annotated false color BSE image of a type 1a Plag, with An compositions from spot analyses. (c) Same for type 1b Plag, with An compositions from spot analyses. (d) Same for type 2 Plag, with An compositions from spot analyses. (e) Annotated BSE image of a main-stage Plag with the analyzed traverse from rim to core shown by a red arrow. (f) Traverse analysis of An content from rim to core, denoted by the red arrow.

Table 2.3: Plagioclase compositions and textures in pumices representative for the main- and late-stage eruption stages.

	KELUT90B- PLG-b1	KELUT90B- PLG-b2	KELUT90B- PLG-y4	KELUT90B- PLG-r5	PL1- plag3- row3	PL1- plag3- row5- rim	PL2- 2- plag4	PL2- 2- plag1	PL2- 2- plag3	PL2- plag3	PL2- plag- encl1	PL2- plag1	PL2- plag3
Stage	Plag	Plag	Plag	Plag	Plag	Plag	Plag	Plag	Plag	Plag	Plag	Plag	Plag
	Main	Main	Main	Main	Main	Main	Late	Late	Late	Late	Late	Late	Late
	Type 1 core	Type 2 core	Type 3 core	Rim	Microlite - core	Microlite - rim	Type 1 core	Type 2 core	Type 3 core	Rim	Enclave	Microlite - core	Microlite - rim
wt. %													
SiO ₂	48.7	46.5	49.2	52.4	49.9	51.3	46.0	47.9	48.6	57.5	57.8	51.7	57.5
Al ₂ O ₃	31.5	33.2	30.9	29.4	31.6	30.7	33.6	31.6	31.6	26.1	26.4	30.4	26.1
Na ₂ O	2.2	1.4	2.5	3.7	3.2	3.8	2.0	3.4	3.6	6.8	6.9	4.0	6.8
CaO	15.6	17.3	15.1	13.5	15.0	14.0	17.0	15.0	14.6	8.0	9.0	13.0	8.0
K ₂ O	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.3	0.3	0.1	0.3
MgO	NA	NA	NA	NA	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.0
FeO	0.6	0.6	0.6	0.7	0.6	0.6	0.3	0.3	0.3	0.5	0.6	0.5	0.5
Total	98.6	98.9	98.4	99.8	100.5	100.6	98.9	98.3	98.8	99.2	101.0	99.8	99.2
An	79.8	87.2	76.9	66.9	71.5	66.3	82.5	71.1	69.2	40.8	40.6	64.7	40.8

$An = 100 \times Ca / (Ca + Na)$. See supplementary materials for more analyses.

NA = not available

Main-stage Opx phenocrysts display a bimodal distribution with a mode at Mg-number = 62-70 and another one at 70-74 (Fig. 7a, Table 2.4). The low Mg-number mode characterizes gloms, Opx cores with Cpx overgrowths, and most cores of both zoned and unzoned phenocryst. A Mg-number > 70 is common for rims of reversely zoned phenocrysts and microlites. Reversely zoned Opx phenocrysts (Fig. 7b) commonly display sharp compositional steps, with higher Mg-number in rims (72-74) than cores (66-70) (Fig. 7c). Opx crystals in late-stage pumice show a wide compositional spread (Mg-number = 58-72), and many are more evolved than Opx from the main-stage (Table 2.4). Most unzoned crystals have a core compositionally similar to main-stage Opx (Mg-number = 68-69), and some Opx phenocrysts show normal zoning (Fig 7d), with Mg-number 64-68 in cores and 58-62 in rims (Fig. 7e). The composition of Opx in gloms (Mg-number = 59-72) overlap with those of phenocryst cores and microlites. Overgrowth Opx cores have similar compositions to main-stage overgrowth ones (Mg-number = 68-70). Opx in Amph breakdown textures overlap with most other compositions (Mg-number = 60-68).

Fig. 2.7: (a) Histograms of point analyses and traverses of Opx compositions, subdivided according to the textural groups: cores of phenocrysts, overgrowth Opx cores and microlites; rims of zoned phenocrysts; and gloms. Red arrows indicate the direction of traverse analysis. (b) BSE image of a reversely zoned main-stage Opx. (c) Traverse analyses from rim to core of Mg-number of a main-stage Opx. (d) BSE image of a normally zoned late-stage Opx. (e) Traverse analysis from rim to core of Mg-number of a late-stage Opx.

Cpx phenocrysts in main-stage samples (Mg-number = 70-78, $\text{Wo}_{38-45}\text{En}_{40-48}$) show a narrower compositional range than Opx, and vary depending on the textural group (Fig. 2.8a and Table 2.4; for Wo and En distributions, see Fig. S3). Phenocryst cores either overlap or have

lower Mg-number (70-76) than rims (72-76), rarely Cpx also show reverse zoning (Fig. 2.8b-c). Glom Cpx cores overlap with phenocryst cores at Mg-number = 71-76. Cpx overgrowth and microlites record the largest compositional range in Mg-number (72-74), and in Wo and En content ($\text{Wo}_{41-44}\text{En}_{40-43}$) compared to the rest of the Cpx. Late-stage Cpx (Mg-number = 58-73, $\text{Wo}_{38-48}\text{En}_{31-48}$; Table 2.4), are more evolved than main-stage Cpx. Phenocrysts show normal zoning (Fig. 2.8d), with higher Mg-number in cores (= 70-76) than rims (= 68-70; Fig. 2.8e). Cpx in gloms display the widest compositional range (Mg-number = 62 to 79, $\text{Wo}_{41-49}\text{En}_{32-45}$). Cpx microlites and overgrowth (Mg-number = 72-74, $\text{Wo}_{42-44}\text{En}_{41-43}$) have higher Mg and Ca compared to the phenocrysts. Cpx found as pseudomorph (Mg-number = 69-74, $\text{Wo}_{41-44}\text{En}_{39-42}$) is likely produced from Amph breakdown.

Fig. 2.8: (a) Histograms of point analyses and traverses of Cpx compositions, subdivided into the same textural groups as Opx. Traverse directions shown by red arrows. (b) BSE image of a reversely zoned main-stage Cpx. (c) Traverse from rim to core of Mg-number of a main-stage Cpx. (d) BSE image of a normally-zoned late-stage Cpx. (e) Traverse analysis from rim to core of Mg-number of a late-stage Cpx.

Table 2.4: *Opx and Cpx compositions and textures in pumices representative for the main and late eruption stages.*

	PL1-1- px-z1a	PL1-1- px- MX1	90B- opxcpx17	PL1- site1-px4	PX6-c- only	glom1- c-only	PL2-2px7	PL2- site1-px7	PL1-1- px6	90- 23- px18	90B- opxcopxrim-1	PL1- site1-px8	PX5- core- only	glom4- c-only	PL2-px7	PL2- site1-px2
	Opx	Opx	Opx	Opx	Opx	Opx	Opx	Opx	Cpx	Cpx	Cpx	Cpx	Cpx	Cpx	Cpx	Cpx
	Main	Main	Main	Main	Late	Late	Late	Late	Main	Main	Main	Main	Late	Late	Late	Late
	Pheno	Glom	Overgrowth	Microlite	Pheno	Glom	Overgrowth	Microlite	Pheno	Glom	Overgrowth	Microlite	Pheno	Glom	Overgrowth	Microlite
wt. %																
SiO ₂	53.36	52.02	52.1	52.2	53.09	52.43	53.1	51.3	52.48	51.8	50.81	51.23	51.4	51.7	51.4	51.0
TiO ₂	0.18	0.21	0.2	0.2	0.12	0.18	0.1	0.2	0.33	0.4	0.32	0.37	0.3	0.4	0.4	0.3
Al ₂ O ₃	1.07	1.75	1.4	1.8	1.01	1.61	0.8	1.6	1.71	2.0	1.82	1.59	2.0	2.2	1.7	1.6
FeO*	21.51	21.90	20.1	18.9	18.87	19.32	18.5	21.2	10.85	11.0	9.84	10.06	9.4	9.5	9.4	11.2
MnO	0.85	0.71	0.9	0.7	0.73	0.71	0.7	0.7	0.52	0.4	0.48	0.48	0.4	0.4	0.4	0.5
MgO	23.23	23.39	23.4	24.5	23.07	22.74	23.6	22.9	14.57	14.7	14.53	14.73	14.6	14.3	14.3	14.4
CaO	1.42	1.34	1.2	1.5	1.57	1.56	1.5	1.6	20.75	19.4	20.67	20.27	21.0	20.9	21.2	20.0
Na ₂ O	0.01	0.01	0.0	0.1	0.02	0.02	0.0	0.2	0.3	0.3	0.29	1.38	0.3	0.3	0.3	1.8
Total Oxide	101.60	101.30	99.2	99.9	98.50	98.60	98.4	99.7	101.5	99.9	98.8	100.1	99.5	99.7	99.1	100.9
Mg Number	65.81	65.6	67.5	69.8	68.5	67.7	69.4	65.8	70.5	70.4	72.5	72.3	73.4	72.9	73.0	71.8
Wo	2.81	2.63	2.4	2.9	3.24	3.23	3.1	3.1	41.9	40.1	42.59	41.7	43.2	43.4	43.8	41.8
En	63.96	63.84	65.8	67.7	66.32	65.53	67.2	63.7	41.0	42.2	41.57	42.2	41.7	41.3	41.1	41.8
Fs	33.23	33.53	31.7	29.3	30.43	31.23	29.7	33.1	17.1	17.8	15.84	16.2	15.1	15.3	15.2	16.4

FeO* and structural end-members based on Deer et al. (1992). Mg Number = $Mg/(Mg+Fe_{total})$. Please see supplementary material for more analyses.

The two partially reacted amphibole phenocrysts (Mg-number = 76-83) from the main-stage straddle the magnesio-hastingsite and tschermakite-pargasite end-members (Table 2.5) defined by Leake *et al.* (1997). Both phenocrysts have reaction rims consisting of anhedral, fine-grained assemblage of Opx + Cpx + Plag + Mag. Magnetite in main-stage samples shows a narrow range of $X_{\text{usp}} = 0.28 - 0.30$ (Table 2.5), whereas magnetite in late-stage pumice shows a bimodal distribution at about 0.30 and at 0.31-0.34 (Fig. S4a), with no overlap. Ilmenite also displays a bimodal distribution, with a first mode at $X_{\text{ilm}} = 0.88-0.91$ and a second one $X_{\text{ilm}} = 0.91 - 0.92$ (Fig. S4b).

Table 2.5: Representative Amph and Fe-Ti oxides compositions in main- and late-stage pumices.

	PL1new-1- amph2	PL1 amph1_8		90-23- Mag1	Mag- Ilm-13	Mag- Ilm-26
	Amph	Amph		Mag	Mag	Ilm
	Main	Main		Main	Late	Late
SiO ₂	41.46	42.59	TiO ₂	8.7	9.4	43.9
TiO ₂	1.41	1.55	Al ₂ O ₃	2.9	1.2	2.4
Al ₂ O ₃	14.92	14.01	Cr ₂ O ₃	0.0	0.1	0.0
Cr ₂ O ₃	0.00	0.02	FeO	39.6	41.2	34.2
Fe ₂ O ₃	5.10	8.61	Fe ₂ O ₃	44.7	44.3	14.6
FeO	7.04	3.45	MnO	0.5	0.6	1.0
MnO	0.15	0.17	MgO	2.1	1.0	2.3
MgO	13.28	14.35		0.11	0.1	0.1
CaO	12.50	11.68				
Na ₂ O	2.29	2.25	Total	99.0	97.9	98.68
K ₂ O	0.31	0.29				
F		0.165	Structural cations***			
Cl			Ti	1.70	2.0	6.9
H ₂ O _{calc}	1.93	1.87	Al	0.89	0.4	0.3
Total	100.39	101.01	Cr	0.01	0.0	0.0
			Fe ²⁺	12.44	13.1	7.4

	PL1new-1- amph2	PL1 amph1 8		90-23- Mag1	Mag- Ilm-13	Mag- Ilm-26
	Amph	Amph		Mag	Mag	Ilm
	Main	Main		Main	Late	Late
<hr/>						
<i>Structural</i>						
<i>Formula</i>			Fe ³⁺	3.19	3.0	0.9
<i>T site</i>			Mn	0.11	0.1	0.2
Si	6.00	6.07	Mg	0.81	0.4	0.7
Al ^{IV}	2.00	1.93	Si	0.03	0.0	0.0
Ti	0.0	0.00				
<i>C site</i>						
Al ^{VI}	0.55	0.43				
Ti	0.15	0.17				
Cr	0.00	0.00				
Fe ³⁺	0.56	0.92				
Mg	2.87	3.05				
Fe ²⁺	0.85	0.41				
Mn	0.02	0.02				
<i>B site</i>						
Fe ²⁺	0.00	0.00				
Ca	1.94	1.78				
Na	0.06	0.22				
<i>A site</i>						
Na	0.58	0.41				
K	0.06	0.05				
Mg/(Mg + Fe ²⁺)	0.84	0.88				
Mg Number	78.02	76.75				
Pressure (MPa)*	508	484				
Temperature (°C)*	912	939				
End- member**	Magnesio- Hastingsite	Tschermakite- Pargasite				

*Pressure and temperature calculated using formulation of Ridolfi & Renzulli (2012).

**Structural formulae according to Leake et al. (1997).

***Structural cations calculated using Droop (1987).

2.4.2. Pre-eruptive Magma storage conditions

2.4.2.1 Pyroxene temperature constraints

The pyroxene-melt equilibrium temperatures from the main-eruptive stage samples show a wide range, from about 950 to 1100°C across textural groups. Opx-melt temperatures vary between about 980 to 1050 °C, and the crystal core temperatures overlap or are somewhat higher than those obtained from the rims. The high temperature range from Opx-melt equilibria is close to or overlaps with the whole-rock liquidus temperatures (T_{liquidus}) calculated with MELTS at NNO with 3-4 wt. % of water in the melt, and about 50°C lower the liquidus with 2 wt. % water in the melt (Fig. 2.9a). Moreover, temperatures recorded from individual core to rim crystal traverses record a temperature decrease of about < 50 °C, even for crystals that are reversely zoned in Mg-number (Fig. S5). Opx microlite-melt temperatures overlap with those of the phenocryst rims. Cpx-melt temperatures overlap or are somewhat higher than those of Opx, with a mode at ~1050°C. The temperatures of crystal cores and rims overlap, except for reversely zoned (in Mg-number) Cpx traverses, where core temperatures are generally higher than the rims. Despite this apparent core to rim temperature decrease, the crystal cores in zoned Opx and Cpx are resorbed, and suggest a period of crystal dissolution between cores and rims induced by temperature and compositional effects. Finally, Opx-Cpx temperatures partly overlap or are slightly higher than those of Opx and Cpx-melt with one main mode at ~1000 ($\pm 25^\circ\text{C}$) and smaller one at ~1080 ($\pm 25^\circ\text{C}$). Temperature ranges from core-core pairs, rim-rim pairs, and microlites overlap.

Fig. 2.9: (a) Histograms of calculated temperatures for the main- and late-stage pumice samples constrained by different geothermometers and for various textures (cores, rims, microlites, Mag-Ilm pairs). Geothermometers include: two-pyroxene QUILF geothermometer (Andersen et al., 1993); Opx- and Cpx-melt geothermometers (eq. 28a and eq. 33, respectively) (Putirka 2008), using core-whole rock pairs and rim-interstitial glass pairs; and Mag-Ilm geothermometer for late-stage pumice (GE: Ghiorso & Evans (2008); S: Sauerzapf et al. (2008)). Whole rock liquidus temperatures ($T_{liquidus}$) at various water contents are also provided for comparison and were calculated using rhyolite-MELTS (Gualda et al., 2012; Ghiorso & Gualda, 2015) and the main-stage pumice KELUT90B used as input material. (b): $D^{Mg-Fe^{2+}}K_d$ vs. ΔH_2O , as recorded by main-stage

Opx cores and rims calculated using an empirical relationship from experimental results by Waters and Lange (2017).

Opx and Cpx core-melt temperatures for the late-stage deposits are similar and overlap with those of the main-stage (1040-1070°C), and are somewhat higher than those of the rims and microlites (970-1020°C) (Fig. 2.9a). The cores of zoned Opx and Cpx crystals tend also to be resorbed as in the main-stage samples. Opx-Cpx pair temperatures (990-1030°C) overlap between core and rims (Figure 9). Opx-Cpx temperatures for the microlites in late-stage pumice overlap with those for crystal rims but are lower than those inferred for Opx-Cpx pairs in main-stage pumice.

2.4.2.2. Magnetite-ilmenite oxybarometer

Temperatures obtained from Mag-Ilm pairs from the late-stage pumice are 780-850°C, i.e. 100 to 150°C lower than those inferred from silicate minerals (Fig. 2.9a). Temperatures obtained using the Ghiorso and Evans (2008) model have a mode at 825°C, and an fO_2 of about 0.5-2 log units above the NNO buffer. The model of Sauerzapf *et al.* (2008) model yields somewhat lower temperatures ($T = 780-800^\circ\text{C}$), but a similar range in fO_2 . Such low temperatures indicate that the late-stage magmas experienced at some point in their history cooler storage conditions than the main-stage magma, which is consistent with their higher crystallinity, and the presence of low temperature minerals such as quartz.

2.4.2.3 Amphibole-melt geothermobarometer

We obtained temperature and pressure estimates from the two Amph phenocrysts from the main-stage samples (Fig. 2.10). The Putirka (2016) and Li *et al.* (2021) combined formulation yields 960-980°C, and 400-550 MPa. Slightly lower temperatures (920-970°C) but higher pressures (480-590 MPa) are derived from the Ridolfi & Renzulli (2012) Amph-only formulation, whereas significantly higher temperatures (1000-1030°C) and pressures (570-830 MPa) result when applying the formulation of Ridolfi *et al.* (2010). These temperature estimates for amphibole either overlap with or are lower than pyroxene-based temperatures for crystal rims and

microlites.

Fig. 2.10: *P-T storage condition of the 1990 magma estimated from amphibole composition in pumices from the main eruptive stage using the different geothermometers. Storage conditions were computed by using the Amph-melt geothermometer of Putirka (2016) ($\pm 30^{\circ}\text{C}$; $\pm 100\text{ MPa}$), as well as the Amph chemometric formulations by Ridolfi et al. (2010) ($\pm 22^{\circ}\text{C}$; $\pm 210\text{ MPa}$) and Ridolfi & Renzulli (2012) ($\pm 24^{\circ}\text{C}$; $\pm 91\text{ MPa}$).*

2.4.2.4 Clinopyroxene-melt geobarometer

We obtained pressure estimates from the Cpx-melt pairs from the main-stage samples using the formulations by Neave and Putirka (2017) and Putirka (2008) (Fig. S10). Both formulations yield overlapping pressures of 100-350 MPa, with comparable peaks at $\sim 150\text{ MPa}$. These pressure

estimates overlap with saturation pressure estimates, but are lower than estimates from Amphib based geobarometers.

2.4.3 Dissolved water content, saturation pressures, and exsolved fluids

We assessed the concentration of dissolved water in the melt with the plagioclase-melt equilibrium model of Waters & Lange (2015), using the Plag rim and interstitial glass compositions, and the temperature obtained from Opx rim-melt (Table S2.3). Main-stage plagioclase rims of An₆₀₋₇₀ yield ~2-4 wt. % water in the melt, consistent with the water content required to crystallize amphibole. In comparison, the late-stage plagioclase rims have lower anorthite content, with An₄₀ that gave higher values of ~4-6 wt. % water in the melt. Cassidy *et al.* (2016) studied the 2014 eruption deposits and found that plagioclase-hosted melt inclusions contained 0.4 -2.3 wt. % water and up to 336 mg/kg CO₂. Assuming that this CO₂ content is also representative of the 1990 melts, we calculated volatile saturation pressures for the main-stage pumices of 110 to 170 MPa (~4-7 km depth), whereas for the late-stage pumices we obtained 150 to 230 MPa (~6-9 km depth) (Fig. 2.11; Table S2.3). The whole-rock, pre-eruptive temperature, mineral assemblage, and phenocryst content of the 1990 main pumices and the 2014 pumice are similar and thus suggest that they had similar pre-eruptive content (Chapter 3).

We also assessed the existence of an exsolved pre-eruptive volatile phase by comparing the SO₂ mass that was degassed during the eruption as measured by satellite data (e.g., Carn 2019), and that which can be produced by degassing of the melt alone (e.g. by the petrologic method, see methods section above). We used the total SO₂ gas detected by satellite over the course of the eruption from February to March 1990 (~0.17 Mt of SO₂; Carn *et al.* 2015). After correcting for post-entrapment crystallization, pyroxene-hosted melt inclusions have 440-1110 mg/kg SO₂ (Table 2.8) whereas the interstitial melt has about 60-90 SO₂ mg/kg. Considering a crystal content of 30-47 vol. %, and a DRE volume of 0.13 km³ we find that about 0.05-0.18 Mt SO₂ could have been outgassed from the melt during the eruption (Table 2.8). These values partly overlap with the amount detected from space-borne sensing. This implies that about 0.12 Mt SO₂ could be stored in an exsolved fluid phase at pre-eruptive conditions. We acknowledge that these values

are likely underestimates of the true amount of exsolved fluid phase from the eruption.

Uncertainties include maximum melt inclusion SO₂ content not being well constrained, errors related to the SO₂ detected from satellite, instrumental errors during analyses of glasses on the EPMA, and uncertainties related to erupted volume estimation from deposits used to scale the degassed SO₂ content.

2.4.4 Timescales of magmatic processes

We find that Mg/Fe concentration profiles of reversely zoned Opx crystals in the main- and late-stage pumices yield overlapping timescales (Fig. 2.12). Timescales of Opx crystals range from about a couple of weeks to up to three months using the Mg-Fe inter-diffusion coefficient from Dohmen *et al.* (2016), which are about a factor of 3 shorter when using the diffusion coefficient from Ganguly & Tazzoli (1994). On the other hand, timescales from Cpx profiles vary from one to three months. Bearing this in mind, the Opx timescales better overlap better with those of Cpx when using the diffusion coefficient of Dohmen *et al.* (2016) rather than Ganguly & Tazzoli (1994). Hereafter we refer to the computed timescales from Dohmen *et al.* (2016), which appear more consistent with the recorded length of the pre-eruptive signals.

2.5. Discussion

2.5.1 A range of pre-eruptive storage conditions and Kelud's plumbing system

Kelud volcano has consistently erupted basaltic andesite magma for over a hundred years (Bourdier *et al.*, 1997; Humaida, 2013; Jeffery *et al.*, 2013). The main-stage and late-stage pumice samples from the 1990 eruption have both this same composition and display mineralogical and textural features broadly similar to previously erupted products. However, the late-stage pumices are more crystal-rich, have a more evolved glass composition, and record lower temperatures than the main stage pumices, and thus the magma was stored at cooler pre-eruptive conditions.

Our geothermobarometry results indicate that the highest temperatures are about 1050°C and recorded by Opx and Cpx cores in both main-stage and late-stage pumices (Fig. 2.8), and match the liquidus temperature of the whole-rock with 3 wt. % water in the melt. These

temperatures are also consistent with the estimates of Cassidy *et al.* (2019, 2016) for the 2014 eruption using the Plag-melt equilibria and experiments. Pyroxene rim compositions give lower temperatures of around 980 °C. Isobaric MELTS modelling at 100 MPa and with 3 wt. % water in the melt indicates that at the above temperature range plagioclase is An₈₄₋₈₉, which is the composition of the mantle zones of the Plag phenocrysts. Amphibole temperatures calculated following Putirka (2016) are similar to that of pyroxene rims (about 970 °C), but much lower temperatures of about 800°C were obtained with the Mag-Ilm equilibria in the late-stage samples. Colder storage conditions for the late-stage magma are also indicated by the presence of quartz and the lower An (= 40) of Plag rims compared to those from the main-stage Plag rims (An₅₈₋₇₀ ; Fig. 2.7a). Oxygen fugacity constrained from the Fe-Ti oxide equilibria in the late-stage pumice indicate relatively oxidizing conditions of about 1 log unit above the NNO buffer.

Mineral-melt equilibria data indicates that the melt could have contained up to 3-4 wt. % dissolved water, which is high enough to stabilize amphibole in a range of typical arc compositions (Costa *et al.*, 2013; Sisson & Grove, 1993). Although amphibole phenocrysts were found in the rocks, amphibole pseudomorphs are more common, and thus magmas were stored close to the stability field of amphibole. Our pre-eruptive pressure estimates from Amph and Plag hygrometry-H₂O/CO₂ saturation suggest that Kelud's plumbing system also has a significant vertical extent. Volatile saturation pressures (110-170 MPa) correspond to 4-9 km depth (using an average local crustal density of 2640 kg m⁻³ ; Smyth *et al.*, 2007). A caveat to these depths is that given the minimal value represented CO₂ content used in these calculations from Cassidy *et al.* (2016), these pressures and depth estimates are likely minima values. Recalculation of these saturations and pressures with the scaled fluxed CO₂ content from VolatileCalc and zoned Opx (437 ppm) increases the saturation pressure to 160-190 MPa, which corresponds to 6-8 km depth using the same local crustal density (Table 2.6). On the other hand, pressure estimates from amphibole phenocrysts correspond to about 15-19 km depth (Fig. 2.10). Previous studies have suggested that the magma plumbing system of at Kelud may extend to 30 km depth beneath the volcano (Jeffery *et al.*, 2013) so it is possible that part of the crystal cargo from the 1990 eruption could have formed deeper than we have estimated. Thus, our data and those from the literature suggest that the magma plumbing system of Kelud is extended vertically and includes thermally

zoned magma storage levels of at least 15 km (see Fig. 2.11). In addition, mass balance calculations of the sulphur budget (see section 4.3) indicate that the magma coexisted with an exsolved volatile phase at pre-eruptive conditions.

Table 2.6: Summary of calculations to test the CO₂ fluxing hypothesis.

1. Melt volatile content	
<i>1a. Initial melt volatile content</i>	Volatile content
H ₂ O (wt. %)	3.8 - 5
CO ₂ (ppm)	336 - 0
<i>1b. Final melt volatile content</i>	
H ₂ O (wt. %)	2.0
CO ₂ (ppm)	759
<i>1c. Change in melt volatile content</i>	
H ₂ O (wt. %)	1.8 - 3.0
CO ₂ (ppm)	423 - 759
2. Mass balance of amount of CO ₂ fluxed	
Erupted volume (DRE) (km ³)	0.13
Rock density (kg m ⁻³)	2402
Mass of magma (Mt)	312
Melt proportion	0.58
Mass of melt (Mt)	180
	Range
Fluxed CO ₂ (ppm)	244 - 437
Fluxed CO ₂ (Mt)	0.08 - 0.14
3. Amount of limestone vs. mafic magma degassing needed for CO ₂ flushing	
<i>3a. Effect of limestone assimilation</i>	
CO ₂ in pure limestone (wt. %)	44
Mass of limestone (Mt)	0.13 - 0.23
Volume of limestone ^{&} (m ³)	84840
<i>3b. Effect of degassing basaltic magma[#]</i>	
CO ₂ content in wt. %	Mass of basaltic melt (Mt)

0.5	15 - 31
1	27 - 55

Volume of basaltic melt* (m ³)	
0.5	5034 - 10 403
1	9060 - 18 456

4. Time needed to produce total 0.08-0.14 CO₂ using degassing data of Javanese volcanoes[‡]

Volcano	CO ₂ degassing (tonnes/day)
Merapi	104
Bromo-Semeru	2184
Raung-Ijen	1111
Time (days)	
Merapi	1346
Bromo-Semeru	64
Raung-Ijen	126

\$ Maximum CO₂ content taken from Cassidy et al. (2016).

Range of CO₂ content taken from arc basalts (min CO₂ from modal CO₂ content from Galunggung - Sisson and Bronto, 1988; max CO₂ content from Cerro Negro - Lowenstern, 2001).

‡ CO₂ fluxes from Javanese volcanoes Aiuppa et al. (2019).

& Density of pure calcite = 2711 kg m⁻³ (<https://www.mindat.org/min-859.html>)

* Density of wet basalt = 2980 kg m⁻³ (P.V. Sharma, 1997, pg 17)

In summary, we propose that the 1990 eruption pre-eruptive plumbing system comprise a mushy reservoir filled with melts and crystals, at depths ranging from about 4 km down to at least 19 km depth below the crater, with temperatures ranging from 980 to 1030°C, and water contents in the melt of 2-4 wt. % (Fig. 2.11). The shallow reservoir also contained an exsolved fluid phase before magma ascent towards the surface. The geometry of the plumbing system was such that it allowed for the coexistence of magmas with a range of crystallinities and interstitial melt compositions. We further propose that the hotter and less crystal-rich of the central parts erupted as the main phase magma, whereas colder (down to ~800°C), and more crystal-rich parts of the margins produced the late-stage magmas. Hence, it is likely that the magma reservoir beneath Kelud is thermally zoned, with storage temperatures varying from ~750°C (lowest estimate from Mag-Ilm) at its margins to ~980°C in more inner zones (average of pyroxene-melt rim

temperatures), and to $\sim 1030^{\circ}\text{C}$ in its central part (average of pyroxene-melt core temperatures). Such range of temperatures can also explain the abundant presence of a variety of gloms that could be parts of the higher crystallinity and colder regions of the plumbing system (e.g. Nakada *et al.*, 1994).

Fig. 2.11: Schematic cartoon of Kelud's plumbing system according to petrologic observations and geothermobarometric estimates and of the pre-eruptive processes that most likely drove the 1990 eruption. The magma reservoir is likely to be zoned both in temperature ($^{\circ}\text{C}$) and water content (wt. %). Inset white box summarizes the corresponding mineral textures and compositions as a function of depth. Distinct magma types from the main and late stages along with their crystal cargoes are shown in the drawing. The fluxing of CO_2 dominated fluid from depth as well as the creation of an exsolved fluid phase in the shallow parts of the system are also highlighted and considered key for driving the short-lived explosive eruptions of Kelud. The brick-like pattern represents the volcanoclastic crustal sediments and carbonates that are found underneath Kelud (Jeffery *et al.*, 2013 and references therein)

2.5.2 Magmatic processes and timescales related to the 1990 eruption

2.5.2.1 Relating mineral textures and chemistry to pre-eruptive processes

Many studies have proposed that intrusion of primitive magma and mixing are the main processes commonly driving volcanic eruptions, as the influx of more mafic hotter and volatile-rich magma can build enough overpressure (Costa & Chakraborty, 2004; Folch & Martí, 1998; Huppert *et al.*, 1982). Moreover, mafic magma intrusion has also been proposed based on textural evidence of the crystal cargo, including multimodal core and rim mineral compositions, reverse zoning of Mg-number in mafic minerals such as pyroxenes, and of An in plagioclase (Streck, 2008). We found that Opx and Cpx show a limited range in compositional zoning in Mg-number or are reversely zoned, with rims that have higher Mg-number than the cores. This is especially true for Opx in the main-stage magma (23% of the Opx population surveyed). Although the reverse zoning in Opx could be interpreted as evidence of input of more primitive melt before the eruption, we would also expect to find reverse zoning in plagioclase, but this is not the case. We also did not find the typical bimodal crystal populations that appears in many systems where intrusion of primitive magma has been recognized. Moreover, the calculated temperature of the Opx rims and the cores overlaps, or the rims yield somewhat lower temperatures despite having higher Mg-number. An alternative possibility in relating these observations with their magmatic processes is that the reverse zoning in Opx reflects an increase in oxygen fugacity and/or decrease of the water content in the melt. Waters and Lange (2017) found a systematic increase of the Mg-number of the Opx as the water content in the melt decreases, and they experimentally calibrated a relationship between the two variables. We have exploited this finding by applying the experimental $^{Fe^{2+}-Mg}K_d$ relationship to find the change in water composition corresponding to the change observed between rim and core compositions i.e.:

$$\Delta^{Fe^{2+}-Mg}K_d = \left(\frac{[X_{MgO}^{liquid} X_{FeO}^{opx}]}{[X_{FeO}^{liquid} X_{MgO}^{opx}]} \right)_{core} - \left(\frac{[X_{MgO}^{liquid} X_{FeO}^{opx}]}{[X_{FeO}^{liquid} X_{MgO}^{opx}]} \right)_{rim} \quad (2)$$

From this, it is apparent that a decrease of water in the melt of up to ~2 wt. % from the Opx core to the rim (Fig. 2.9b) can explain the increase of Mg-number of the Opx cores (67-70) to the rims (70-72). Such a water decrease would also lead to crystallization and normal zoning in plagioclase, and thus would explain several of the textural and compositional features of Opx and

Plag. Moreover, fluid fluxing can result in breakdown of Amph phenocrysts and megacrysts, which has been observed experimentally at Mt St Helens (Riker et al., 2015). The observed water decrease in the melt could be related to magma degassing and ascent towards the surface, and/or fluxing of the reservoir by CO₂ dominated fluids from depth.

2.5.2.2. Fluid fluxing from depth and creation of an exsolved volatile phase

In recent years it has become apparent that in addition to replenishment by a more primitive melt, magma plumbing systems may be fluxed by hot volatiles arising from the deeper part of the magma system (Mastin and Witter, 2000; Spilliaert *et al.*, 2006; Giuffrida *et al.*, 2017; Flaherty *et al.*, 2018; Hartung *et al.*, 2019). Petrological analysis of melt inclusions and modeling support this possibility, and such fluid addition from depth can also account for the permanent volcanic plumes of many mafic volcanoes. Given the dependency of different volatile elements on pressure, the deeper parts of the system are typically CO₂-rich, because CO₂ is much less soluble than water and SO₂ with decreasing pressure, and can thus degas earlier and flux through the upper parts of the system, with mechanisms that may include channeling (Caricchi *et al.*, 2018; Collombet *et al.*, 2021; Giuffrida *et al.*, 2017; Spilliaert *et al.*, 2006). CO₂ fluxing can have widespread effects on a shallow magmatic system that vary depending on the pressure, but include the crystallization of high-Mg, high-Ca pyroxene rims (Giuffrida *et al.*, 2017). Thus, we propose that addition of CO₂-rich fluids from depth may have decreased the water fugacity and thus water content of the melt in the shallower parts of the Kelud magmatic system and may explain the reverse zoning of Opx, normally zoned Plag, and the Cpx overgrowths and reverse zoning of some Cpx in our samples (Fig. 2.4d).

2.5.2.3 Mass balance constraints on fluid fluxing

Quantifying the CO₂ that may have fluxed through the system is challenging because it is a dynamic process. There are no measurements of pre-eruptive/syn-eruptive CO₂/SO₂ and H₂O/CO₂ values of the gases for the 1990 eruption, although some fumaroles were measured in 1978 (H₂O/CO₂ = 17) and after the eruption in August 1990 (H₂O/CO₂ = 7.7) (Global Volcanism

Program, 1990). Moreover, although melt inclusion compositions can be in principle used to identify the CO₂ fluxing (Wallace, 2005) it is becoming increasingly apparent that a significant part of the CO₂ can be trapped in bubbles inside the inclusion, and thus the data is also difficult to interpret in terms of fluid fluxing. To test the CO₂ fluxing hypothesis we propose, we have performed a series of calculations based on some observations and mass balance as we describe below.

The change in Mg-Fe in reversely zoned Opx can be explained by a water loss of the melt from about 4 wt. % to about 2 wt. % (section 5.2.1, Fig. S6), which we propose it is due to addition of CO₂ of mafic magma from depth or limestone assimilation. Assuming that the melt is fluid saturated, we calculated the concentration of CO₂ that would need to be added to the melt to decrease the water content in the melt from about 4 to 2 wt. % (Table 2.6). For this we used two end-member cases of the initial (pre- fluxing) CO₂ concentration in the melt, one close to zero and another of 336 ppm as measured in melt inclusions from the 2014 magma (Cassidy *et al.*, 2016). We found that for these two end members, the melt would have gained about 420 ppm to 760 ppm CO₂. Taking into account the crystal proportions and volume of the eruption (DRE) (which corresponds to 180 Mt of erupted magma) gives that between about 0.08 to 0.14 Mt of CO₂ should have been added to the melt.

To further test whether these are realistic amounts of CO₂ we also calculated: (1) the mass of pure limestone and basaltic magma that would be need to degas to generate such mass of CO₂, and (2) the time that would be required to degas such amount of CO₂ using the degassing fluxes from other opne vent volcanoes in Java. We describe these below in two sections., and where our calculations are summarized in Table 2.6. Such sources of CO₂-dominated fluids could come from the degassing of deep-seated basaltic magma, for example at Cerro Negro (Lowenstern, 2001) or Galunggung (Sisson and Bronto, 1998), or from assimilation of limestone or volcanoclastic crustal sediment underlying Kelud that commonly underlie active volcanoes along the Sunda Arc. Calc-silicate skarn xenoliths have been found in rocks from the more recent 2007 dome (Jeffery *et al.*, 2013), and crustal limestones also outcrops in some localities around East Java (e.g. Smyth *et al.*, 2007). Jeffery *et al.* (2013) suggested that crustal assimilation likely came from volcanoclastic crustal sediment making up most of the country rock (~25% contamination), with limestone and

skarns possibly making up smaller portions, as well. This contrasts with other volcanoes such as Merapi, where limestone is the dominant source of crustal contaminant (Handley *et al.*, 2014). The process of crustal CO₂ assimilation reaction at volcanoes such as Merapi (Central Java, Indonesia) is shown to enhance the intensity of explosive eruptions by a factor of 3-5 (Troll *et al.*, 2012), and could make a significant contribution to the overall volatile budget of the magma (Deegan *et al.*, 2010). Thus, we calculated the amount of mass contribution of either limestone assimilation or basalt degassing from depth to produce the change in CO₂ in the melt that we have estimated (Table 6). Here we assume that the entirety of the CO₂ exsolved originates either from limestone assimilation or degassing of basaltic magma. We used the stoichiometric concentration of CO₂ in pure limestone, and basaltic magma containing 0.5-1 wt. % CO₂. We find that it would require up to 0.13-0.23 Mt of limestone or CO₂ from 15-55 Mt basaltic magma, although this is likely an underestimation. These masses are much smaller than the total amount of magma erupted, and thus they seem realistic.

Finally, it is also worth evaluating whether accumulating such an amount of CO₂ fluid before eruption is realistic. To do this, we consider CO₂ fluxes from passively degassing volcanic plumes of volcanoes that are similar to Kelud in terms of magma composition, tectonic setting, and geographical location, as we do not have CO₂ fluxes from Kelud itself. Aiuppa *et al.* (2019) reported 104 tonnes/day of CO₂ for Merapi, 1.1 kt/day for Raung-Ijen, and 2.1 kt/day for Bromo-Semeru. Using a range of these values (Table 2.6) we find that to flux 0.14 Mt would require CO₂ fluxes between that of Bromo-Semeru (2.2 kt/day or 64 days) and Raung-Ijen (1.1 kt/day or 126 days). These times are short compared to the inter-eruptive repose at Kelud of several years, and thus our estimates of accumulation time also seem realistic. In summary, we believe that it is possible that the estimated amount of fluids can flux through Kelud's magmatic system and accumulate months before eruption.

Regardless of its source, volatile fluxing can thus affect the textures and compositions of minerals without necessarily affecting the bulk rock composition, if no crystal cargo were brought up with the volatiles. Most importantly, CO₂ fluxing favours the exsolution of water and thus a dehydration of the melt (Spilliaert *et al.*, 2006), thereby promoting enhanced magma crystallization as well as the accumulation of an exsolved fluid phase. Fluid addition dominated

by CO₂ from depth or through crustal contamination plus crystallization at the shallow parts of the plumbing system can lead to melt supersaturation in volatiles, and the creation of an exsolved volatile phase, for which we have found also evidence using the SO₂ budget of the eruption (Table 2.7). Given that Kelud's morphology is analogous to that of a semi-plugged volcano (Whelley *et al.*, 2015), fluid accumulation in the reservoir is possible and may lead to the overpressure necessary to promote explosive eruptions (Stock *et al.*, 2016). Various studies of the 2014 eruption have also proposed that the 1990 eruption of Kelud was probably driven by volatile accumulation rather than magma replenishment, in a similar manner to that of the 2014 eruption and the Calbuco 2015 eruption in Chile (Arzilli *et al.*, 2019; Cassidy *et al.*, 2019; Namur *et al.*, 2020; Pardini *et al.*, 2018).

Table 2.7: Petrologic calculations of outgassed SO₂, compared with satellite (TOMS) detection of SO₂ emissions during the 1990 Kelud eruption, following the methodology of Jay *et al.* (2014).

1. Kelud's excess SO ₂ gas	90-23	Units
Erupted volume (DRE)	0.13	km ³
Rock density	2402	kg/m ³
Mass of magma	312	Mt
Concentration of SO ₂ melt Inclusion	440	ppm
Concentration of SO ₂ interstitial glass	90	ppm
Glass proportion	0.53	
2. Petrologic calculations		
SO ₂ degassed from the melt	0.05	Mt
3. Volcanic gas satellite measurements		
Atmospheric SO ₂	0.17	Mt
Excess SO ₂ exsolved from melt	0.12	Mt

2.5.3. Time scales of processes and relation to monitoring data

The monitoring records that we have compiled may also be related to fluid movement and accumulation prior to the 1990 eruption and which were captured as unrest signals.

Vandemeulebrouck *et al.* (2000) showed that the baseline low frequency hydroacoustic noise started to increase as far back as April 1989. Although the baseline increase was lower than the unrest observed in November-February, this could indicate that the volatile pressure had increased enough to allow gases to leak to the surface and reach the bottom of the lake. In the November-February unrest period there is a stepwise increase in lake temperature, with a temporary dip in January due to a short rainfall episode (Fig 12b). This trend in lake temperature is accompanied by a significant increase in the hydroacoustic noise level in the ultrasonic band after the November swarm (Fig 12d). However, ultrasonic noise levels declined after the January swarm until just before the eruption, in contrast with the gradual increase in audiometric noise level. Vandemeulebrouck *et al.* (2000) interpreted these variations as the hydrothermal system opening up to prime for an eruption, with the drop in January reflecting a large outgassing episode into the lake.

In addition to the hydroacoustic record, the unrest include two major VT seismic swarms in November and January, accompanied by sharp pulses in seismic energy release (Fig 12c) (Lesage & Surono, 1995). Between these swarms, there is incremental increase in both number of VT earthquakes and a minor spike in seismic energy release. Lesage & Surono (1995) interpreted these patterns in seismicity as originating from the brittle plug fracturing and opening of the system. Thus, it seems possible that the plug was fractured from a combination of pulses of fluid fluxing (seismic swarms) and accumulation fluids exerting overpressure on the plug (incremental increase in seismicity). Our interpretation of the changes in Mg-number of pyroxene (reversely zoned crystals) is that they record a decrease in the water content in the melt due to CO₂-dominated fluids from depth (basaltic magma or limestone degassing) rather than more primitive magma intrusion. Our models of equilibration of the Fe/Mg zoning of these same pyroxenes gave times of 2-3 months before the eruption, which is within the duration of unrest signals in both the seismicity (Lesage & Surono, 1995), crater lake temperature, and hydroacoustics (Vandemeulebrouck *et al.*, 2000)(Fig. 12a-d). However, we do not observe an exact match between timing of the crystals and the changes of the monitoring parameters. Crystal zoning timescales precede the recorded seismic swarms or spikes in seismic energy by up to a week, and steep increases of the lake temperature and/or hydroacoustic signals by up to two weeks. This is

different from other studies where the match between the crystal zoning and seismicity has been reported (Costa *et al.*, 2020; Kahl *et al.*, 2011; Saunders *et al.*, 2012). Although we do not have enough data in crystal zoning to make it statistically robust observation, such a time difference could be related to the lag of time between the phenomena of fluid percolation from depth and the processes that are responsible for the changes in seismic data and water lake changes. Finally, we emphasize that our diffusion timescales are considerably longer than what would be expected for a simple process of magma decompression and ascent from depth and thus the zoning recorded in the pyroxenes is more likely due to the fluid fluxing than simple magma ascent, where most of the orthopyroxene cores and rims would likely have crystallized at saturation pressure; relatively few pyroxene crystallized below the saturation depth. As noted in the previous section, it seems possible to add the necessary mass of CO₂ to the system in times of a few months and thus it is compatible with duration of the unrest and also with the time scales of the crystals.

Fig. 2.12: (a) Histogram of calculated Opx and Cpx diffusion timescales (recalculated dates before the 1990 eruption day) compared to the pre-eruptive temporal evolution of (b) crater lake temperature (Vandemeulebrouck et al., 2000); (c) seismicity (black histogram = number of VT events per hours, red line = cumulative seismic energy) (Lesage and Surono, 1995); and (d) hydroacoustics (audiometric and ultrasonic bands) signals (Vandemeulebrouck et al., 2000). Vertical red bands highlight the timing of seismic swarms and are used as a visual guidance and comparison to changes in other data. The missing data interval in lake temperature and hydroacoustics was due to power supply failure.

2.5.4. A general model for Kelud eruptions and their relation to other volcanoes

We believe that a simple conceptual model to explain the explosive (e.g. VEI 4) but short-lived eruptions, that have limited unrest until very close to the eruption is the accumulation of a pre-existing volatile phase over time, and especially the addition of fluids from depths that may overpressure the system to fracture the plug. The resulting eruption is highly explosive but very brief, because it is mainly driven by accumulated fluids in the upper parts of the system. The monitoring data show that for volcanoes with a water lake, it might be possible to identify when the fluid pressure has become large enough for gases to start leaking towards the surface and affect the hydroacoustics and lake temperature. Although changes in seismicity occur much closer to eruption, especially the exponential increases that are typically associated with run-away processes and failure of the rocks (e.g. Nakamichi *et al.*, 2017).

Fluid accumulation may also explain why these eruptions also show limited unrest in terms of signals and duration, whereas we would expect renewed intrusions with more primitive magma and the significant addition of mass to have much stronger signals, especially seismicity as seen at other volcanoes such as Soufrière Hills, Montserrat (Murphy *et al.*, 1998; Plail *et al.*, 2018), Tungurahua (Myers *et al.*, 2014; Samaniego *et al.*, 2011), and Ruapehu (Conway *et al.*, 2018; Kilgour *et al.*, 2013). From a petrologic and monitoring perspective, we can consider the 2014 eruption of Kelud as an intra-volcanic analogue to the 1990, as it was quite similar in many volcanological and petrological attributes to the 1990 eruption. In turn, the 1990 and 2014 eruptions are similar to the VEI 4 explosive eruption of Calbuco volcano in 2015. Prior to the 2015 eruption, Calbuco also had a protracted repose time with the last recorded activity in 1996, yet experienced a short and subdued unrest of only 2-3 hours before erupting explosively (VEI 4) (Global Volcanism Program, 2015). The similarities between these different eruptions and volcanoes may indicate that they operate by similar processes, and that fluid fluxing from depth accompanied by accumulation of a pre-existing volatile phase can be a major scenario to be considered for future events (e.g. Petrelli *et al.*, 2018).

2.6. Conclusion

The combined petrological and monitoring data we report for the Kelud 1990 eruption

suggest that the explosive but short-lived event was probably driven by accumulation of exsolved fluids at the top of the plumbing system. Fluxing of CO₂-dominated fluids from depth was likely a main contributor to the over pressures that eventually broke a plugged conduit necessary for the eruption to occur. The fluid fluxing promoted partial dehydration of the magma, leading to crystallization and second boiling and additional fluid exsolution. Diffusion profiles in zoned pyroxene crystals allow us to infer fluid fluxing and overpressure build up in the shallow magmatic system began 2-3 months before the eruption. This time frame which matches with the onset and duration of both seismic and crater lake unrest signals. The conceptual model we propose is likely applicable to other short-lived but explosive eruptions with limited unrest such the 2014 Kelud eruption or the 2015 Calbuco in Chile.

2.7. ACKNOWLEDGEMENTS

We thank C.Widiwijayanti, S.Jenkins, J.Herrin, J. Oalman, L. Cheng, G. Fabbro, R.I. Made, D. Schonwalder, L. Siang Joo, and E. Y. Yin for assistance with sample preparation, analyses and discussions on the Kelud volcano system. We also thank student assistants W. Wijaya and J. Fu for digitizing historical unrest records. Thanks also go to J. Vandemeulebrouck for providing the original dataset for the hydroacoustic measurements. This research was supported by the Earth Observatory of Singapore via its funding from the National Research Foundation Singapore and the Singapore Ministry of Education under the Research Centres of Excellence initiative. The data underlying this article are available in the article and in its online supplementary material.

2.7. Supplementary Material

Fig. S2.1: Normalized whole rock and glass MgO vs. $\text{CaO}/\text{Al}_2\text{O}_3$ showing trends of post entrapment crystallization in melt inclusion walls.

Fig. S2.2: (a) Primitive mantle normalized extended trace element diagram; (b) CI chondrite normalized rare earth elements plot.

Fig. S2.3: Cpx chemistry, subdivided into the same textural groups as Opx. (a) Wo and (b) En.

Fig. S2.4: Fe-Ti oxide mineral chemistry histograms, subdivided into: (a) Main- and late-stage Mag, and (b) Late-stage Ilm.

Fig. S2.5: Selected Opx-melt and Cpx-melt core to rim traverses with calculated temperature, melt Fe/Mg, pyroxene Fe/Mg, and DK_d . (See Thesis Appendix).

Fig. S2.6: Representative profiles of pyroxene phenocrysts used to model timescales. (a) BSE image of Opx with traverse analysis shown by a red arrow. (b) Traverse analysis in Opx, showing distance from rim to core vs. Mg #, with model timescales. (c) Same as a) for Cpx. (d) Same as b) for Cpx.

Fig. S2.7: Timescales of diffusion for main- and late-stage pyroxenes: (a) late-stage pyroxene (b) main-stage pyroxene.

Fig. S2.8: Plot of H₂O vs. CO₂ isobars calculated by VolatileCalc (Newman and Lowenstern, 2002) overlain by paths of CO₂ addition through fluxing and models of closed-system degassing paths determined by the starting point (maximum water saturation, or analogous to the 2014 eruption; Cassidy *et al.*, 2016).

Fig. S2.9: Pressure estimates from Cpx-melt geobarometers using formulations by (a) Neave and Putirka (2017), and (b) Putirka (2008).

Table S2.1: Summary of unrest signals (seismicity, crater lake temperature, and hydroacoustics) recorded before the 1990 eruption of Kelud. Description of unrest came from geophysical, hydroacoustics, and lake parameters, and interpretation of processes from literature. References are coded as follows: [1] VSI (Volcanological Survey of Indonesia) Reports of Activity of the Kelud Volcano 1989-1990 (in Indonesian); [2] Vandemeulebrouck *et al.* (2000); [3] Lesage & Surono (1995); [4] Pardyanto (1990); [5] Badrudin (1994); [6] Sudradjat & Siswowidjoyo (1993); [7, 8] Global Volcanism Program (1990). All times quoted are at GMT + 7 hours. SPL = Sound Pressure Level.

Phases	Days before eruption*	Duration*	Description	Start Date	End Date	Historical Account*	Ref	Seismicity	Ref	Hydro Acoustics	Ref	Lake Chem	Ref	Others	Ref	Ref	Hazard mitigation strategies employed*	Ref		
Pre-unrest	-316	70 days	Initiation of unrest	April 1989	1 Nov 1989 (main unrest start)			Seismicity averaged ~10 VT earthquakes monthly and small swarms	1	Steady increase in baseline of low frequency (1-50 Hz) SPL band	2						Lake starting to boil at depth, likely from increased fumarolic activity with thermal input from incoming volcanic gas	2		
First Phase	-102	80 days	Main unrest	1 Nov 1989 (Nov swarm start)	19 Jan 1990 (Jan swarm end)			Seismicity comprise VT A type (Minakami, 1960) earthquakes, seismic multiplets, monochromatic events	2, 3	Increase in low frequency SPL band recorded	2	pH decreased from 5.3 to 3.8	5	ARGOS: Lake bottom T rise from 30°C to 60°C	2, 3, 4		Hydroacoustics: heating and pressurization of hydrothermal system with distinct degassing regimes and fluid saturation pressure	2	Evacuation drill practised and communication network established	6
								Two major seismic VT swarms (Dec 1989 and Jan 1990) released significant portions of seismic energy	3	Increase in audiometric (500-5000 Hz) SPL band in Nov 1989	2	Increase in volatile elements e.g. Cl, B, SO4 detected	5	ARGOS: Lake surface T rise from 30°C to 48°C	2, 3, 4		Lake temperature: enhanced convection due to thermal energy input with incoming gas	2		
								Seismicity recorded remained moderately above pre-unrest levels between swarms until Jan 1990	3	Increase in ultrasonic (20-1000 kHz) in Dec 1989, plateaus, and then irregularly decreased after the Jan seismic swarm	2	Increase in leached rock forming elements e.g. Na, K, Mg, Ca, Si	5	Exsolution of whitish colloidal sulfur globules	2		Seismicity: suggests fracturing of a brittle plug likely from remnant 1966 lava along with magma migration to shallow depths	3		

Phases	Days before eruption*	Duration*	Description	Start Date	End Date	Historical Account*	Ref	Seismicity	Ref	Hydro Acoustics	Ref	Lake Chem	Ref	Others	Ref	Ref	Hazard mitigation strategies employed*	Ref		
Second Phase	-23	22 days	Temporary quiescence	19 Jan 1990 (Jan swarm end)	9 Feb 1990 (midnight)			Relocated hypocentral distances using interspectral methods show sources were 150-750m below crater bottom	2					Lake level subsidence	2		Lake chemistry: increase in fumarolic activity coupled with dissolution of wall rock from incoming gas	4		
								Seismic multiplet hypocentral distances were relocated to sources with distances of <30m apart	3					Lake colour turned from green (normal) to white (unrest)	6					
								Seismicity drops significantly in both number of events and energy released		Hydroacoustic noise plateaus at all frequency bands	2									
Third Phase	-1	1 days	Escalation	9 Feb 1990 (midnight)	10 Feb 1990 11:41 (Start of eruption)	Seismicity spiked on 9 Feb, 9:37	1, 6	Micro-tremors were recorded 2 hours before the eruption	3, 6					Temperature increase recorded at the lake	3		Exchanges between magma, hydrothermal system, and lake	2	Tentative call of eruption announced when earthquake amplitude increased at 9:00 am	6
						Seismicity evolved from discrete episodic events to successive drumbeat to continuous saturating signals at around 9:45am	2, 3	>400 low magnitude, low energy earthquakes detected, but unfelt	3, 6					Strong bubbling noise heard	3		Geothermal self-sealing process	2		
Eruption	+ 1 day			10/2/90 11:41		Strong explosive eruption with large eruption plume. Hazards: volcaniclastic flow, pyroclastic flow, lahar, ash fall.	6													

Phases	Days before eruption*	Duration*	Description	Start Date	End Date	Historical Account*	Ref	Seismicity	Ref	Hydro Acoustics	Ref	Lake Chem	Ref	Others	Ref	Ref	Hazard mitigation strategies employed*	Ref
Post-eruption	+ 2	+ 54 minutes		10/2/90 11:41	10/2/90 12:35	Eruption began at 11:41 am local time with a series of a phreatic blasts producing a 5 km plume, then followed by 5 phreatomagmatic explosions.	3										2	
		+ 6 hours 25 minutes		10/2/90 12:35	10/2/90 17:00	12:35 marked start of paroxysmal eruption phase with pyroclastic flows Large Plinian column (>10 km, with some reports up to 12 km) started and was sustained 'for a few hours'	3											
		+ approx. 2 days		10/2/90 17:00	11/2/1990- 12/2/1990	Heavy ashfall observed at Margomulyo observatory at 17:00	3, 6, 8											
						Several small explosions occurred during the night of the 10 Feb eruption along with ash fall	3											
				15/12/90	20/2/90	Post-eruptive lahars began and continued for several days due to heavy rain. Minor eruptive activity for ~ 2 hours on 16 Feb 1990 sent ash clouds 600m above vent.	7											
		+ 8 days		12/2/90	20/2/90	The eruption was declared as ended	6											

Phases	Days before eruption*	Duration*	Description	Start Date	End Date	Historical Account*	Ref	Seismicity	Ref	Hydro Acoustics	Ref	Lake Chem	Ref	Others	Ref	Ref	Hazard mitigation strategies employed*	Ref	
Post-eruptive activity	+ 150 days			20/2/90	19/7/90	Crater deepened and unstable, landslides frequent, with open vent blowing steam and gas	8												
	+ 187-195 days				25/8/1990-2/9/1990	Arcuate fractures 1-20m deep cut thick tephra layers emitting high T gas. Active vents emit white/blue gases	8							Lake replaced by muddy water (T = 85°C)	8		Gas emitted may represent passive degassing of pyroclastic deposits or active degassing of shallow magma	8	Reports from an international investigation team of VSI (Indonesia), CNRS, and U. Paris (France)

Table S2.3: Representative compositions of melt inclusions and interstitial glasses, as well as calculated melt compositions.

Sample	Stage	Analyses	SiO ₂	TiO ₂	Al ₂ O ₃	FeO*	MnO	MgO	CaO	Na ₂ O	K ₂ O	P ₂ O ₅	Cl	SO ₃	Total	Original Total
<i>Glass Inclusions</i>																
PL1new-MI1-5	main	EPMA	69.09	0.58	15.18	4.16	0.18	0.98	3.34	4.43	1.63	0.18	0.19	0.04	100	94.73
PL2glass2MI4	late	EPMA	75.59	0.05	14.08	1.40	0.08	0.20	1.64	4.67	2.12	0.05	0.12	<0.01	100	95.88
<i>Interstitial Glass</i>																
90BR2-MI2-glass-ig1	main	EPMA	68.52	0.55	15.14	4.36	0.12	1.09	3.80	4.42	1.67	0.18	0.15	0.01	100	97.07
PL2pseudo1gm2	late	EPMA	78.75	0.16	11.82	1.02	0.03	0.09	0.61	3.77	3.47	-0.00	0.24	0.03	100	99.05
<i>Calculated Melt</i>																
90B-calc	main	Calculated	63.85	0.25	17.10	4.18	0.17	2.43	6.95	3.62	1.22	0.23	NA	NA	100	
9023-calc	main	Calculated	65.93	0.48	15.33	3.66	0.25	1.93	7.10	3.65	1.38	0.29	NA	NA	100	
PL1-calc	main	Calculated	63.90	0.20	17.75	3.45	0.18	2.34	6.83	3.66	1.38	0.32	NA	NA	100	
BR-calc	main	Calculated	63.41	0.24	17.19	4.76	0.19	2.23	6.90	3.51	1.30	0.28	NA	NA	100	
90-20-calc	main	Calculated	65.65	0.38	17.44	2.74	0.17	0.97	7.30	3.87	1.25	0.22	NA	NA	100	
90-2-calc	main	Calculated	65.58	0.54	15.72	4.39	0.20	1.37	6.87	3.78	1.31	0.23	NA	NA	100	
PL2-calc	late	Calculated	66.18	0.02	16.78	4.08	0.20	2.41	4.97	3.78	1.32	0.26	NA	NA	100	

Table S2.4: Summary of both Plag and interstitial glass compositions, temperature, and water content used to compute saturation pressures, based on the Ghiorso and Gualda (2015) model. Lithostatic depths were derived from the averaged local crust density from Smyth *et al.* (2007).

Sample ID	grain ID	Type	Geo-thermo-barometer	Texture	T (°C)	Water Content	Plag Composition		Glass Composition								Sat P (MPa)	Sat Depth (km)
							X(An)	X(Ab)	SiO2	TiO2	Al2O3	FeO	MgO	CaO	Na2O	K2O		
Main-stage magma																		
90B	PLG-b2	rim	Opx-Liquid	Rim - Interstitial Glass	943	4.1	0.61	0.39	66.71	0.5	15.51	4.37	1.29	4.1	4.22	1.54	190	7.3
90B	PLG-r3	rim	Opx-Liquid	Rim - Interstitial Glass	943	4.1	0.61	0.40	66.71	0.5	15.51	4.37	1.29	4.1	4.22	1.54	190	7.3
90B	PLG-r5	rim	Opx-Liquid	Rim - Interstitial Glass	943	4.2	0.66	0.34	66.71	0.5	15.51	4.37	1.29	4.1	4.22	1.54	194	7.5
90B	PLG-y2	rim	Opx-Liquid	Rim - Interstitial Glass	943	4.1	0.63	0.37	66.71	0.5	15.51	4.37	1.29	4.1	4.22	1.54	190	7.3
90B	PLG-y4	rim	Opx-Liquid	Rim - Interstitial Glass	943	4.1	0.63	0.37	66.71	0.5	15.51	4.37	1.29	4.1	4.22	1.54	190	7.3
90B	PLG-y5	rim	Opx-Liquid	Rim - Interstitial Glass	943	4.1	0.62	0.38	66.71	0.5	15.51	4.37	1.29	4.1	4.22	1.54	190	7.3
90B	PLG-b4	rim	Opx-Liquid	Rim - Interstitial Glass	943	4.1	0.61	0.39	66.71	0.5	15.51	4.37	1.29	4.1	4.22	1.54	190	7.3
90B	PLG-b4	rim	Opx-Liquid	Rim - Interstitial Glass	943	4.2	0.67	0.33	66.71	0.5	15.51	4.37	1.29	4.1	4.22	1.54	194	7.5
90B	PLG-b1	rim	Opx-Liquid	Rim - Interstitial Glass	943	4.1	0.61	0.39	66.71	0.5	15.51	4.37	1.29	4.1	4.22	1.54	190	7.3
PL1	PL1-plag1	microlite	Opx-Liquid	Microlite - Interstitial Glass	943	4.1	0.66	0.34	66.96	0.49	15.14	3.48	1.24	4.09	4.65	1.57	190	7.3
PL1	PL1-plag2	microlite	Opx-Liquid	Microlite - Interstitial Glass	943	4.0	0.59	0.41	66.96	0.49	15.14	3.48	1.24	4.09	4.65	1.57	186	7.2
PL1	PL1-plag2	microlite	Opx-Liquid	Microlite - Interstitial Glass	943	4.1	0.65	0.35	66.96	0.49	15.14	3.48	1.24	4.09	4.65	1.57	190	7.3

Sample ID	grain ID	Type	Geo-thermo-barometer	Texture	T (°C)	Water Content	Plag Composition		Glass Composition								Sat P (MPa)	Sat Depth (km)
							X(An)	X(Ab)	SiO2	TiO2	Al2O3	FeO	MgO	CaO	Na2O	K2O		
PL1	PL1-plag3-row1-core	microlite	Opx-Liquid	Microlite - Interstitial Glass	943	4.2	0.74	0.26	66.96	0.49	15.14	3.48	1.24	4.09	4.65	1.57	194	7.5
PL1	PL1-plag3-row3	microlite	Opx-Liquid	Microlite - Interstitial Glass	943	4.1	0.64	0.36	66.96	0.49	15.14	3.48	1.24	4.09	4.65	1.57	190	7.3
PL1	PL1-plag3-row4-rim	microlite	Opx-Liquid	Microlite - Interstitial Glass	943	4.1	0.72	0.28	66.96	0.49	15.14	3.48	1.24	4.09	4.65	1.57	190	7.3
					15	4.1	0.6	0.4	66.8	0.5	15.4	4.0	1.3	4.1	4.4	1.6	190.6	7.4
90B	KELUT90B-PLG-b2-10nA	rim	Opx-Liquid	Rim - Interstitial Glass	979	3.4	0.61	0.39	66.71	0.5	15.51	4.37	1.29	4.1	4.22	1.54	163	6.3
90B	KELUT90B-PLG-r3-10nA	rim	Opx-Liquid	Rim - Interstitial Glass	979	3.4	0.61	0.40	66.71	0.5	15.51	4.37	1.29	4.1	4.22	1.54	163	6.3
90B	KELUT90B-PLG-r5-10nA	rim	Opx-Liquid	Rim - Interstitial Glass	979	3.5	0.66	0.34	66.71	0.5	15.51	4.37	1.29	4.1	4.22	1.54	165	6.4
90B	KELUT90B-PLG-y2-10nA	rim	Opx-Liquid	Rim - Interstitial Glass	979	3.5	0.63	0.37	66.71	0.5	15.51	4.37	1.29	4.1	4.22	1.54	164	6.3
90B	KELUT90B-PLG-y4-10nA	rim	Opx-Liquid	Rim - Interstitial Glass	979	3.5	0.63	0.37	66.71	0.5	15.51	4.37	1.29	4.1	4.22	1.54	165	6.4
90B	KELUT90B-PLG-y5-10nA	rim	Opx-Liquid	Rim - Interstitial Glass	979	3.4	0.62	0.38	66.71	0.5	15.51	4.37	1.29	4.1	4.22	1.54	163	6.3
90B	KELUT90B-PLG-b4-10nA	rim	Opx-Liquid	Rim - Interstitial Glass	979	3.4	0.61	0.39	66.71	0.5	15.51	4.37	1.29	4.1	4.22	1.54	163	6.3
90B	KELUT90B-PLG-b4-10nA	rim	Opx-Liquid	Rim - Interstitial Glass	979	3.5	0.67	0.33	66.71	0.5	15.51	4.37	1.29	4.1	4.22	1.54	166	6.4
90B	KELUT90B-PLG-b1-10nA	rim	Opx-Liquid	Rim - Interstitial Glass	979	3.4	0.61	0.39	66.71	0.5	15.51	4.37	1.29	4.1	4.22	1.54	163	6.3
PL1	PL1-plag1	microlite	Opx-Liquid	Microlite - Interstitial Glass	979	3.4	0.66	0.34	66.96	0.49	15.14	3.48	1.24	4.09	4.65	1.57	163	6.3

Sample ID	grain ID	Type	Geo-thermo-barometer	Texture	T (°C)	Water Content	Plag Composition		Glass Composition								Sat P (MPa)	Sat Depth (km)
							X(An)	X(Ab)	SiO2	TiO2	Al2O3	FeO	MgO	CaO	Na2O	K2O		
PL1	PL1-plag2	microlite	Opx-Liquid	Microlite - Interstitial Glass	979	3.3	0.59	0.41	66.96	0.49	15.14	3.48	1.24	4.09	4.65	1.57	160	6.2
PL1	PL1-plag2	microlite	Opx-Liquid	Microlite - Interstitial Glass	979	3.4	0.65	0.35	66.96	0.49	15.14	3.48	1.24	4.09	4.65	1.57	162	6.3
PL1	PL1-plag3-row1-core	microlite	Opx-Liquid	Microlite - Interstitial Glass	979	3.5	0.74	0.26	66.96	0.49	15.14	3.48	1.24	4.09	4.65	1.57	166	6.4
PL1	PL1-plag3-row3	microlite	Opx-Liquid	Microlite - Interstitial Glass	979	3.4	0.64	0.36	66.96	0.49	15.14	3.48	1.24	4.09	4.65	1.57	162	6.2
PL1	PL1-plag3-row4-rim	microlite	Opx-Liquid	Microlite - Interstitial Glass	979	3.5	0.72	0.28	66.96	0.49	15.14	3.48	1.24	4.09	4.65	1.57	165	6.4
				Average main stage	15	3.4	0.6	0.4	66.8	0.5	15.4	4.0	1.3	4.1	4.4	1.6	163.4	6.3
Late-stage magma																		
PL2	PL2-2-plag1	rim	Mag-Ilm (Sauerzapf)	Rim - Interstitial Glass	795	5.2	0.38	0.619	78.01	0.16	11.71	1.01	0.09	0.6	3.73	3.44	211	8.1
PL2	PL2-2-plag1	rim	Mag-Ilm (Sauerzapf)	Rim - Interstitial Glass	795	5.3	0.41	0.5	78.01	0.16	11.71	1.01	0.09	0.6	3.73	3.44	212	8.2
PL2	PL2-2-plag1	rim	Mag-Ilm (Sauerzapf)	Rim - Interstitial Glass	795	5.3	0.45	0.547	78.01	0.16	11.71	1.01	0.09	0.6	3.73	3.44	215	8.3
PL2	PL2-2-plag2	rim	Mag-Ilm (Sauerzapf)	Rim - Interstitial Glass	795	5.2	0.4	0.597	78.01	0.16	11.71	1.01	0.09	0.6	3.73	3.44	212	8.2
PL2	PL2-2-plag3	rim	Mag-Ilm (Sauerzapf)	Rim - Interstitial Glass	795	5.2	0.38	0.621	78.01	0.16	11.71	1.01	0.09	0.6	3.73	3.44	211	8.1
PL2	PL2-2-plag3	rim	Mag-Ilm (Sauerzapf)	Rim - Interstitial Glass	795	5.2	0.4	0.5	78.01	0.16	11.71	1.01	0.09	0.6	3.73	3.44	212	8.2
PL2	PL2-2-plag4	rim	Mag-Ilm (Sauerzapf)	Rim - Interstitial Glass	795	5.4	0.58	0.418	78.01	0.16	11.71	1.01	0.09	0.6	3.73	3.44	221	8.5
PL2	PL2-2-plag5	rim	Mag-Ilm (Sauerzapf)	Rim - Interstitial	795	5.2	0.4	0.597	78.01	0.16	11.71	1.01	0.09	0.6	3.73	3.44	212	8.2

Sample ID	grain ID	Type	Geo-thermo-barometer	Texture	T (°C)	Water Content	Plag Composition		Glass Composition								Sat P (MPa)	Sat Depth (km)
							X(An)	X(Ab)	SiO2	TiO2	Al2O3	FeO	MgO	CaO	Na2O	K2O		
				Glass														
PL2	PL2-2-plag5	rim	Mag-Ilm (Sauerzapf)	Rim - Interstitial Glass	795	5.4	0.58	0.419	78.01	0.16	11.71	1.01	0.09	0.6	3.73	3.44	221	8.5
PL2	PL2-plag2-core	microlite	Mag-Ilm (Sauerzapf)	Microlite - Interstitial Glass	795	5.6	0.71	0.288	78.01	0.16	11.71	1.01	0.09	0.6	3.73	3.44	227	8.8
PL2	PL2-plag2-rim	microlite	Mag-Ilm (Sauerzapf)	Microlite - Interstitial Glass	795	5.1	0.31	0.691	78.01	0.16	11.71	1.01	0.09	0.6	3.73	3.44	205	7.9
PL2	PL2-plag3	microlite	Mag-Ilm (Sauerzapf)	Microlite - Interstitial Glass	795	5.3	0.41	0.592	78.01	0.16	11.71	1.01	0.09	0.6	3.73	3.44	212	8.2
PL2	PL2-plag4	microlite	Mag-Ilm (Sauerzapf)	Microlite - Interstitial Glass	795	5.3	0.42	0.58	78.01	0.16	11.71	1.01	0.09	0.6	3.73	3.44	213	8.2
PL2	PL2-plag4	microlite	Mag-Ilm (Sauerzapf)	Microlite - Interstitial Glass	795	5.5	0.61	0.386	78.01	0.16	11.71	1.01	0.09	0.6	3.73	3.44	223	8.6
PL2	PL2-plag5	microlite	Mag-Ilm (Sauerzapf)	Microlite - Interstitial Glass	795	5.5	0.61	0.39	78.01	0.16	11.71	1.01	0.09	0.6	3.73	3.44	223	8.6
PL2	PL2-2-plag1	rim	Mag-Ilm (Ghiorso)	Rim - Interstitial Glass	846	4.0	0.4	0.5	78.01	0.16	11.71	1.01	0.09	0.6	3.73	3.44	154	5.9
PL2	PL2-2-plag1	rim	Mag-Ilm (Ghiorso)	Rim - Interstitial Glass	846	4.0	0.4	0.597	78.01	0.16	11.71	1.01	0.09	0.6	3.73	3.44	154	5.9
PL2	PL2-2-plag1	rim	Mag-Ilm (Ghiorso)	Rim - Interstitial Glass	846	4.0	0.41	0.5	78.01	0.16	11.71	1.01	0.09	0.6	3.73	3.44	154	5.9
PL2	PL2-2-plag2	rim	Mag-Ilm (Ghiorso)	Rim - Interstitial Glass	846	3.9	0.38	0.621	78.01	0.16	11.71	1.01	0.09	0.6	3.73	3.44	152	5.9
PL2	PL2-2-plag3	rim	Mag-Ilm (Ghiorso)	Rim - Interstitial Glass	846	4.2	0.58	0.418	78.01	0.16	11.71	1.01	0.09	0.6	3.73	3.44	162	6.3
PL2	PL2-2-plag4	rim	Mag-Ilm (Ghiorso)	Rim - Interstitial Glass	846	4.0	0.4	0.597	78.01	0.16	11.71	1.01	0.09	0.6	3.73	3.44	154	5.9

Sample ID	grain ID	Type	Geo-thermo-barometer	Texture	T (°C)	Water Content	Plag Composition			Glass Composition							Sat P (MPa)	Sat Depth (km)
							X(An)	X(Ab)	SiO2	TiO2	Al2O3	FeO	MgO	CaO	Na2O	K2O		
PL2	PL2-2-plag4	rim	Mag-Ilm (Ghiorso)	Rim - Interstitial Glass	846	4.2	0.58	0.419	78.01	0.16	11.71	1.01	0.09	0.6	3.73	3.44	162	6.3
PL2	PL2-2-plag5	rim	Mag-Ilm (Ghiorso)	Rim - Interstitial Glass	846	4.0	0.38	0.619	78.01	0.16	11.71	1.01	0.09	0.6	3.73	3.44	152	5.9
PL2	PL2-2-plag5	rim	Mag-Ilm (Ghiorso)	Rim - Interstitial Glass	846	4.1	0.45	0.547	78.01	0.16	11.71	1.01	0.09	0.6	3.73	3.44	156	6.0
PL2	PL2-2-plag5	rim	Mag-Ilm (Ghiorso)	Rim - Interstitial Glass	846	4.1	0.45	0.547	78.01	0.16	11.71	1.01	0.09	0.6	3.73	3.44	156	6.0
PL2	PL2-plag1	microlite	Mag-Ilm (Ghiorso)	Microlite - Interstitial Glass	846	4.3	0.71	0.288	78.01	0.16	11.71	1.01	0.09	0.6	3.73	3.44	167	6.4
PL2	PL2-plag2-core	microlite	Mag-Ilm (Ghiorso)	Microlite - Interstitial Glass	846	3.8	0.31	0.691	78.01	0.16	11.71	1.01	0.09	0.6	3.73	3.44	148	5.7
PL2	PL2-plag3	microlite	Mag-Ilm (Ghiorso)	Microlite - Interstitial Glass	846	4.0	0.41	0.592	78.01	0.16	11.71	1.01	0.09	0.6	3.73	3.44	154	5.9
PL2	PL2-plag3	microlite	Mag-Ilm (Ghiorso)	Microlite - Interstitial Glass	846	4.2	0.61	0.386	78.01	0.16	11.71	1.01	0.09	0.6	3.73	3.44	163	6.3
PL2	PL2-plag4	microlite	Mag-Ilm (Ghiorso)	Microlite - Interstitial Glass	846	4.0	0.42	0.58	78.01	0.16	11.71	1.01	0.09	0.6	3.73	3.44	154	6.0
PL2	PL2-plag4	microlite	Mag-Ilm (Ghiorso)	Microlite - Interstitial Glass	846	4.2	0.61	0.39	78.01	0.16	11.71	1.01	0.09	0.6	3.73	3.44	163	6.3
				<i>Average late-stage</i>	<i>15</i>	<i>5.3</i>	<i>0.47</i>	<i>0.52</i>	<i>78.01</i>	<i>0.16</i>	<i>11.71</i>	<i>1.01</i>	<i>0.09</i>	<i>0.60</i>	<i>3.73</i>	<i>3.44</i>	<i>215</i>	<i>8.3</i>

Table S2.5: Summary of Opx/Cpx diffusion timescales, and magma ascent rates estimated from these timescales and historical reports. Either the modal best fit or the maximum timescale was used to calculate the rate of degassing, assuming the lithostatic depth corresponds to the maximum saturation pressure.

Mineral	Diffusion pair	Method	main (n)	late (n)	T type	T (°C)	log(<i>f</i> O ₂)	t range (days)	timescale type	Timescale (days)	Geological Interpretation	Max. Sat P (MPa)	Depth (m)	Calculated rate (m/s)
Orthopyroxene	Mg-Fe diffusion	Dohmen et al. (2016)	20		Opx-melt (rim-glass)	979	-9.6	20-110	modal	90	degassing	174	6728	0.0009
	Mg-Fe diffusion	Dohmen et al. (2016)		14	Opx-melt (calculated melt)	972	-9.7	11-102	modal	69	remobilization + degassing	174	6728	0.0011
	Mg-Fe diffusion	Ganguly and Tazzoli (1994)	20		Opx-melt (rim-glass)	979		4-50	modal	21	degassing	174	6728	0.0037
	Mg-Fe diffusion	Ganguly and Tazzoli (1994)		14	Opx-melt (calculated melt)	972		2-17	mean	9	remobilization + degassing	174	6728	0.0087
Clinopyroxene	Mg-Fe diffusion	Müller et al. (2013)	2		Cpx-melt (rim-glass)	1023		32-123	max	123	CO2 flushing	174	6728	0.0006
	Mg-Fe diffusion	Müller et al. (2013)		2	Cpx-melt (calculated melt)	976		60-104	max	104	CO2 flushing	174	6728	0.0007
								Non-mineral parameter	t (days)	Time (s)				
								Onset of seismicity	0.5	43200	magma ascent	174	6728	0.16

Table S2.6: Summary of historical volcanic activity and trigger processes driving eruptions for Merapi and Kelud. Classification scheme for the type of volcano is from Whelley *et al.* (2015). Information on eruption parameters and unrest duration is taken from the Global Volcanism Program (volcano.si.edu/), Pallister *et al.* (2013), Ratdomopurbo *et al.* (2013), Lesage & Surono (1995), and Hidayati *et al.* (2018). Magmatic processes are taken from Costa *et al.* (2013) for Merapi and from this study for Kelud.

Volcano	Merapi	Kelud
Type (Whelley et al., 2015)	Open-vent stratocone	Semi-plugged stratocone
Years of recorded activity	~11,000	~2,300
Notable explosive eruptions	1930, 1961, 1992, 2010, 2014, 2018	1901, 1919, 1951, 1966, 1990, 2014
Notable effusive eruptions	2006	1920, 2007
Modal VEI (since 1900 CE)	2	4
Modal VEI > 2 (since 1900 CE)	3	4
No. eruptions (Total) (GVP)		
Since 1000 CE	87	40
Since 1900 CE	27	10
No. eruptions (VEI > 2) (GVP)		
Since 1000 CE	19	22
Since 1900 CE	5	6
VEI > 2 eruption / Total Eruption		
Volcano	Merapi	Kelud
Since 1000 CE	0.22	0.55

Since 1900 CE	0.19	0.60
Recurrence interval (VEI > 2)		
Since 1000 CE	54	46
Since 1900 CE	20	17
Approximate unrest duration		
Seismic (earliest reported detection)	months to years	days to months
Deformation (earliest reported detection)	months to years	months
Approximate eruption duration	weeks to years (explosive), months (effusive)	days (explosive), months (effusive)
Trigger processes (Costa et al., 2013; Li et al., 2020)	Magma mixing + volatile flushing+ carbonate assimilation	volatile flushing + degassing

Table S2.7: Representative Opx-melt, Cpx-melt, and Opx-Cpx temperature ranges computed across traverses of reversely zoned Opx and Cpx phenocrysts, microlites, and Opx-Cpx overgrowths.

Mineral	Stage	Texture	Mineral growth zone	Melt Pair	Opx Mg #	Cpx Mg #	Opx-Liquid T ($\pm 48^\circ\text{C}$)	Cpx-Liquid T ($\pm 42^\circ\text{C}$)	Opx-Cpx QUIF T ($\pm 20^\circ\text{C}$)
Opx	Main	Reversely zoned	core	Whole rock	67-70		991-1053		
		Reversely zoned	rim	Interstitial glass	70-74		943-1002		
		Reversely zoned	rim	calculated melt	70-74		968-1022		
		Microlite	core	Interstitial glass	69-74		969-1016		
		Microlite	core	calculated melt	67-70		969-983		
	Late	Reversely zoned	core	Whole rock	68-73		1043-1065		
		Reversely zoned	rim	calculated melt	59-72		966-975		
		Microlite	core	calculated melt	64-69		998-1015		
	Cpx	Reversely zoned	core	Whole rock		70-76		1005-1060	
		Reversely zoned	rim	interstitial glass		72-76		956-1053	
		Reversely zoned	rim	calculated melt		72-76		956-1027	
	Late	Reversely zoned	core	Whole rock		70-76		1027-1064	
		Reversely zoned	rim	calculated melt		68-76		926-987	
Opx-Cpx	Main	Core-Core				70-76			947-1094
		Rim-Rim				72-76			984-1082
		Microlite-Microlite				74			996-1082

Mineral	Stage	Texture	Mineral growth zone	Melt Pair	Opx Mg #	Cpx Mg #	Opx-Liquid T ($\pm 48^{\circ}\text{C}$)	Cpx-Liquid T ($\pm 42^{\circ}\text{C}$)	Opx-Cpx QUIF T ($\pm 20^{\circ}\text{C}$)
Opx-Cpx	Late	Core-Core				70-76			990-1024
		Rim-Rim				72-76			956-1027
		Microlite-Microlite				72			949-1028
Opx-Cpx	Main	Overgrowth	Opx-Cpx			72-73			973-1003
Opx-Cpx	Late	Overgrowth	Opx-Cpx			72-74			1004-1024

Table S2.2: Major element compositions of whole rocks, glasses, and minerals (Plag, Opx, Cpx, Mag, Ilm, Amph) (see Thesis appendix).

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**CHAPTER 3: The role of magmatic storage conditions and excess fluids in the
effusive to explosive eruption style**

The Role of Magma Storage Conditions and Excess Fluids in the Transition from Effusive to Explosive Eruption Styles

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Key Points:

- We use phase equilibria experiments to evaluate the role of magmatic storage conditions on eruption style of Kelud volcano, Indonesia.
- Explosive eruptions retain an excess fluid phase, whereas the lava dome lose this phase gradually; both share similar storage conditions.
- The accumulation of fluids could lead to decreasing magma density over time, which could be monitored using gravity measurements.

Abstract

We investigate the role of pre-eruptive magma conditions in controlling eruption styles at basaltic andesite volcanoes, and their relationship to monitoring data. We focus on a cycle of explosive (1990, sub-Plinian) → effusive (2007 dome) → explosive (2014, sub-Plinian) eruptions at Kelud volcano, Indonesia. We conducted petrological analyses of eruption products and phase equilibria experiments using a pumice from the 1990 eruption across a wide range of conditions (temperature, pressure, oxygen fugacity, and volatile contents). We are able to reproduce the main mineral assemblage of all three magmas (plagioclase + pyroxenes + amphibole + olivine + magnetite) at $T = 975 \pm 39^\circ\text{C}$, $P = 175 \pm 25 \text{ MPa}$, $f\text{O}_2 = \text{NNO}$, and 4-6 wt. % water in the melt, which is also consistent with the phenocryst contents for explosive eruptions (30-50 wt. %). The high phenocryst content of the 2007 dome (~ 70 wt. %) implies a lower volatile content (~1 wt. % water in the melt), which likely resulted from slow magma ascent towards the surface alongside progressive equilibration. Mass balance calculations on the sulfur budget of the 1990 and 2014 magmas, show that they contained an excess fluid phase that was stored with the magma, and we propose that this led to their more explosive eruption style compared to the 2007 dome. Our hypothesis of accumulation of excess fluids could perhaps be recorded as changes in gravity data over time, and may open doors to better anticipate eruption styles.

Plain Language Summary

Many volcanoes can erupt explosively or grow lava domes, and it is still difficult to know how and when the volcano may erupt in the future. We use experiments to investigate whether the temperature, pressure, and dissolved gas content of eruptible molten rock underneath a volcano can control its eruption style, and then relate them to monitoring data signals typically used to anticipate eruptions. We also study rocks from the 1990-

2014 eruptions of Kelud volcano in Indonesia, which is notorious for its explosive and short eruptions, but can also shift to lava dome growth. We find that the depth, temperature and gases dissolved in the melt are essentially the same for the 2007 lava dome, and the 1990 and 2014 explosive eruptions. However, explosive eruptions also accumulate a separate surplus gas phase before eruption (e.g. “pressure cooker” effect), whereas before lava dome growth this gas phase is lost over time to the surface. Thus it may be possible to anticipate eruption styles by tracking the gravity and density changes below the volcano.

3.1. Introduction

Volcanoes can display a range of eruption styles, spanning from small phreatic events, to dome growth, or explosive events with tall eruptive columns. Such changes can occur between consecutive eruptions of the same volcano, and even within a single eruption. Some well-known examples of volcanoes that display large variations in eruptive styles between eruptions, include Merapi (Indonesia e.g. Surono et al., 2012), Soufrière Hills (Montserrat; e.g. Young et al., 1998), and Mt. St Helens (USA; e.g. Pallister et al., 1992). Examples of how a single volcanic eruption can also rapidly transition from effusive to explosive and vice versa were observed in the 1991 Pinatubo eruption (Bernard et al., 1996; Pallister et al., 1996), the 2009 eruption at Redoubt (Bull and Buurman, 2013a), or the 2011 eruption at Puyehue-Cordón Caulle (Elissondo et al., 2016). The changes in eruptive style are typically abrupt and difficult to anticipate, which makes the mitigation of associated hazards incredibly challenging.

Changes in eruptive styles are largely controlled by the physical and chemical properties of the magmas at their storage zones, and how these change as the magma ascends towards the surface and goes through the brittle-ductile transition (e.g. Cashman et al., 2013; Dingwell et al., 1993a). Some parameters include the pre-eruptive magmatic storage pressure, temperature, crystallinity, melt composition and magmatic volatile contents. The pre-eruptive volatile content of the melt is especially important in determining key parameters, namely the viscosity, buoyancy, and magma ascent rate (M. Cassidy et al., 2018; Giordano et al., 2008a; Gonnermann

and Manga, 2013a). In addition, the presence of an exsolved volatile phase in the pre-eruptive system due to second boiling (Sisson and Bacon, 1999) or volatile flushing (Caricchi et al., 2018) can also have a large impact on eruption dynamics. Moreover, such exsolved fluid phase has been documented and quantified for many explosive eruptions (Scaillet et al., 1998). Notwithstanding our understanding of the parameters and processes leading to explosive eruptions it is still very challenging to anticipate whether a given volcano will erupt explosively or effusively (M. Cassidy et al., 2018; Shinohara, 2008).

In this study, we investigate the pre-eruptive conditions and processes that may have led to the explosive-effusive-explosive eruptions of Kelud volcano (Indonesia), as exemplified by the 1990 → 2007 → 2014 eruptions. We also report new petrological observations that we combine with various mineral-melt geothermobarometers, and new phase equilibria experiments to constrain the pre-eruptive storage conditions of the three eruptions. The combined petrological and experimental results suggest that the magma that fed the 1990, 2007, and 2014 events were essentially stored at similar temperatures, pressures, and fO_2 range. We propose that the higher explosivity of the 1990 and 2014 eruptions was instead driven by the presence of an exsolved volatile phase that was lacking in the 2007 dome eruption, and this led to slower ascent, enhanced degassing, and subsequent re-equilibration of the magma towards the surface that ultimately produced a dome.

3.2 Geological Setting

3.2.1 Kelud volcano

Kelud (Kelut) volcano is an active basaltic-andesite semi-plugged composite strato-cone complex situated in East Java, Indonesia (Whelley et al., 2015; Wirakusumah, 1991). The volcano hosts a persistent crater lake fed by meteoric water (neutral pH) during repose, and explosive eruptions typically generate syn-eruptive and post-eruptive cold lahars (Thouret et al., 1998). Kelud typically generates short-lived explosive eruptions with run-up times of mere hours (Global Volcanism Program, 2013a; Lesage and Surono, 1995a; Maeno et al., 2019a). Kelud has erupted at least 32 times in the last 100 years (Global Volcanism Program, 2013a), but here we focus on

the last three eruptions in 1990, 2007, and 2014.

The 1990 explosive eruption began after ~3 months of unrest followed by quiescence for ~3 weeks (Bourdier et al., 1997). The escalation towards eruption occurred in hours, giving communities only one hour to evacuate their homes (Global Volcanism Program, 1990a). The explosive eruption in 2014 largely followed a similar pattern in terms of duration of heightened unrest and steep increase in seismicity hours to days before the eruption (Hidayati et al., 2018a). These 1990 and 2014 events generated eruptive columns as high as 17 km (Bourdier et al., 1997; Kristiansen et al., 2015; Nakashima et al., 2016) with a VEI of 4 and Dense Rock Equivalent (DRE) volumes of $6.3 \times 10^7 \text{ m}^3$ (1990) and $2.1 \times 10^8 \text{ m}^3$ (2014), respectively (Maeno et al., 2019a). Moreover, the eruptions were short-lived and volcanic activity and unrest returned to background levels within days to weeks of the main eruptive phase (Global Volcanism Program, 2014a; Pardyanto, 1990).

The lava dome extrusion of November 2007 and was preceded by unrest that started as early as January 2007, according to Lubis (2014a) who detected up to 11 cm of inflation around the summit region from remote sensing data. From July to August 2007 unrest involved intense degassing on the lake floor and an increase in seismicity (Hidayati et al., 2018a) and lake temperature rising up (from ~30°C to ~75°C), as well as heightened CO₂ emissions from the lake (Caudron et al., 2012; Global Volcanism Program, 2007; Hidayati et al., 2009; Kunrat, 2009). Continuous seismic unrest started around September 2007, involving multiple swarms and low frequency earthquakes (Hidayati et al., 2009). The seismic unrest was further accompanied by inflation from 9th October until 3rd November, when the signal changed to deflation and gave way to slow dome extrusion (Hidayati et al., 2018a). The final dome was 200 m high and 400 m wide, with a volume of $3.5 \times 10^7 \text{ m}^3$ which is about half the volume of the 1990 eruption, but about one order of magnitude smaller than the 2014 event (Global Volcanism Program, 2008; Maeno et al., 2019a).

3.3 Materials and Methods

We performed petrological analyses of two 2007 dome fragments previously studied in

Humaida (2013), and two pumices sampled following the 2014 eruption (sampled by H. Humaida), and also include the data from the six main-stage pumices from the 1990 eruption (already studied in Chapter 2). We chose one basaltic andesite pumice from the 1990 eruption (KELUD1990-PL1 or PL1 from Chapter 2) as the starting material for experiments, because it was the most mafic, and had the same mineral assemblage of the other samples except for the absence of olivine.

3.3.1 Selection of experimental conditions

We experimentally investigated a range of variables that includes previous estimates from mineral-melt geothermobarometers (Chapter 2). We varied the temperature from 950 to 1060°C, pressure from 100 to 400 MPa, f_{O_2} at the Ni-NiO buffer (NNO) and up to two log units above (NNO + 2) and varied a volatile composition in the capsule from pure water to pure CO₂ (See below for more details).

3.3.2 Preparation of experimental charges

A starting glass was prepared by finely crushing the pumice using a ceramic mortar and pestle, and homogenized by fusing the powder at 1400°C and at atmospheric pressure for around 6 hours in a standard Thermconcept furnace at 1750°C. EPMA analyses of the fused glass confirmed that glass it was homogenous, and of the same composition as the whole rock (Table 3.1). This glass was crushed again to a fine dry powder with an agate mortar and pestle, and was used as starting material for all experiments. About 0.03g of dry glass was loaded in Au capsules (of size 10-15 mm x 2.5 x 0.2 mm wall thickness) for the 950°C and 1000°C experiments, whereas Au-Pd capsules were used for the 1060°C experiments.

We varied the fluid composition (referred to as $\text{XH}_2\text{O}_{\text{in}} = \text{initial H}_2\text{O} / [\text{H}_2\text{O} + \text{CO}_2]$ in moles) from 0 to 1 by adding various amounts of deionized water and CO₂ (in the form of silver oxalate) to the dry glass powder according to the methodology of Scaillet et al. (1995). All the successful runs were fluid saturated. The capsules were arc-welded and weighed before being stored in a 60°C oven to homogenize the fluid content for 6-12 hours. After each experiments, the capsule was re-weighed again to check for fluid loss during storage and subsequent experiments.

To determine whether the charges were properly sealed, their weight had to be within 0.0005 g of the original value, which is the precision of the analytical balance. We observed that capsules from successfully quenched experiments were shrunk and flattened but had the same weight as before the experiment. Upon opening, the charges ejected gas with an audible pop. In contrast, failed charges appeared bloated, and commonly showed a difference in mass between before and after the experiments.

Table 3.1. *Representative compositions for the starting glass, whole rock, clinopyroxene-hosted melt inclusions, and interstitial glass from the 1990, 2007, and 2014 eruptions.*

	Whole rock	Whole rock	Whole rock	Starting dry glass	Measured matrix glass ^a	Calculated matrix glass	Measured matrix glass	Cpx glass inclusions ^a	Cpx glass inclusions
Year	1990	2007	2014	1990	1990	2007	2014	1990	2014
<i>n</i>	1	1	1	10	27	1	5	15	5
Normalized wt. %									
SiO ₂	54.3	54.9	55.3	55.0 (0.3)	68.4 (1.4)	69.3	67.1 (0.2)	69.1 (1.5)	68.5 (0.8)
TiO ₂	0.7	0.6	0.6	0.6 (0.1)	0.53 (0.07)	0.9	0.6 (0.1)	0.5 (0.1)	0.7 (0.1)
Al ₂ O ₃	19.0	18.6	18.5	19.0 (0.1)	15.4 (0.5)	14.0	15.5 (0.2)	16.0 (0.5)	15.7 (0.6)
FeO*	9.3	9.2	8.9	8.9 (0.5)	4.1 (0.3)	3.7	4.6 (0.2)	3.3 (0.9)	4.0 (0.3)
MnO	0.2	0.2	0.2	0.19 (0.04)	0.15 (0.02)	0.1	0.17 (0.05)	0.14 (0.04)	0.16 (0.05)
MgO	3.7	3.7	3.6	3.8 (0.1)	1.1 (0.1)	0.6	1.4 (0.1)	0.7 (0.4)	1.0 (0.1)
CaO	9.1	9.0	9.0	8.74 (0.09)	3.9 (0.4)	5.3	4.5 (0.1)	3.3 (0.6)	3.5 (0.3)
Na ₂ O	2.9	2.9	3.0	2.9 (0.1)	4.5 (0.2)	3.6	4.3 (0.2)	4.8 (0.5)	4.5 (0.3)
K ₂ O	0.7	0.7	0.7	0.68 (0.03)	1.6 (0.1)	2.1	1.6 (0.1)	1.8 (0.2)	1.63 (0.06)
P ₂ O ₅	0.2	0.1	0.1	0.13 (0.02)	0.21 (0.03)	0.4	0.25 (0.03)	0.22 (0.04)	0.26 (0.04)
Original total	99.7	101.1	101.0	100.4 (0.9)	98.9 (1.0)	100.0	99.0 (0.3)	94.8 (1.3)	93.7 (0.7)
Na ₂ O + K ₂ O	3.6	3.6	3.7	3.6 (0.1)	6.0 (0.2)	5.7	5.9 (0.2)	6.5 (0.5)	5.7 (0.3)
Range of SO ₃ (ppm)	n.a.	n.a.	n.a.	n.a.	57-138	n.a.	b.d.	395-1130	348-706

Cl (wt. %)	n.a.	n.a.	n.a.	0.030	0.12 (0.02)	n.a.	0.13 (0.01)	0.19 (0.01)	0.16 (0.02)
				(0.003)					

Note. n.a. = not analyzed. b.d.l. = below detection limit. ^aAverage values of compositions from Chapter 1. Individual major element oxide compositions are normalized in wt. %, but original total is presented.

3.3.3 Experimental equipment

All experiments were conducted at Institut de Sciences de la Terre Orléans (France) using internally heated pressure vessel (IHPV), following the procedure outlined in Scaillet and Evans (1999). Argon was used as a pressurizing medium mixed with different H₂ concentrations at room temperature to establish different $f\text{O}_2$ conditions (ranging from NNO to NNO + 2), and using a Shaw membrane to establish and maintain the $f\text{H}_2$ osmotic equilibrium (Scaillet et al., 1992). A factory calibrated pressure transducer was used to measure and monitor pressure (± 2 MPa), whereas temperature was monitored with unsheathed type-S thermocouples, and the temperature of the IHPV “hotspot” was maintained at $< 10^\circ\text{C}$ and with an uncertainty of $\pm 5^\circ\text{C}$ (Scaillet et al., 1992). Experiments were raised from room temperature directly up to run temperature in around an hour, where in each experimental run contained around 4-7 capsules, including one sensor for $f\text{O}_2$ (see below). Once the target run conditions were achieved, experiments were run for 18-66 hours. Experiments were terminated with a drop quench device, allowing the sample holder to fall in the cold part of the vessel at the bottom ($< 50^\circ\text{C}$) ensuring isobaric quenching and cooling rates of 100°C/s . A fast quench device was set up as part of the experiments (Roux and Lefèvre, 1992). Previous studies have shown that crystal-melt equilibrium is attained using the same protocols. General observations of equilibrium include homogeneous glass composition within a given charge, lack of chemical zoning in experimental crystals, and systematic changes in petrologic variables (e.g. crystal content) with experimental variables (temperature and water content). Equilibrium, rather than quench, textures are characteristic of the run products we report and we believe they reflect attainment of chemical equilibrium at the desired run conditions.

3.3.4 Calculation of fO_2 and dissolved water content in experimental charges

The oxygen fugacity (fO_2) was calculated using a sensor capsule comprising two water-saturated (10mg added water), hand-pressed Ni-Pd-NiO powder pellets separated by inert ZrO powder (Taylor et al., 1992). We forgot to add a the sensor capsule for one experimental run ($T = 1060^\circ\text{C}$, $P = 200$ MPa), and thus the final calculated fO_2 for the fluid saturated charge ($XH_2O_{in} = 1.0$) as the result of the average between the two closest isobaric runs ($T = 1060^\circ\text{C}$, $P = 100$ and 400 MPa). For undersaturated charges, we calculated the fO_2 according to the following formula employed by Scaillet and Evans (1999):

$$fO_2(\text{charge}) = fO_2(\text{sensor}) + 2 \left[\log(H_2O)_{\text{fluid}(\text{charge})_{\text{final}}} \right] \quad (1)$$

Where $fO_2(\text{charge})$ is the calculated oxygen fugacity of the charge, $fO_2(\text{sensor})$ is the sensor oxygen fugacity, and the $H_2O_{\text{fluid}(\text{charge})_{\text{final}}}$ is the dissolved water content in the glasses. We could not calculate fO_2 for dry charges (no water in the melt). Finally, the water content of the experimental glasses was obtained by calculating the fluid composition through mass-balance along with the solubility model for mixed H_2O - CO_2 fluids from Shishkina et al. (2010), with a relative error of ± 12 %.

3.3.5 Analytical techniques

Whole-rock analyses of samples, including the pumice starting material, were ground and fused into a lithium tetraborate disk before being analyzed for whole rock major element oxide compositions using X-Ray Fluorescence (XRF) at the Activation Laboratory in Ancaster, Canada following the approach outlined in Norrish and Hutton (1969). Mineral proportions were obtained by counting the phenocryst content using the JMicrovision software on plain polarized images of the entire thin section (for the 1990 samples), and using a Pelcon mechanical point counting stage (for the 2007 and 2014 samples). For each sample, we counted up to 1400-1600 points to ensure statistically significant results with relative errors of $< 10\%$. Results from point counting and mineral analyses (see below) allowed us to calculate the matrix glass of the 2007 dome samples through mass balance. Such calculations are necessary to remove the effect of the extensive microlite crystallization of the 2007 matrix, and we use such compositions for

geothermobarometric calculations.

We made general observations of experimental charges, and identified phases using the scanning electron microscope (SEM) at ISTO-Orléans, France and the Earth Observatory of Singapore. We determined the crystal content of the experimental charges by thresholding the greyscale of multiple back-scattered electron (BSE) images of a charge map using ImageJ, we estimated the volumetric area of phases in all charges. From these results, we calculated the mass proportions of the main minerals using standard mineral densities.

Minerals and glass from natural samples and experimental charges were analyzed for their chemical compositions on the JEOL JXA-8530F electron microprobe (EPMA) at the Facility for the Analyses Characterization, Testing and Simulation (FACTS), Nanyang Technological University, Singapore. Analyses of orthopyroxene, clinopyroxene, olivine and Fe-Ti oxides were done on the EPMA in spot mode with 15 kV accelerating voltage, beam size of 1 mm, and 20nA beam current. Amphibole and plagioclase were analyzed in spot mode with 15 kV accelerating voltage, beam size of 1 mm, and 10nA current. Glass was analyzed in spot mode with 6 kV, and beam size of 10 mm and 5 nA current. The same conditions and procedures were used to observe and analyze the glasses and minerals of the 2007 and 2014 rocks. For clinopyroxene-hosted glass inclusions, we corrected for post-entrapment crystallization of the melt inclusion walls (Buchholz et al., 2013). The relative errors for glasses are 0.4-0.8 % for SiO₂, Al₂O₃, and CaO; 1-3 % for MgO, FeO, Na₂O, K₂O; and 9-41% MnO, TiO₂, P₂O₅, and Cl. For pyroxenes, the relative errors are 0.2-1.0 % for SiO₂, Al₂O₃, and CaO, MgO, FeO; 1-30% for Na₂O, K₂O, and 2-55% MnO, TiO₂, and Cr₂O₃. Relative errors for Fe-Ti oxide analyses are 0.3-0.6% for FeO, 0.5-7.5% for TiO₂, 0.5-1.8% for MgO. For olivine analyses are 0.2-0.5% SiO₂, MgO, FeO; and 0.8-18% Al₂O₃, CaO, MnO. The relative error for the only amphibole analyses are 0.3-0.8% for SiO₂, Al₂O₃, CaO, FeO, MgO; 4.2-4.4% MnO, TiO₂; and 11-30% for Na₂O and K₂O.

The mineral end-members were calculated using their molar compositions as in Chapter 2 and according to Deer et al. (1992). Pyroxenes are characterized with the Mg # ($Mg \# = 100 \times Mg / [Mg + Fe^*]$ in mol, where Fe* is total iron as Fe²⁺). We further characterize pyroxenes using their wollastonite ($Wo = 100 \times Ca / [Ca + Mg + Fe^*]$), ferrosilite ($Fs = 100 \times Fe / [Ca + Mg + Fe^*]$), and enstatite ($En = 100 \times Mg / [Ca + Mg + Fe^*]$) endmembers. Plagioclase end member

compositions were classified using their molar compositions for anorthite ($An = 100 \times Ca / [Ca + Na + K]$), albite ($Ab = 100 \times Na / [Ca + Na + K]$), and orthoclase ($Or = 100 \times K / [Ca + Na + K]$). Olivine is characterized using the forsterite content ($Fo = 100 \times Mg / [Mg + Fe^*]$), whereas amphibole is classified according to the compositional end-members outlined in Leake et al. (1997), as determined by Ridolfi et al. (2010). Glass compositions were characterized using their normalized to 100% anhydrous major element oxides and total alkali-silica (TAS) composition. It was difficult to obtain good quantitative analyses of plagioclase crystals in experimental charges as they are typically small and may contain Fe-Ti oxide inclusions. To be able to report approximate An contents of plagioclase, we have filtered for analyses with $FeO^* < 1$ wt. % and $TiO_2 < 0.1$ wt. %, and subtracted the composition of magnetite from the electron microprobe analyses to match these constraints. We report these recalculated compositions to fit the structural formulae.

3.4 Results

3.4.1 Petrological observations and geothermobarometry of the 1990, 2007 and 2014 magmas

We made new petrological observations and geothermobarometric estimates from the deposits of the 1990, 2007, and 2014 eruptions (Tables 3.1-4). Whole rock major elements vary over a small range across eruptions and are classified as basaltic andesite (Table 3.1). The calculated matrix compositions, the measured interstitial glasses, and clinopyroxene-hosted melt inclusions are of a similar dacitic composition (see Chapter 2). The three eruptions have deposits with different phenocryst (> 100 μm) content: 31-47 wt. % in the 1990 pumices; 70-72 wt. % for the 2007 dome; and 29-35 wt. % in 2014 pumices (Table 3.2). The mineral assemblage for all three eruptions includes phenocrysts of plagioclase (Plag), clinopyroxene (Cpx), orthopyroxene (Opx), and magnetite (Mag). The 1990 and 2014 pumices also host partially reacted amphibole (Amph), and we have also identified pseudomorphs of Amph megacrysts and symplectites after Ol breakdown in the 2007 dome, meaning that both Amph and Ol may have also been stable in the 2007 magma (See Supplementary Material). We also found partially reacted olivine (Ol) microphenocrysts (< 100 μm) in the 2014 pumice.

Table 3.2: Mineral assemblage and phenocryst content of samples from 1990, 2007, and 2014 eruptions.

Sample ID	90-23	PL1	2007A	2007B	14-PUMI-1	14-PUMI-2
Eruption	1990	1990	2007	2007	2014	2014
Phase ^b	wt. %	wt. %	wt. %	wt. %	wt. %	wt. %
Glm*	51.0	64.5	27.8*	30.2*	70.5	65.1
Plag	36.1	13.1	48.2	47.7	21.2	19.9
Cpx	4.5	6.0	4.6	3.9	1.2	2.1
Opx	4.1	7.9	10.6	12.0	3.0	7.5
Mag	4.3	8.4	8.5	6.2	3.6	4.7
Amph		0.1	0.3		0.5	
Ol						0.7
Total	100.0	100.0	100.0	100.0	100.0	100.0
Phenocryst content	49	35	72	70	29	34

Notes. ^aFor these samples Glm means matrix and include glass and microlites. ^bOpx = orthopyroxene; Cpx = clinopyroxene; Plag = plagioclase; Mag = magnetite; Ol = olivine; Amph = amphibole

Accessory minerals include ubiquitous apatite (Apa), which is found in all three eruptions; quartz (Qz) rich enclaves occur in the 1990 late-stage pumice; and cristobalite (Crs) is found as vesicle infill in the 2007 dome samples (See Supplementary Material). Ilmenite (Ilm) is present as rims around Mag in the 1990 late-stage pumice, and as exsolution lamellae in Mag in the 2007 deposits (See Supplementary Material). The compositions of the main minerals of the three eruptions are also broadly similar, with the histograms of compositional mineral indicators (e.g. Mg #) typically overlap for the three eruptions (Fig. 1a-c; Table 3.3), and are also similar to those of previous studies from the same eruptions (e.g. Cassidy et al., 2019a, 2016; Jeffery et al., 2013a).

Table 3.3: *Summary of representative mineral compositions from the 1990-2014 crystal deposits.*

Mineral	Cpx	Cpx	Cpx	Opx	Opx	Opx	Mineral	Amph ^a	Amph
Eruption year	1990	2007	2014	1990	2007	2014	Eruption year	1990	2014
rock type/stage	main-stage pumice	dome	pumice	main-stage pumice	dome	pumice	rock type/stage		
Texture	cores, glom	cores, glom	cores, glom	cores, glom	glom	cores, glom	Texture		
n	8	16	17	11	7	9	n	18	4
<hr/>									
wt. %									
SiO ₂	51.6 (0.7)	51.8 (0.4)	51.1 (0.6)	52.8 (0.2)	52.9 (0.1)	52.6 (0.3)	SiO ₂	41.6 (0.6)	43.0 (2.7)
TiO ₂	0.5 (0.3)	0.33 (0.04)	0.4 (0.1)	0.19 (0.03)	0.16 (0.01)	0.19 (0.02)	TiO ₂	1.5 (0.1)	1.7 (0.7)
Al ₂ O ₃	1.8 (0.6)	1.7 (0.1)	2.2 (0.8)	1.0 (0.2)	0.9 (0.2)	1.0 (0.2)	Al ₂ O ₃	14.9 (0.7)	11.9 (3.4)
FeO*	9.2 (0.6)	9.5 (0.1)	9.5 (0.4)	19.5 (0.3)	19.2 (0.2)	19.4 (0.3)	Cr ₂ O ₃	0.05 (0.03)	
MnO	0.5 (0.1)	0.51 (0.03)	0.5 (0.1)	1.0 (0.2)	0.90 (0.04)	0.91 (0.04)	FeO*	11.3 (0.3)	10.5 (1.8)
MgO	14.5 (0.1)	14.3 (0.2)	14.5 (0.1)	23.1 (0.2)	22.84 (0.07)	23.1 (0.2)	MnO	0.15 (0.01)	0.13 (0.07)
CaO	21.1 (0.4)	20.8 (0.3)	20.6 (0.4)	1.4 (0.2)	1.44 (0.08)	1.45 (0.03)	MgO	13.9 (0.3)	14.7 (0.1)
Na ₂ O	0.27 (0.02)	0.29 (0.02)	0.3 (0.1)	0.01 (0.01)	0.02 (0.01)	0.015 (0.003)	CaO	12.0 (0.2)	12.0 (0.6)
K ₂ O							Na ₂ O	2.24 (0.8)	2.1 (0.4)
Total	99.4 (0.2)	99.3 (0.4)	99.0 (0.3)	99.0 (0.3)	98.4 (0.1)	98.7 (0.4)	K ₂ O	0.31 (0.02)	0.4 (0.02)
							Cl	0.016 (0.005)	

							F	0.13 (0.07)		
							Total	97.9 (0.4)	96.6 (0.2)	
Pyroxene end-members ^b							Amph end- member ^d	Mg-Hst	Ts-Prg	
Wo	43.6 (0.8)	43.2 (0.6)	42.0 (0.6)	2.9 (0.4)	3.0 (0.2)	3.1 (0.1)				
En	41.6 (0.3)	41.3 (0.5)	43.2 (0.8)	65.9 (0.3)	65.9 (0.3)	63.7 (0.4)				
Fs	14.9 (0.9)	15.5 (0.3)	14.8 (0.6)	31.2 (0.5)	31.1 (0.2)	33.2 (0.5)				
Mg #	73.6 (1.3)	72.8 (0.5)	73.9 (0.9)	67.8 (0.5)	67.9 (0.2)	65.7 (0.5)				
Mineral	Ol	Ol	Mineral	Plag	Plag	Plag	Plag			
Eruption year	2014	2014	Eruption year	1990	2007	2014	2014			
rock type/stage			rock type/stage	main-stage pumice	dome	pumice	pumice			
Texture	low-Fo	high-Fo	Texture	microlite/rim	rim	core	rim			
n	9	3	n	13	28	3	2			
SiO ₂	36.8 (0.2)	37.55 (0.33)	SiO ₂	49.1 (1.2)	50 (2)	44.6 (0.1)	51.0 (0.1)			
TiO ₂	0.03 (0.02)	0.02 (0.02)	TiO ₂		0.03 (0.03)	0.02 (0.02)	0.02 (0.01)			
Al ₂ O ₃	0.01 (0.02)	0.03 (0.03)	Al ₂ O ₃	31.5 (1.0)	31 (1)	33.4 (0.2)	29.3 (0.1)			
FeO*	26.6 (1.1)	23.41 (1.41)	FeO*	0.32 (0.05)	0.63 (0.06)	0.55 (0.02)	0.67 (0.01)			
MnO	0.68 (0.05)	0.52 (0.07)	MnO		0.01 (0.01)					
MgO	34.5 (0.99)	37.06 (0.87)	MgO	0.04 (0.02)	0.05 (0.02)	0.06 (0.02)	0.08 (0.01)			
CaO	0.17 (0.04)	0.2 (0.05)	CaO	14.8 (1.0)	14 (1)	18.4 (0.2)	13.42 (0.05)			
Na ₂ O			Na ₂ O	3.4 (0.6)	3.5 (0.7)	1.2 (0.1)	3.9 (0.1)			
K ₂ O			K ₂ O	0.06 (0.02)	0.09 (0.04)					
			Total	99.1 (0.5)	98.9 (0.5)	98.3 (0.2)	98.35 (0.01)			
P ₂ O ₅	0.04 (0.02)	0.03 (0.03)								
Total	98.9 (0.31)	98.8 (0.51)								

Plag end-member^c

Fo content ^c	69.8 (1.5)	73.8 (1.6)	An	70.7 (5.3)	68 (7)	89.2 (0.9)	65.8 (0.5)
			Ab	29.0 (5.2)	31 (6)	10.8 (0.9)	34.2 (0.5)
			Or	0.3 (0.1)	0.6 (0.3)	n.a.	n.a.

Notes. *n.a.* = not analyzed. FeO^* or Fe^* = total Fe as Fe^{2+} . *Glom* = glom. See Table 3.2 for meaning of mineral abbreviations. ^aAverage amphibole composition From Chapter 2. ^bPyroxene end-members: wollastonite, $Wo = 100 \times Ca / [Mg + Fe^* + Ca]$; enstatite, $En = 100 \times Mg / [Mg + Fe^* + Ca]$; ferrosilite, $Fs = 100 \times Fe^* / [Mg + Fe^* + Ca]$; $Mg \# = 100 \times Mg / [Mg + Fe^*]$. ^cPlagioclase end-members: anorthite, $An = 100 \times Ca / [Ca + Na + K]$; albite, $Ab = 100 \times Na / [Ca + Na + K]$; orthoclase, $Or = 100 \times K / [Na + Ca + K]$. ^dAmphibole end-members according to Leake et al. (1997) as calculated in Ridolfi et al. (2010). *Mg-Hst* = magnesio-hastingsite; *Ts-Prg* = Tschermakite-Pargasite. ^eOlivine Fo content, $Fo = 100 \times Mg / [Mg + Fe^*]$.

We made geothermobarometric estimates for the 1990-2014 magma storage and ascent conditions from mineral and glass/whole rock/matrix compositions (Table 3.4). For this we used core-whole rock and rim-interstitial/matrix glass pairs (see also Chapter 2 for the 1990 eruption). The pyroxene-liquid or two pyroxene equilibria formulations of Putirka (2008a) give temperatures that range from about 1030°C for the crystal cores, to about 975°C (down to 950°C) for the crystal rims. Moreover, the mineral and glass compositions of the three eruptions give pre-eruptive temperatures that are within about $\pm 30^\circ\text{C}$ (Table 3.4). These temperature estimates also overlaps with those obtained from amphibole-melt equilibria at about 960°C for the 1990 and 2014 eruptions. Pressure estimates we obtained come from the amphibole-melt geobarometer formulation of Putirka (2016), where pressures range from 450 MPa up to 700 MPa for the 1990 and 2014 eruptions, respectively.

Table 3.4. *Petrological storage conditions estimates from mineral-melt geothermobarometers, hygrometers and $\text{H}_2\text{O}-\text{CO}_2$ saturation models for the 1990, 2007, and 2014 mineral populations.*

Year	1990 ^a				2007				2014			
Crystal Zone	core		rim		Core ^f				core		rim	
	n	T (°C)	n	T (°C)	n	T (°C)			n	T (°C)	n	T (°C)
Opx-melt ^b	75	1023 (19)	37	976 (17)	2	1032 (2)			15	1039 (15)	1	974
Cpx-melt ^b	122	1043 (13)	23	1045 (34)	5	1029 (3)			18	1028 (6)		
Two-px ^{b,c}	67	1023 (40)	67	1030 (43)	2	980 (9)					7	948 (8)
Ol-melt ^b									8	1018 (5)		
Year	1990				2007				2014			
	type	n	$\text{H}_2\text{O}_{\text{melt}}$ (wt. %)	P_{sat} (MPa) ^e	zone	n	$\text{H}_2\text{O}_{\text{melt}}$ (wt. %)	P_{sat} (MPa) ^f		n	$\text{H}_2\text{O}_{\text{melt}}$ (wt. %)	P_{sat} (MPa) ^g
Plag-melt ^d	rim	9	4.1 (0.2)	172 (1)	core	82	4.4 (0.2)	189	core	2	6.0 (0.2)	214
	micr	9	4.1	170 (2)	rim	28	4.4	189	rim	2	4.0	168

	(0.2)			(0.2)			(0.2)		
Year	1990			2007			2014		
	n	T (°C)	P _{store} (MPa)	n	T (°C)	P _{store} (MPa)	n	T (°C)	P _{store} (MPa)
Amph-melt ^h	20	960 (10)	450 (80)	not analyzed			8	940 (80)	700 (90)

Note. Temperatures from pyroxene-based geothermometers were calculated using Putirka (2008) (SEE for Opx-liquid = $\pm 39^\circ\text{C}$; Cpx-liquid = $\pm 42^\circ\text{C}$; two-pyroxene = $\pm 60^\circ\text{C}$) and Andersen et al. (1993) ($\pm 37^\circ\text{C}$), assuming a constant pressure of 100 MPa. Temperatures from amphibole-melt geothermometer were calculated using Putirka (2016) (SEE = $\pm 30^\circ\text{C}$), with the Al/Si equilibrium test described in Li et al. (2021) ($^{Al/Si}K_d = 0.96 \pm 0.4$). Dissolved water content of main-stage pumices were calculated using the plagioclase-melt hygrometer of Waters and Lange (2015) (± 0.35 wt. %), and the saturation pressures were calculated using the Ghiorso and Gualda (2015) mixed H₂O-CO₂ saturation model. The saturation pressure and water content calculated for 2014 pumices were calculated in the same way as the 1990 eruption, but with the average estimated using the temperature calculated from two-pyroxene geothermometer of Putirka (2008) (SEE $\pm 37^\circ\text{C}$). Temperatures from the olivine-melt geothermometer were calculated using equation 21 of Putirka (2008) (SEE $\pm 36^\circ\text{C}$). See Table 3.2 for meaning of abbreviations; px = pyroxene; micr = microlite. Parameters in italics are average calculated values from Chapter 2 and this study. Numbers in parentheses refer to 1 standard deviation (sigma), but where the 1 sigma is lower than the error, the error is reported instead. ^aThe storage temperatures and pressures, water content and saturation pressures of the 1990 pumices were calculated in Chapter 2 using temperatures estimated from orthopyroxene rims and interstitial glass pairs. ^bOl-melt geothermometer (Eq. 21); Opx-melt geothermometer (Eq. 28a); Cpx-melt geothermometer (Eq. 33); two-pyroxene geothermometer (Eq. 37) from Putirka (2008). ^cQUILF two-pyroxene geothermometer (Andersen et al., 1993). ^dPlag-melt hygrometer from Waters and Lange (2015) with minimum temperature estimates from Opx-melt and two-pyroxene geothermometers from Putirka (2008). ^eSaturation pressure and dissolved water contents for the 1990 eruption were estimated using Plag rims and microlites from Chapter 2 and the average Opx-melt temperature of $943 \pm 48^\circ\text{C}$. ^fFor 2007 dome samples, the calculated interstitial melt was used for rim Opx-liquid geothermometer calculations and Plag-melt hygrometer. ^gSaturation pressure is calculated with the MagmaSat application using a mixed H₂O-CO₂ model (Ghiorso and Gualda, 2015), and the average water content value from with the Plag-melt hygrometer. ^hEq 7a (pressure) from Amph-melt geothermobarometer (Putirka, 2016) with Al/Si equilibrium K_d constant proposed in Li et al. (2020).

The water content in the melt for the 1990 and 2014 magmas was calculated using the plagioclase-melt hygrometer of Waters and Lange (2015) using rim-interstitial glass pairs range from 3 to 4 wt. % for an averaged temperature of $T = 975^{\circ}\text{C}$, which is consistent with previous estimates in Chapter 2. These water contents in the melt correspond to $\text{H}_2\text{O}-\text{CO}_2$ saturation pressures of 170-190 MPa using the model by Ghiorso and Gualda (2015), which is also similar to the range of pressures obtained in Chapter 2. Surprisingly, the water content in the melt estimated for the 2007 samples using plagioclase rim and core and the calculated matrix glass is ~ 4 wt. % water, and thus similar to those of the 1990 and 2014 eruptions.

Another important aspect to consider towards improving our understanding the volatile content of these eruptions is the likely existence of an exsolved fluid phase at pre-eruptive eruptions. Chapter 2 calculated the amount of S that could be degassed for the 1990 eruption and estimated that 0.01-0.12 Mt could reside in an excess volatile phase. We have done the same calculation of the sulfur budget for the 2014 magma and satellite measurements; (see Methodology section), and we find a range of excess volatile phase of 0.08-0.10 Mt of S (Table 3.11).

Fig. 3.1. Histograms of representative mineral compositions from the 1990-2014 eruptions: **a.** pyroxenes, **b.** olivine, and **c.** plagioclase. Plagioclase composition from the 2014 eruption comes from a combination of this study and Cassidy et al. (2016) and those of the 1990 from Chapter 2.

3.4.2 General observations from the experimental results

Successful experimental charges range from complete glass to almost fully crystallized.

Glass-rich charges are devoid of vesicles (Fig. 2). Most charges (Fig. 2b-e, g-h) have a porphyritic texture, with subhedral to euhedral crystals set in interstitial glass with vesicles. Crystals may vary in size from phenocrysts (> 100 μm) to microlites (< 10 μm). Typically, Opx and Ol are subhedral to euhedral, commonly with Mag and Plag inclusions (>100 μm) (Fig. 2c). Some charges have clusters of Fe-Ti oxides microlites, as well as Fe-Ti oxides distributed throughout the charge (Fig. 2d). Despite the large range in crystal sizes, minerals and glass appears to be unzoned, according to BSE images, which is likely indicative of compositional equilibrium. Due to the small size of many crystals, it was very challenging to obtain a good quantitative chemical analysis, and thus we relied on mineral identification using EDS spectra obtained in SEM or electron probe. We obtained glass compositions from glass-rich experimental charges or for those where glass “pools” larger than about 10 μm , and we found that they are homogeneous in composition (Fig. 2a-d). For charges with low water contents, phases are often too small to analyze. For charges that failed i.e. where the fluid escaped the capsule during the experiment, we consistently observe a very high crystal content and a quench texture, with abundant microlites of Opx and Plag, and rare Ilm and glass; these were not used further.

3.4.3 Phase relation, crystallinities, and mineral assemblages

The full experimental phase assemblage of all charges includes Opx $\pm$ Cpx $\pm$ Plag $\pm$ Mag $\pm$ Ilm $\pm$ Amph $\pm$ Ol + glass (Fig. 2a-h). We did not identify experimental apatite, but we cannot rule out that it is not present. The crystal content from experimental charges varies from virtually none to about 88 wt. % (Table 3.5), and increases as temperature and water content decreases, and also as $f\text{O}_2$ increases. We produced liquidus or near- liquidus experiments with < 1 wt. % of crystals at 1060°C, NNO at water saturated conditions (about 5-9 wt. % H_2O in the melt) and at 200 and 400 MPa (Fig. 2a). These conditions match with the model liquidus temperature calculated from rhyolite-MELTS in Chapter 2. At 100 and 200 MPa and 1000°C, the crystal content is varies between about 68 to 44 wt. % for 2-4 wt. % water in the melt. Increasing the temperature to 1060°C decreases the crystal content to 52 to 31 wt. % at 3-4 wt. % water in the melt, but it increases up to 74 wt. % for < 2 wt. % in the

melt. Similar changes in crystal content with temperature and water content in the melt for different experimental pressures (See Supplementary Material). The effect of increasing fO_2 from NNO to NNO + 2 is to increase somewhat the proportion of magnetite with comparable crystal content.

Fig. 3.2 Annotated BSE images of selected representative experimental charges in order of decreasing crystallinity. **a.** 1060°C-200 MPa-NNO. **b.** 1000°C-100 MPa-NNO + 2. **c.** 950°C-150 MPa-NNO. **d.** 1000°C-200 MPa-NNO. **e.** 950°C-200 MPa-□NNO + 2. **f.** 950°C-200 MPa-NNO + 2. **g.** 950°C-400 MPa-NNO. **h.** Inset of charge in **g.** labelled with abbreviated mineral names (Gl = glass, Plag = plagioclase, Cpx = clinopyroxene, Opx = orthopyroxene, Mag = magnetite, Amph = amphibole).

The relationship between crystallinity, temperature, and water content in the melt can be used to obtain first order constraints on the pre-eruptive conditions (Fig. 3.3). Using a pre-eruptive temperature storage of about $975 \pm 39^\circ\text{C}$ for the three eruptions, as suggested by storage condition data of all eruptions (Table 3.4), we find that the 1990 and 2014 melt could contain about 4-6 wt. % water, or 4-5 wt. % at 100-200 MPa. The much higher phenocryst content of the 2007 dome would imply significantly lower water content in the melt (~ 1 wt. %). However, as we have discussed in the geothermobarometry results section above, we believe this does not reflect the pre-eruptive conditions, as the plagioclase-matrix equilibria suggest similar water contents in the melt for the 2007 and the 1990 and 2014 eruptions, and rather reflects re-equilibration and maturation during slow ascent. We find that experimental Opx and Plag are present at all conditions below the liquidus, and Cpx stability field has a somewhat smaller stability field (Fig 4a-c, Fig. S3.4 of Supplementary Material). We identified experimental amphibole at 950-1000°C and 200-400 MPa, with 4.5-6 wt. % water in the melt (Fig 3.4a-b). Despite our efforts we were not able to confidently identify Amph at lower pressures (< 200 MPa) and 950°C charges owing to the high crystallinity and small crystal sizes, although we suspect it is stable by comparing to the results of other phase equilibria studies with similar bulk compositions (e.g. Erdmann et al., 2016; Pichavant et al., 2002; Prouteau and Scaillet, 2003). We identified experimental Ol with 3-4 wt. % water in the melt at NNO and < 150 MPa (Fig. 3.4b). At NNO + 2, Ol stability extends to higher pressures and water content (at 200 MPa, 1000°C, and 3-6 wt. % water in the melt; Fig 3.4c). The stability of Fe-Ti oxides is also controlled by the dissolved water content and $f\text{O}_2$. Ilmenite is stable at lower dissolved water contents than magnetite, whereas with increasing $f\text{O}_2$ makes magnetite more stable at low water contents. Given the wide stability field of pyroxenes and plagioclase, the most diagnostic mineral to establish the pre-eruptive conditions is the presence of Amph in the 1990 and 2014, and xenocrysts and pseudomorphs in the 2007 lava domes. Amph stability requires water contents of ≥ 3 wt. % in the melt, $T < 1000^\circ\text{C}$ and $P \geq 200$ MPa. Cassidy et al. (2019a) conducted experiments using the 2014 Kelud rock, and the stability of anhydrous minerals they reported are quite similar to those we found, but did not explore

the P-T-water content in the melt at which Amph is stable; thus they did not experimentally grow the mineral.

Table 3.5. Summary of experimental results, including crystal content, mineral assemblage and normalized mineral proportions and original major element totals. Dissolved H₂O and CO₂ concentrations were calculated using the H₂O-CO₂ solubility model of Shiskina et al. (2010).

Charge ID	log(fO ₂) ^a (bar)	ΔNNO ^b	XH ₂ O _{in} ^c	Calculated melt volatile content ^d			Phase proportions ^{e,f} (wt. %)									
				XH ₂ O _{fluid}	H ₂ O _{melt} (wt. %)	CO ₂ -melt (wt. ppm)	Opx	Cpx	Plag	Mag	Ilm	Ol	Amph	Gl	Total	
<i>T = 1000°C, P = 100 MPa, t = 66 hours</i>																
SUPL1-1	-9.5	0.8	1.00	1.0	3.5	0	6.0	2.8	30.4	1.1		3.4		56.3	100	
SUPL1-2	-9.8	0.6	0.80	0.7	3.0	162	12.4	8.1	29.6	2.1				47.8	100	
SUPL1-3	-10.3	0.1	0.66	0.6	2.5	267	13.2	8.7	33.9	2.7				41.5	100	
SUPL1-4	-10.9	-0.6	0.56	0.5	2.3	312	14.9	8.3	42.8	2.3				31.7	100	
<i>T = 1000°C, P = 150 MPa, t = 19 hours</i>																
SUPL1-5	-8.5	1.8	1.00	1.0	4.4	0	18	25	2					55.0	100	
SUPL1-6	-8.7	1.6	0.82	0.8	3.8	250	3.7	2.3	23.3	0.5		4.3		65.9	100	
SUPL1-7	-9.0	1.4	0.67	0.6	3.2	414	13.1	7.6	29.7	1.8				47.8	100	
SUPL1-8	-9.0	1.3	0.63	0.6	3.1	444	13.4	12.1	34.6	1.8				38.1	100	
SUPL1-9	-9.5	0.9	0.41	0.3	2.3	633	13.4	5.3	55.9	3.7				21.8	100	
SUPL1-10	n.a.	n.a.	0.00	0.0	0.0	888	23.7		57.8		0.7			17.9	100	
<i>T = 1000°C, P = 200 MPa, t = 22 hours</i>																
SUPL1-11	-9.1	1.2	1.00	-	-	-	-	-	-	-	-	-	-	-	-	
SUPL1-12	-9.4	0.9	0.84	0.7	4.4	421	7.6	4.1	25.9	0.9				61.6	100	
SUPL1-13	-9.6	0.8	0.75	0.6	3.9	573	5.1	6.8	29.2	1.0				57.9	100	
SUPL1-14	-9.9	0.4	0.55	0.4	3.1	835	11.2	8.2	35.8	1.2				43.5	100	
SUPL1-15	-10.7	-0.4	0.30	0.2	1.8	1090	14.6	15.3	36.0	0.6				33.5	100	
SUPL1-16	n.a.	n.a.	0.00	0.0	0.0	1263	25.3		53.1		0.6			21	100	
<i>T = 1000°C, P = 400 MPa, t = 23 hours</i>																
SUPL1-17	-9.2	1.1	1.00	1.0	8.3	-	-	-	-	-	-	-	-	-	-	
SUPL1-18	-9.5	0.8	0.85	0.7	6.5	1681	13.9	1.8	5.6	0.3			< 0.01	78.4	100	

Charge ID	log(fO ₂) ^a (bar)	ΔNNO ^b	XH ₂ O _{in} ^c	Calculated melt volatile content ^d			Phase proportions ^{e,f} (wt. %)									
				XH ₂ O _{fluid}	H ₂ O _{melt} (wt. %)	CO ₂ -melt (wt. ppm)	Opx	Cpx	Plag	Mag	Ilm	Ol	Amph	Gl	Total	
SUPL1-19	-10.4	0.0	0.54	0.3	3.8	2977	16.5	12.0	21.6	0.3					49.6	100
SUPL1-20	-11.4	-1.0	0.27	0.1	1.9	3438	16.0	12.0	28.5	0.8					42.7	100
SUPL1-21	n.a.	n.a.	0.00	0.0	0.0	3638	25.0		37.7		0.4				36.9	100
<i>T = 950°C, P = 150 MPa, t = 66 hours</i>																
SUPL1-22	-10.0	1.1	1.00	1.0	4.3	0	7.1	1.2	19.3	3.5		5.1			63.8	100
SUPL1-23	-10.2	0.9	0.84	0.8	3.7	245	14.4	3.6	29.3	4.3					48.4	100
SUPL1-24	-10.3	0.8	0.75	0.7	3.5	327	16.8	7.6	27.8	0.6					47.2	100
SUPL1-25	-10.8	0.3	0.49	0.4	2.5	582	14.0	10.8	33.8	0.8					40.6	100
SUPL1-26	-11.0	0.1	0.39	0.3	2.2	647	13.5	11.0	42.5	0.6					32.4	100
SUPL1-27	n.a.	n.a.	0.00	0.0	0.0	890	35.5		52		0.5				12	100
<i>T = 950°C, P = 200 MPa, t = 49 hours</i>																
SUPL1-28	-10.7	0.4	1.00	1.0	5.1	0	19.9	13.2	28.6	3.0					35.2	100
SUPL1-29	-10.9	0.2	0.86	0.8	4.6	291	19.0	7.6	38.5	4.3					30.7	100
SUPL1-30	-11.1	0.0	0.68	0.6	3.8	588	17.7	20.6	31.9	0.9					28.8	100
SUPL1-31	-11.4	-0.3	0.54	0.4	3.2	797	12.8	15.4	44.0	1.6					26.3	100
<i>T = 950°C, P = 400 MPa, t = 67 hours</i>																
SUPL1-32	-9.8	1.3	1.00	1.0	8.1	0	17.9	8.4	10.7	3.2					60.0	100
SUPL1-33	-10.3	0.8	0.78	0.6	5.8	2066	14.3	3.7	16.0	3.0			< 0.01		63.0	100
SUPL1-34	-10.6	0.6	0.71	0.4	4.9	2526	11.2	3.9	29.4	3.2					52.3	100
SUPL1-35	-11.0	0.1	0.50	0.3	4.3	3029	11.0	2.9	35.2	3.2					47.7	100
SUPL1-36	-11.5	-0.4	0.35	0.1	2.6	3322	12.9	10.2	30.5	2.7					43.6	100
SUPL1-37	n.a.	n.a.	0.00	0.0	0.0	3685	30.4		39.4		0.4				29.8	100

Table 5. Experimental conditions and run product information (continued).

Charge ID	log(<i>f</i> O ₂) ^a (bar)	Δ <i>NNO</i> ^b	XH ₂ O _{in} ^c	Calculated melt volatile content ^d			Phase proportions ^{e,f} (wt. %)									
				XH ₂ O _{fluid}	H ₂ O _{melt} (wt. %)	CO ₂ -melt (wt. ppm)	Opx	Cpx	Plag	Mag	Ilm	Ol	Amph	Gl	Total	
<i>T = 1060°C, P = 100 MPa, t = 18 hours</i>																
SUPL1-38	-8.1	1.4	1.00	1.0	3.6	0			28.7	1.9					69.3	100
SUPL1-39	-8.4	1.1	0.78	0.7	3.0	168			56.8	2.4		< 0.1			40.8	100
SUPL1-40	-8.8	0.7	0.73	0.6	2.8	220			46.0	3.6		0.9			49.5	100
SUPL1-41	-9.2	0.2	0.67	0.6	2.6	251	4.9	3.1	43.6	0.4					48.0	100
SUPL1-42	-10.3	-0.9	0.37	0.3	1.7	424	9.5	7.7	43.6	3.7					35.5	100
SUPL1-43	n.a.	n.a.	0.00	0.0	0.0	563	22.5	0.8	38.1		12.6				26.0	100
<i>T = 1060°C, P = 200 MPa, t = 94 hours</i>																
SUPL1-44	-8.4	1.1	1.00	1.0	5.3	0			0.8						99.2	100
SUPL1-45	-8.9	0.5	0.72	0.5	3.6	696	16.6	2.1	16.9	2.1					62.4	100
SUPL1-46	-9.3	0.1	0.53	0.3	2.8	914	12.9	7.9	28.2	0.9					50.1	100
SUPL1-47	-10.3	-0.8	0.27	0.1	1.4	1153	20.1	1.3	37.6	2.0					39.0	100
SUPL1-48	n.a.	n.a.	0.00	0.0	0.0	1260	21.5		42.6	0.9					35.0	100
<i>T = 1060°C, P = 400 MPa, t = 49 hours</i>																
SUPL1-49	-8.6	0.9	1.00	1.0	8.6	0									100.0	100
SUPL1-50	-10.1	-0.7	0.59	0.2	3.0	3206	2.7	1.8	13.8	0.2					81.5	100
SUPL1-51	-11.6	-2.1	0.22	0.0	1.1	3543	9.1	6.4	21.8	1.7					61.0	100
<i>T = 1000°C, P = 100 MPa, t = 77 hours</i>																
SUPL1-52	-8.4	1.9	1.00	1.0	3.5	0	5.8	5.6	25.8	3.2		0.9			58.7	100
SUPL1-53	-8.6	1.7	0.83	0.8	3.0	143	11.0	2.5	29.2	2.8					54.5	100
SUPL1-54	-8.7	1.6	0.77	0.7	2.9	178	11.8	4.3	30.6	2.8					50.5	100
SUPL1-55	-9.0	1.3	0.57	0.5	2.3	311	13.7	4.1	38.1	3.1					41.0	100
SUPL1-56	-9.4	0.9	0.42	0.3	1.8	399	16.0	11.1	33.2	0.4					39.3	100
SUPL1-57	n.a.	n.a.	0.00	0.0	0.0	564	23.9		44.7		2.4				29.0	100

Charge ID	log(<i>f</i> O ₂) ^a (bar)	Δ <i>NNO</i> ^b	XH ₂ O _{in} ^c	Calculated melt volatile content ^d			Phase proportions ^{e,f} (wt. %)									Total
				XH ₂ O _{fluid}	H ₂ O _{melt} (wt. %)	CO ₂ -melt (wt. ppm)	Opx	Cpx	Plag	Mag	Ilm	Ol	Amph	Gl		
<i>T = 1000°C, P = 200 MPa, t = 19 hours</i>																
SUPL1-58	-8.5	1.8	1.00	1.0	5.2	0	14.3	3.1	15.7	0.6					66.0	100
SUPL1-59	-8.7	1.6	0.85	0.8	4.5	355	2.0	1.5	20.2	1.0		4.0			71.2	100
SUPL1-60	-8.9	1.4	0.73	0.6	3.9	575	6.4	4.7	21.4	3.3		5.9			58.4	100
SUPL1-61	-9.1	1.2	0.59	0.5	3.5	726	13.2	6.3	28.3	1.6					50.6	100
SUPL1-62	-10.0	0.3	0.29	0.2	1.9	1086	15.5	13.0	28.0	3.0					40.6	100
SUPL1-63	n.a.	n.a.	0.00	0.0	0.0	1263	22.5		39.0		9.4				29.0	100
<i>T = 950°C, P = 200 MPa, t = 71 hours</i>																
SUPL1-64	-9.3	1.8	1.00	1.0	5.1	0	15.3	18.0	19.9	1.0					45.7	100
SUPL1-65	-9.5	1.7	0.86	0.8	4.5	303	16.7	5.2	31.4	3.7					43.0	100
SUPL1-66	-9.7	1.4	0.73	0.6	3.8	583	-	-	-	-	-	-	-	-	-	-
SUPL1-67	-10.0	1.1	0.54	0.4	3.1	804	15.0	11.1	34.3	3.1					36.4	100
SUPL1-68	-10.9	0.2	0.28	0.2	1.7	1104	25.5	22.2	21.4	0.5					30.5	100
SUPL1-69	n.a.	n.a.	0.00	0.0	0.0	1266	42.6		41.4		0.6				15.4	100

Note. ^a $\log(fO_2)$ determined using water saturated Ni-Pd alloy capsules, calculated using the formulation by Pownceby and O'Neill (1994). For undersaturated charges, we calculated the fO_2 using the formula outlined in section 3.4. ^b $\Delta NNO = \log(fO_2) - \log(fO_2)$ at Ni-NiO buffer.

^c $XH_2O_{in} = H_2O/(H_2O + CO_2)$ loaded in capsules in moles. ^dWater and CO_2 content in the melt were calculated from mass balance combined with the mixed H_2O - CO_2 solubility model of Shishkina et al. (2010) for H_2O and Dixon et al. (2008) for CO_2 . ^ePhase proportions were calculated using grayscale thresholding of BSE charge maps using ImageJ software and then converted to phase proportions. ^fSee Table 2 for meaning of abbreviations, with the addition of Gl that we refer to glasses only. For charges where only CO_2 was added, we could not calculate the $\log(fO_2)$.

Fig. 3.3. Dissolved water content versus crystal content of experimental charges for **a.** 200-400 MPa, **b.** 100-200 MPa at NNO, and **c.** 100-200 MPa at NNO + 2. Dashed lines denote extrapolated crystal contents of experimental charges. Grey, red and blue semi-transparent boxes represent the field bounded by the phenocryst content of natural samples, water content in the melt for the given temperature with SEE errors ($975 \pm 39^\circ\text{C}$) for the 1990 pumices (explosive), 2007 dome fragments (effusive), and 2014 pumices (explosive). Dashed arrows indicate possible changes of temperature and water in the melt during ascent for the 2007 magma. The crystal contents were obtained by Chapter 2 and this study (Table 1). Average temperature estimates from each eruption are calculated from mineral-melt geothermobarometry listed in Table 3.

Fig. 3.4 Phase relations for **a.** 200-400 MPa, **b.** 100-200 MPa at NNO, and **c.** 100-200 MPa at NNO + 2. Grey, red and blue semi-transparent boxes represent the same parameters as Fig. 3.3. Dashed lines denote inferred phase stability fields at the given temperature and water content. Dashed arrows indicate potential degassing pathways. The phenocryst contents were estimated from Chapter 2 and this study (Table 1). Mineral name abbreviations are the same as in Fig 1, with the addition of Liq for liquid and Ilm for ilmenite. Pressure specific stability are specified next to the boundary line. Red line with 'liq' represents the liquidus boundary at the given pressure and temperature.

3.4.4 Mineral and glass compositions

3.4.4.1 Glass

Experimental glass compositions vary with water content and temperature (Fig 5a-h), with compositions ranging from basaltic andesite to dacite as temperature decrease from 1060 to 950°C (Table 6). The most evolved glass that we were able to analyze has 67 wt. % SiO₂ is at 200 MPa, 1060°C, NNO at 1 wt. % water, with 50-54 wt. % crystals in the charge (Fig. 3.5a). The glass we analyzed from the rest of the charges range from basaltic andesite to andesite. For the same temperature, pressure, and fO_2 , oxides such as SiO₂, K₂O, and CaO increases as water content in the melt decreases, indicating the melt is becoming more evolved (Fig. 3.5a, c, e). Changing the fO_2 from NNO to NNO + 2 does not significantly affect the SiO₂ content of the melt for the same pressure, temperature, and dissolved water content. The FeO* (3.5-9 wt. %), MgO (0.6-3.9 wt. %), and CaO (5-9.5 wt. %) of experimental glasses (Fig 3.5d-f) are controlled by crystallization of ferromagnesian minerals such as pyroxenes and magnetite. The limited number of natural and experimental glasses that we were able to analyze preclude direct and detailed comparisons that would allow to establish the pre-eruptive conditions. The lack of agreement between the matrix glass compositions and experimental glasses could be due to the effect of syn-eruptive crystallization. These typically manifests as Plag microlites in natural rocks. We observe microlites in one 1990 pumice and the 2007 dome, which would explain why the natural rocks have a higher SiO₂ content than the experimental glasses.

Table 3.6. Experimental glass chemistry.

T (°C)	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	950
Charge	SUP	SUP	SUPL	SUPL1	SUPL	SUPL	SUPL1	SUPL	SUPL	SUPL	SUPL
^a	L1-1	L1-2	1-6	-7	1-8	1-12	-13	1-16	1-17	1-19	1-21
n:	1	1	4	2	3	1	1	4	2	1	1
wt. %											
SiO ₂	52.8	56.1	57.4 (0.6)	60.1 (0.6)	58 (2)	56.5	59.6	56.7 (0.7)	56.1 (0.7)	55.8	61.2

TiO ₂	0.5	0.4	0.7 (0.1)	0.9 (0.2)	0.8 (0.2)	0.7	0.8	0.6 (0.1)	0.9 (0.3)	0.5	0.7
Al ₂ O ₃	20.8	23.4	19 (2)	16.40 (0.01)	20 (3)	20.5	17.0	22 (1)	18.8 (0.7)	23.0	17.1
FeO*	6.3	4.7	6.9 (0.5)	8.3 (0.2)	7 (2)	7.4	8.6	6.3 (0.5)	9.2 (0.5)	5.2	7.8
MnO	0.1	0.1	0.17 (0.01)	0.20 (0.01)	0.17 (0.03)	0.2	0.2	0.13 (0.02)	0.18 (0.01)	0.1	0.3
MgO	1.9	1.6	2.8 (0.3)	2.7 (0.1)	2.0 (0.5)	2.1	2.2	1.4 (0.2)	3.1 (0.2)	1.2	2.3
CaO	9.0	9.7	8.6 (0.9)	6.69 (0.01)	8 (2)	8.7	6.5	8.7 (0.7)	7.6 (0.3)	9.6	6.3
Na ₂ O	3.0	3.3	3.2 (0.1)	3.1 (0.1)	3.37 (0.09)	3.0	3.7	3.4 (0.1)	3.2 (0.03)	3.5	3.1
K ₂ O	0.6	0.7	0.8 (0.1)	1.22 (0.01)	0.9 (0.2)	0.8	1.1	0.9 (0.1)	0.80 (0.04)	0.7	0.2
P ₂ O ₅	0.1	0.2	0.17 (0.02)	0.27 (0.03)	0.19 (0.06)	0.1	0.2	0.17 (0.03)	0.17 (0.02)	0.2	1.1
Total ^b	95.0	96.2	89.8 (0.3)	87.2 (1.0)	90.2 (0.8)	95.3	94.0	95.2 (1.0)	91.9 (0.8)	93.7	85.8
TAS content	3.7	4.0	4.0	4.3	4.3	3.8	4.9	4.3	4.0	4.2	4.9
H ₂ O content ^c	3.5	3	3.8	3.2	3.1	4.4	3.9	8.3	6.5	3.8	4.3
T (°C)	1060	1060	1060	1060	1060	1060	1060	1060	1060	1060	1060
Charge ^a	SUP L1- 37	SUP L1- 38	SUPL 1-39	SUPL1 -40	SUPL 1-41	SUPL 1-43	SUPL1 -44	SUPL 1-45	SUPL 1-46	SUPL 1-48	SUPL 1-49
n:	3	5	4	4	1	5	2	3	1	4	4
wt. %											
SiO ₂	56.4 (0.04)	56.5 (0.6)	55.9 (0.9)	56.7 (0.4)	59.6	55.0 (0.6)	60 (2)	57.8 (0.3)	66.6	56.0 (0.4)	57.6 (0.2)
TiO ₂	0.66 (0.06)	0.7 (0.1)	0.6 (0.1)	0.8 (0.1)	1.0	0.7 (0.1)	1.0 (0.1)	0.80 (0.03)	1.7	0.6 (0.1)	0.70 (0.02)
Al ₂ O ₃	18.5 (0.3)	19 (2)	20 (2)	19 (2)	16.7	18.8 (0.1)	18 (3)	21.9 (0.1)	14.9	19.2 (0.03)	17.5 (0.1)
FeO*	7.4 (0.2)	6.7 (0.8)	5.9 (0.9)	6.2 (0.4)	7.1	8.5 (0.3)	8 (1)	4.6 (0.01)	3.5	7.4 (0.2)	7.5 (0.1)
MnO	0.22 (0.03)	0.21 (0.03)	0.20 (0.03)	0.19 (0.03)	0.3	0.2 (0.03)	0.2 (0.1)	0.12 (0.01)	0.1	0.2 (0.05)	0.22 (0.01)
MgO	4.2 (0.1)	3.88 (0.04)	3.6 (0.5)	3.5 (0.3)	3.4	4.0 (0.1)	1.6 (0.3)	0.68 (0.04)	2.0	3.8 (0.1)	4.1 (0.02)
CaO	8.6	8.9	9.5	9.4	7.7	9.03	7 (2)	9.1	5.4	9.1	8.2

	(0.2)	(0.8)	(0.9)	(0.7)		(0.03)		(0.1)		(0.1)	(0.1)
Na ₂ O	3.1 (0.1)	3.1 (0.1)	3.1 (0.1)	3.0 (0.1)	3.0	3.0 (0.1)	3.6 (0.2)	3.6 (0.1)	3.7	2.8 (0.05)	3.1 (0.04)
K ₂ O	0.75 (0.02)	0.8 (0.1)	0.6 (0.1)	0.8 (0.1)	1.0	0.69 (0.01)	1.2 (0.2)	1.00 (0.02)	1.9	0.6 (0.04)	0.8 (0.01)
P ₂ O ₅	0.15 (0.02)	0.15 (0.01)	0.14 (0.04)	0.14 (0.03)	0.2	0.13 (0.01)	0.2 (0.1)	0.21 (0.03)	0.3	0.1 (0.02)	0.2 (0.01)
Total ²	92.6 (0.2)	94 (1)	93.7 (0.06)	93 (1)	93.6	92.3 (0.6)	95.1 (0.3)	96.7 (0.3)	94.8	90.5 (0.4)	94.9 (0.4)
TAS content	3.8	3.8	3.7	3.8	4.0	3.7	4.9	4.6	5.6	3.4	3.9
H ₂ O content ³	3.6	3.0	2.8	2.6	1.7	5.3	3.6	2.8	1.4	8.6	3.0
T (°C)	1000	1000	1000	1000	1000	1000	1000				
Charge ^a	SUP L1- 52	SUP L1- 53	SUPL 1-54	SUPL1 -55	SUPL 1-58	SUPL 1-59	SUPL1 -60				
n:	1	1	2	1	5	1	3				
wt. %											
SiO ₂	54.8	56.2	56.0 (0.4)	59.6	56.7 (0.2)	57.8	59.5 (0.09)				
TiO ₂	0.3	0.5	0.70 (0.02)	0.6	0.68 (0.05)	16.8	1.0 (0.04)				
Al ₂ O ₃	25.5	22.1	21.8 (0.1)	18.9	18.3 (0.6)	7.3	15.99 (0.09)				
FeO*	3.2	5.7	5.8 (0.4)	6.6	8.1 (0.2)	3.2	9.1 (0.2)				
MnO	0.1	0.1	0.14 (0.02)	0.2	0.20 (0.02)	3.2	0.23 (0.01)				
MgO	1.0	1.5	1.5 (0.1)	1.4	3.5 (0.1)	0.8	2.64 (0.08)				
CaO	10.7	9.6	9.6 (0.1)	7.7	8.5 (0.3)	9.5	6.79 (0.07)				
Na ₂ O	3.7	3.2	3.5 (0.1)	3.5	3.0 (0.1)	0.3	3.27 (0.03)				
K ₂ O	0.5	0.8	0.73 (0.02)	1.2	0.74 (0.04)	0.2	1.17 (0.02)				
P ₂ O ₅	0.1	0.2	0.21 (0.02)	0.3	0.16 (0.03)	1.0	0.22 (0.02)				
Total ^a	93.9	96.6	96.7	98.0	94.5 (0.4)	94.8	94.7 (0.4)				
TAS content	4.2	4.0	4.2	5.2	3.8	4.0	4.4				

H ₂ O							
content	3.5	3.0	2.9	1.8	4.5	3.9	3.5
c							

Notes. ^aSee Table 5. ^bOriginal total in wt. %. ^cH₂O calculated by mass balance and mixed H₂O-CO₂ solubility model of Shishkina et al. (2010) and Dixon et al. (2008). FeO* = total Fe expressed as Fe²⁺. Numbers in parentheses refer to 1s of the mean of multiple analyses. Where the 1s is less than the relative error, the relative error is reported instead. TAS = Total Alkali-Silica content.

Fig. 3.5 Major element oxide compositions of experimental glasses (in wt. %) vs. dissolved water content in the melt for **a.** SiO₂, **b.** Al₂O₃, **c.** CaO, **d.** MgO, **e.** K₂O, **f.** FeO*. Solid coloured boxes denote the range of whole rock and glass compositions reported in Chapter 2 and this study for all three eruptions. The glass composition for the 2007 dome sample was estimated by mass balance calculations (Albarede, 1995). The dashed blue square denotes the pre-eruptive water content in the melt.

3.4.4.2 Plagioclase

It was difficult to obtain “pure” analyses of experimental plagioclase due to its elongated shape (e.g. very thin in one direction) and the presence of various mineral inclusions, so we report the recalculated analyses after subtraction of the effect of mineral inclusions (see methodology section). We first filtered the experimental Plag analyses for their FeO* and TiO₂ contents to remove Mag inclusions, but the MgO remained higher than expected for a plagioclase (~1 wt. %). We thus suspect that there may be some analysis that are mixtures of Plag and Opx, which we have not attempt to correct further. However, this should not affect the relative Ca-Na-K concentrations and thus determination of the stoichiometric Plag end-members. Experimental plagioclase ranges in composition from about An₅₇ to An₇₁ (Table 3.7; Fig 6a), and varies according to the water content in the melt and to a lesser extent, by temperature. For the same *T*, *P* and *f*O₂, we find that water content positively correlates with An content. We have not been able to analyze experimental Plag for near liquidus charges, nor from those with very high crystal content. Some of the experimental Plag compositions overlap with natural Plag microlites and rims from the 1990, 2007, and 2014 eruptions as described in Chapter 2 and in this study with An₅₉₋₇₁ (Fig. 3.6a-c; Table S3.1). Specifically, microlites and phenocryst rims from the 1990-2014 eruptions (An from 65 to 68) overlap with experimental Plag crystallized at 200 MPa, 1000°C and DNNO with ~4 wt. % water. No experimental Plag composition that we analyzed have An content > 71. However, we find that Plag cores and some oscillatory growth zones from all three eruptions with An content of > 71 in this study, Chapter 2, and in Cassidy et al. (2016) (See Fig. 1 and Fig. S3 of Supplementary Data). Thermodynamic modelling with rhyolite-MELTS at 975°C and 4 wt. % water shows that Plag with An content of 85-90 can be produced within the range of experimental temperatures (962-1062°C).

Table 3.7: *Experimental plagioclase chemistry.*

T (°C)	1000	1000	1000	950	950	1060	1060	1000	1000	1000	1000	950	950	950	950
Char ge n	SUPL1- 11N	SUPL1- 12N	SUPL1- 13N	SUPL1- 28N	SUPL1 -30	SUPL1- 44N	SUPL1- 45N	SUPL1- 58N	SUPL1- 59N	SUPL1- 60N	SUPL1- 61N	SUPL1- 63	SUPL1 -64	SUPL1- 65N	SUPL1 -66
	2	1	2	1	3	1	1	1	2	3	2	3	3	2	1
wt. %															
SiO ₂	57.9	59.0	57.5	59.9	54.8 (0.1)	59.2	58.7	58.4	59.9	57.9	62.0	58 (1)	53 (1)	58.6	55.7
TiO ₂					0.2 (0.1)	0.2					0.01	0.2 (0.1)	0.06 (0.02)		0.1
Al ₂ O ₃	25.6	24.1	26.3	23.1	26.4 (0.6)	23.5	25.6	24.6	23.0	25.9	22.4	26 (1)	29.7 (0.6)	24.3	27.3
FeO *	0.2	0.6	0.1	1.1	1.9 (1)	1.1	0.2	0.8	1.1	0.03	0.6	1.4 (0.5)	1.1 (0.1)	1.2	1.1
Mn O	0.1	0.2	0.0	0.2	0.05 (0.01)	0.1	0.1	0.1	0.1	0.05	0.1	0.03 (0.02)	0.02 (0.01)	0.1	0.02
Mg O	1.4	1.4	0.9	3.3	0.6 (0.2)	1.1	0.5	1.6	1.6	0.8	1.2	0.3 (0.1)	0.14 (0.3)	1.4	0.2
CaO	11.1	10.5	11.4	9.5	10.7 (0.4)	10.5	11.0	11.0	10.2	11.4	8.7	10 (1)	13.2 (0.7)	10.3	11.1
Na ₂ O	3.3	3.6	3.7	3.6	3.6 (0.1)	3.5	3.9	3.5	3.8	3.9	3.8	3.5 (0.3)	3.09 (0.03)	3.6	3.5
K ₂ O	0.5	0.7	0.5	0.4	0.3 (0.1)	0.9	0.7	0.7	0.8	0.6	1.2	0.5 (0.2)	0.14 (0.04)	0.5	0.4
Total a	97.5 (0.5)	97.9	98.4 (0.1)	98.3	98.4 (0.5)	97.1	98.0	98.7	98 (1)	98.2 (0.5)	98.4 (0.6)	99.9 (1)	100.5 (0.4)	99.2 (0.6)	99.4
Plag end-member															
An	63.9 (0.5)	58.8	61 (2)	58	61 (2)	60.4	58.5	61.0	57 (1)	59.3 (0.4)	53 (5)	59 (2)	70 (1)	59 (2)	62.0
Ab	32.6 (0.4)	36.6	36 (1)	39	37 (1)	34.2	36.8	34.9	37.8 (0.5)	37 (1)	39 (3)	38 (1)	30 (1)	37.0 (0.8)	35.4
Or	3.5 (0.1)	4.5	4 (1)	3	2 (0.4)	5.4	4.7	4.1	5.3 (0.1)	4 (1)	8 (2)	3 (1)	0.8 (0.3)	3.6 (0.9)	2.6

Notes. FeO = total Fe expressed as Fe²⁺. Numbers in parentheses refer to 1s of the mean of multiple analyses. n = calculated and normalized plagioclase composition after subtraction of Fe-Ti oxide composition. ^aOriginal total oxide in wt. %. See Table 3.3 for end-member abbreviations and calculations.*

3.4.4.3 Orthopyroxene

Experimental Opx composition mainly varies with temperature and water content in the melt (Mg # 57-77; Fig 3.6b, Table 3.8). The Wo component of some of the experimental Opx is high (Wo₆₋₁₁), and is classified as pigeonite according to Deer et al. (1992). For the same P and fO_2 , a temperature increase from 950°C to 1000°C results in an increase in the Mg # of about 58 to 70; a decrease in water content in the melt also results in an increase in Mg #. A strong influence of water content in the Opx-melt Mg # partitioning was reported in previous experimental studies (Waters and Lange, 2017). The 1990, 2007, and 2014 Opx cores and gloms range from Mg # 66 to 76 (average of 66), with a bimodal distribution. This Mg # range overlaps with experimental orthopyroxene compositions at 1000°C, 200 MPa and at NNO for all eruptions, although we have not identified pigeonite in the natural samples.

3.4.4.4 Clinopyroxene

Experimental Cpx is ubiquitous in most charges (Mg # 61-76, Wo₃₃₋₄₀En₃₉₋₄₆Fs₁₅₋₂₅) (Fig 3.6c, Table 3.8). The Mg # of experimental Cpx increases from 61 to 76 with increasing temperature. There appears to be some effect of water content on composition: at 950°C, the experimental Cpx at 200 MPa have higher Mg # (68-69) than at 400 MPa (61-63). As we could not obtain good quantitative analysis of Cpx for all charges, we have no clear indication of the effect of fO_2 on clinopyroxene composition. The 1990, 2007, and 2014 clinopyroxene cores and gloms composition Mg # (70-76, average ~ 74) overlap with experimental clinopyroxene at 1000°C, 200 MPa, and NNO + 2 at 4 wt. % water.

Table 3.8. *Experimental pyroxene chemistry*

Mineral	Pgt	Opx	Opx	Pgt	Opx	Pgt	Opx	Pgt	Pgt	Opx	Opx	Opx
T (°C)	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	950
	SUP	SUP	SUP	SUP	SUPL	SUP	SUPL	SUP	SUP	SUP	SUP	SUP
Charge	L1-02	L1-11	L1-12	L1-12	L1-13	L1-13	L1-16	L1-16	L1-17	L1-18	L1-19	L1-31
n:	3	6	14	1	4	1	5	1	1	1	3	3
wt. %												
SiO ₂	52.0 (1.1)	52.6 (0.8)	52.5 (0.5)	52.1	54.0 (1.0)	52.7	51.0 (0.8)	49.8	51.5	50.1	51.1 (0.6)	51.0 (0.3)
	0.29 (0.02)	0.24 (0.04)	0.27 (0.04)	0.3	0.16 (0.03)	0.2	0.31 (0.07)	0.3	0.2	0.3	0.30 (0.07)	0.34 (0.01)
TiO ₂	)	)	)								)	)
Al ₂ O ₃	1.6 (0.5)	2.3 (0.9)	2.0 (0.3)	2.6	2.7 (0.6)	0.7	4 (1)	6.0	1.2	2.6	2.1 (0.8)	2.6 (0.2)
	0.05 (0.02)	0.03 (0.02)	0.51 (0.05)	0.1	0.5 (0.1)	0.03	0.10 (0.03)	0.1	0.05	b.d.	0.10 (0.04)	0.14 (0.03)
Cr ₂ O ₃	)	)	)								)	)
FeO*	20.9 (0.4)	18.9 (0.7)	20.0 (0.6)	18.2	14.1 (0.1)	22.3	20.9 (0.6)	20.2	22.0	24.8	22.2 (0.3)	24.6 (0.2)
	0.7 (0.1)	0.58 (0.03)	0.63 (0.01)	0.6	0.47 (0.02)	0.7	0.58 (0.03)	0.6	0.7	0.6	0.64 (0.04)	0.65 (0.03)
MnO	)	)	)								)	)
MgO	18.6 (0.5)	22.7 (0.7)	21.9 (0.3)	21.0	25.7 (0.6)	19.4	19.4 (0.6)	18.7	18.4	19.5	19.1 (0.6)	18.1 (0.4)
CaO	5.4 (0.2)	2.2 (0.3)	2.0 (0.2)	3.9	2.3 (0.2)	3.8	2.6 (0.5)	3.1	4.4	2.2	3 (1)	1.8 (0.1)
	0.2(0.2)	b.d.	b.d.	0.1	0.04 (0.03)	0.05	0.2 (0.1)	0.4	0.1	b.d.	0.05 (0.02)	0.03 (0.01)
Na ₂ O	)	)	)								)	)
K ₂ O	0.05 (0.06)	0.02 (0.02)	b.d.	b.d.	b.d.	0.01	0.01 (0.01)	0.0	0.01	b.d.	b.d.	b.d.
Total	99.7 (1.4)	99.6 (1.2)	99.5 (0.5)	98.8	100.0 (0.6)	100.0	99.1 (0.6)	99.1	98.4	100.1	98.5 (0.3)	99.1 (0.6)
Mg # ^a	61.4 (1.1)	68 (2)	66.2 (0.9)	67.2	76.5 (0.5)	60.8	62.3 (0.7)	62.3	59.9	58.3	60.5 (0.5)	56.7 (0.7)
End-member ^a												
Wo	11.4 (0.3)	5 (1)	4.2 (0.4)	8.3	4.7 (0.5)	7.9	6 (1)	7.0	9.3	4.4	6 (3)	3.8 (0.2)
En	54.4 (0.8)	65 (2)	63.4 (0.9)	61.6	72.9 (0.8)	56.0	58.7 (0.9)	58.0	54.3	55.7	57 (2)	54.5 (0.8)
Fs	34.2 (1.1)	30 (1)	32.4 (0.9)	30.1	22.4 (0.4)	36.1	35.5 (0.8)	35.0	36.4	39.8	37.0 (0.6)	41.6 (0.6)

Mineral	Opx	Opx	Opx	Pgt	Pgt	Opx	Opx	Opx	Opx	Opx	Opx	Opx
T (°C)	950	950	950	1060	1060	1060	1060	1060	1060	1000	1000	1000
Charge	SUP	SUP	SUP	SUP	SUPL	SUP	SUPL	SUP	SUP	SUP	SUP	SUP
n:	L1-32	L1-33	L1-34	L1-44	L1-45	L1-46	L1-46	L1-49	L1-50	L1-51	L1-57	L1-59
wt. %	10	6	7	1	1	1	1	9	1	26	1	3
SiO ₂	51.3 (0.6)	51.5 (0.4)	51.8 (0.2)	52.9	53.7	53.7	53.9	52.7 (1.0)	53.1	53.0 (0.9)	52.0	53.1 (0.9)
TiO ₂	0.36 (0.05)	0.37 (0.03)	0.38 (0.04)	0.3	0.1	0.1	0.2	0.20 (0.02)	0.3	0.23 (0.04)	0.3	0.23 (0.05)
Al ₂ O ₃	2.4 (0.5)	2.3 (0.4)	2.5 (0.5)	2.4	1.1	1.1	1.8	3.6 (0.7)	2.6	2.1 (0.7)	2.4	3 (1)
Cr ₂ O ₃	0.11 (0.04)	0.13 (0.01)	0.10 (0.03)	0.0	0.2	0.2	0.2	0.4 (0.4)	0.5	0.04 (0.03)	0.2	0.29 (0.07)
FeO*	23.8 (0.2)	24.0 (0.2)	23.4 (0.3)	22.0	18.9	18.9	19.1	14.7 (0.8)	17.9	17.3 (0.5)	19.5	17.3 (0.2)
MnO	0.65 (0.02)	0.66 (0.02)	0.67 (0.03)	0.7	0.6	0.6	0.7	0.46 (0.03)	0.6	0.58 (0.03)	0.6	0.55 (0.05)
MgO	18.6 (0.2)	18.5 (0.2)	18.9 (0.4)	19.9	22.9	22.9	20.6	25.6 (0.4)	21.9	24.2 (0.9)	22.1	23.5 (0.5)
CaO	1.9 (0.2)	2.1 (0.1)	2.0 (0.2)	2.9	3.3	3.3	4.6	2.2 (0.3)	3.3	2.1 (0.4)	2.1	2.1 (0.9)
Na ₂ O	0.03 (0.01)	0.06 (0.04)	0.06 (0.05)	0.3	0.1	0.1	0.2		0.05	b.d.	0.01	0.04 (0.02)
K ₂ O	b.d.	0.01 (0.01)	0.01 (0.01)	0.03	0.01	0.01	0.01	b.d.	0.01	b.d.	0.03	0.01 (0.01)
Total	99.1 (0.3)	99.5 (0.5)	99.8 (0.4)	101.5	101.0	101.0	101.3	100.2 (0.6)	100.1	100 (1)	99.4	99.9 (0.3)
Mg # ^a	58.2 (0.3)	57.8 (0.2)	59.0 (0.3)	61.7	68.4	68.4	65.8	75.6 (1.0)	68.6	71.4 (0.9)	66.9	70.8 (0.3)
End-member ^a												
Wo	4.0 (0.5)	4.5 (0.3)	4.3 (0.5)	6.1	6.5	6.5	9.5	4.5 (0.6)	6.9	4.3 (0.8)	4.4	4 (2)
En	55.8 (0.4)	55.2 (0.2)	56.5 (0.6)	57.9	63.9	63.9	59.5	72.1 (0.9)	63.9	68 (1)	64.0	68 (1)
Fs	40.1 (0.2)	40.3 (0.2)	39.2 (0.2)	36.0	29.6	29.6	31.0	23.3 (1.0)	29.3	27.4 (0.8)	31.6	28.0 (0.4)
Mineral	Opx	Opx	Pgt	Cpx	Cpx	Cpx	Cpx	Cpx	Cpx	Cpx	Opx	Opx

T (°C)	1000	950	950	1000	950	950	950	1000	1000	950	1060	1000
	SUP	SUP	SUP	SUP	SUPL	SUP	SUPL	SUP	SUP	SUP	SUP	SUP
Charge	L1-61	L1-64	L1-29	L1-18	L1-28	L1-31	L1-34	L1-58	L1-59	L1-64	L1-50	L1-51
n:	1	7	1	3	4	1	5	3	3	1	1	26
wt. %												
SiO ₂	52.2	53.6 (0.7)	52.6	48.9 (0.6)	52.6 (0.9)	50.1	50.7 (0.6)	52 (1)	51.7 (0.6)	53.3	53.1	53.0 (0.9)
TiO ₂	0.3	0.24 (0.05)	0.3	0.62 (0.09)	3.1 (0.6)	0.7	0.72 (0.06)	0.4 (0.1)	0.5 (0.1)	0.4	0.3	0.23 (0.04)
Al ₂ O ₃	2.6	2.2 (0.5)	2.4	5.0 (0.3)	19 (2)	3.2	3.3 (0.2)	3.0 (0.9)	3.1 (0.3)	4.4	2.6	2.1 (0.7)
Cr ₂ O ₃	0.3	0.02 (0.01)	0.01	0.10 (0.06)	b.d.	0.3	0.22 (0.01)	0.4 (0.1)	0.5 (0.1)	0.02	0.5	0.04 (0.03)
FeO*	19.4	18.1 (0.2)	17.7	10.1 (0.3)	14 (1)	14.3	13.1 (0.9)	9.2 (0.1)	10 (2)	10.8	17.9	17.3 (0.5)
MnO	0.6	0.70 (0.05)	0.7	0.40 (0.05)	0.25 (0.01)	0.5	0.4 (0.1)	0.4 (0.1)	0.4 (0.1)	0.5	0.6	0.58 (0.03)
MgO	21.3	22.0 (0.4)	21.5	14.4 (0.5)	0.4 (0.1)	12.7	12.8 (0.1)	15.9 (0.8)	15 (2)	13.2	21.9	24.2 (0.9)
CaO	2.7	3.1 (0.3)	5.0	18.3 (0.8)	19 (2)	16.5	18 (1)	18.4 (0.5)	18 (3)	17.6	3.3	2.1 (0.4)
Na ₂ O	0.1	0.06 (0.01)	0.1	0.28 (0.02)	0.255 (0.01)	0.2	0.24 (0.03)	0.19 (0.02)	0.20 (0.04)	0.3	0.05	b.d.
K ₂ O	0.02	0.02 (0.01)	0.01	0.03 (0.02)	0.5 (0.1)	0.01	0.04 (0.02)	0.03 (0.01)	b.d.	0.1	0.01	b.d.
Total	99.5	100.1 (0.5)	100.3	98.1 (0.2)	101.3 (0.3)	98.4	99.3 (0.8)	100.0 (0.6)	99.7 (0.5)	100.7	100.1	100 (1)
Mg # ^a	66.3	68.4 (0.4)	68.4	71.9 (0.9)	69 (1)	61.3	63.4 (0.7)	76 (1)	73 (1)	68.6	68.6	71.4 (0.9)
End-member ^a												
Wo	5.8	6.5 (0.6)	10.3	40 (1)	39 (3)	36	39 (3)	39 (1)	38 (7)	39.6	6.9	4.3 (0.8)
En	62.4	64.0 (0.7)	61.4	43 (1)	42 (3)	39	39 (1)	46 (2)	45 (4)	41.5	63.9	68 (1)
Fs	31.8	29.5 (0.4)	28.3	17 (1)	19 (1)	25	22 (1)	15.0 (0.3)	17 (3)	19.0	29.3	27.4 (0.8)
Mineral ^l	Opx	Pgt	Opx	Opx	Opx	Cpx	Cpx	Cpx	Cpx	Cpx	Cpx	Cpx
T (°C)	1000	1000	1000	1000	950	1000	950	950	950	1000	1000	950
Charge	SUP	SUP	SUP	SUP	SUPL	SUP	SUPL	SUP	SUP	SUP	SUP	SUP

e	L1- 57	L1- 57	L1- 59	L1- 61	1-64	L1- 18	1-28	L1- 31	L1- 34	L1- 58	L1- 59	L1- 64
n:	1	1	3	1	7	3	4	1	5	3	3	1
wt. %												
SiO ₂	52.0	52.6	53.1 (0.9)	52.2	53.6 (0.7)	48.9 (0.6)	52.6 (0.9)	50.1	50.7 (0.6)	52 (1)	51.7 (0.6)	53.3
TiO ₂	0.3	0.3	0.23 (0.05)	0.3	0.24 (0.05)	0.62 (0.09)	3.1 (0.6)	0.7	0.72 (0.06)	0.4 (0.1)	0.5 (0.1)	0.4
Al ₂ O ₃	2.4	1.5	3 (1)	2.6	2.2 (0.5)	5.0 (0.3)	19 (2)	3.2	3.3 (0.2)	3.0 (0.9)	3.1 (0.3)	4.4
Cr ₂ O ₃	0.2	0.2	0.29 (0.07)	0.3	0.02 (0.01)	0.10 (0.06)	b.d.	0.3	0.22 (0.01)	0.4 (0.1)	0.5 (0.1)	0.02
FeO*	19.5	18.7	17.3 (0.2)	19.4	18.1 (0.2)	10.1 (0.3)	14 (1)	14.3	13.1 (0.9)	9.2 (0.1)	10 (2)	10.8
MnO	0.6	0.7	0.55 (0.05)	0.6	0.70 (0.05)	0.40 (0.05)	0.25 (0.01)	0.5	0.4 (0.1)	0.4 (0.1)	0.4 (0.1)	0.5
MgO	22.1	20.3	23.5 (0.5)	21.3	22.0 (0.4)	14.4 (0.5)	0.4 (0.1)	12.7	12.8 (0.1)	15.9 (0.8)	15 (2)	13.2
CaO	2.1	5.0	2.1 (0.9)	2.7	3.1 (0.3)	18.3 (0.8)	19 (2)	16.5	18 (1)	18.4 (0.5)	18 (3)	17.6
Na ₂ O	0.01	0.06	0.04 (0.02)	0.1	0.06 (0.01)	0.28 (0.02)	0.255 (0.01)	0.2	0.24 (0.03)	0.19 (0.02)	0.20 (0.04)	0.3
K ₂ O	0.03	0.01	0.01 (0.01)	0.02	0.02 (0.01)	0.03 (0.02)	0.5 (0.1)	0.01	0.04 (0.02)	0.03 (0.01)	b.d.	0.1
Total	99.4	99.2	99.9 (0.3)	99.5	100.1 (0.5)	98.1 (0.2)	101.3 (0.3)	98.4	99.3 (0.8)	100.0 (0.6)	99.7 (0.5)	100.7
Mg # ^a	66.9	65.9	70.8 (0.3)	66.3	68.4 (0.4)	71.9 (0.9)	69 (1)	61.3	63.4 (0.7)	76 (1)	73 (1)	68.6
End- memb er ^a												
Wo	4.4	10.5	4 (2)	5.8	6.5 (0.6)	40 (1)	39 (3)	36	39 (3)	39 (1)	38 (7)	39.6
En	64.0	59.0	68 (1)	62.4	64.0 (0.7)	43 (1)	42 (3)	39	39 (1)	46 (2)	45 (4)	41.5
Fs	31.6	30.5	28.0 (0.4)	31.8	29.5 (0.4)	17 (1)	19 (1)	25	22 (1)	15.0 (0.3)	17 (3)	19.0

Notes. ^aPyroxene end-members and Mg # calculations are as in Table 3.3. FeO* = total Fe expressed as Fe²⁺. Pgt: pigeonite. b.d. = below detection level. Numbers in parentheses refer to 1s of the mean of multiple analyses. Where the 1s is less than the relative error, the relative error is reported instead.

3.4.4.5 Olivine

Experimental Ol (100-500 μm) is present in charges at 950-1000°C, $P = 100\text{-}150\text{ MPa}$ at NNO, and 1000°C, 200 MPa, at NNO + 2 (Fig. 3.6d, Table 3.9). Its Fo content ranges from 59 to 76, and increases with temperature for a water content of 3-5 wt. %. There is no systematic change in Fo with increasing $f\text{O}_2$ from NNO to NNO + 2. We can only compare the experimental Ol compositions to Ol from the 2014 eruption, because the Ol from the 1990 and 2007 eruptions have completely reacted to symplectites. There are two compositional groups of Ol from the 2014 eruption, with one at Fo = 72-75 and another at Fo = 67-69. The high-Fo group of Ol overlaps with experimental Ol from 100 MPa, 1060°C and NNO and ~3 wt. % water, and the low-Fo group overlap with experimental Ol from 60°C lower.

3.4.4.6 Amphibole

It was particularly difficult to identify Amph in the experimental charges, and we were able to obtain good quantitative analysis of one experimental Amph (magnesio-hornblende; Mg # = 69; Table 3.9) in the charge at 950°C, 400 MPa, and 6 wt. % dissolved water in the melt (Fig. 2g-h). We also identified additional Amph crystals in other charges using principal component analyses of mineral compositions obtained with the electron microprobe analysis (Fig. S3.2). The geothermobarometry results from the natural Amph of the 1990 and 2014 eruptions agree with the experimental Amph stability field we have found (Fig. 3.4). We reconstructed the composition melt from natural Amph from 1990 and 2014 according to the methodology of Li et al. (2021) to compare the equilibrium SiO_2 content of the parental melt of Amph with that of our glasses. We find that the Al/Si ratio of Amph from 1990 correspond to 53-60 wt. %, which is close to the SiO_2 content of the starting material glass. The equilibrium melt of Amph from 2014 is more silica-rich, with 68-70 wt. % SiO_2 , which overlaps with the interstitial glasses. This suggests that the Amph from 1990 and 2014 came from different melts, where the 1990 Amph was sampled from a less differentiated melt than the 2014 Amph.

3.4.4.7 Fe-Ti oxides

Magnetite and ilmenite crystallized in experimental charges depending on the water content in the melt, and magnetite is more common (Table 3.10). Experimental magnetite ($X_{\text{usp}} = 0.24\text{-}0.60$) is present in almost all water-saturated charges. Ilmenite occurs in water poor charges. Although we have identified ilmenite in charges through its EDS spectrum, we were not able to quantitatively determine their compositions.

Table 3.9. *Experimental amphibole and olivine compositions*

Mineral ^a	Amph	Amph	Amph	Amph	Ol	Ol	Ol	Ol	Ol	Ol	Ol
T (°C)	1000	1000	950	950	1000	1000	950	1060	1060	1000	1000
	SUPL	SUPL	SUPL	SUPL	SUPL	SUP	SUPL	SUPL	SUPL	SUPL	SUPL
Charge	1-16	1-17	1-32	1-28	1-1	L1-6	1-21	1-38	1-39	1-58	1-59
n:	1	1	1	1	7	1	1	1	2	3	3
wt. %											
SiO ₂	48.5	48.9	48.6	52.2	37.2 (0.4)	36.3	36.2	37.5	37.9 (0.5)	38.0 (0.4)	37.5 (0.4)
TiO ₂	0.6	0.9	0.5	0.5	0.02 (0.01)	0.02	0.02	0.05	0.02 (0.01)	0.02 (0.01)	0.02 (0.01)
Al ₂ O ₃	4.5	10.1	5.3	4.0	0.2 (0.2)	0.02	0.02	0.03	0.04 (0.01)	0.03 (0.01)	b.d.
Cr ₂ O ₃	0.1			0.1	b.d.	0.01	b.d.	0.02	0.04 (0.02)	b.d.	b.d.
FeO*	14.6	11.9	15.3	18.4	27.8 (0.2)	27.7	34.1	21.8	21.6 (0.2)	25.1 (0.2)	28.5 (0.3)
MnO	0.4	0.4	0.5	0.6	0.65 (0.02)	0.6	0.8	0.5	0.51 (0.01)	0.53 (0.02)	0.58 (0.01)
MgO	13.1	11.0	15.9	11.9	33.6 (0.2)	32.7	28.1	38.1	38.4 (0.4)	35.7 (0.1)	32.7 (0.3)
CaO	15.7	16.4	12.1	12.7	0.3 (0.1)	0.2	0.2	0.3	0.28 (0.03)	0.23 (0.01)	0.27 (0.4)
Na ₂ O	0.7	1.2	0.3	0.3	b.d.	0.001	0.01	0.01	0.01 (0.01)	b.d.	b.d.
K ₂ O	0.2	0.1	0.0	0.1	b.d.	0.03	0.01	0.01	0.01 (0.01)	b.d.	b.d.
Total	98.5	100.7	98.5	100.8	99.4 (0.5)	97.4	99.2	98.1	98.6 (0.7)	99.4 (0.04)	99.4 (0.1)
End-member ^a	Mg-hbl	und.	Mg-hbl	Mg-hbl							
Mg # ^a	61.5	62.2	68.7	53.6							
Fo content ^a					68.3 (0.2)	67.8	59.5	75.7	76 (1)	71.7 (0.2)	66.9 (0.3)

Notes. See Table 3.2 for meaning of abbreviations. Mg-hbl = Magnesio-hornblende. FeO* = total Fe expressed as Fe²⁺. Mg # = $100 \times \text{Mg} / (\text{Mg} + \text{Fe}^*)$. b.d. = composition below detection level. und. = undetermined. Numbers in parentheses refer to 1s of the mean of multiple analyses. Where

the 1s is less than the % error, the % error is reported instead.

Table 3.10: Experimental Fe-Ti oxides chemistry.

T (°C)	1000	1000	1000	1000	1000	1000	1000
Charge	SUPL1-1	SUPL1-2	SUPL1-3	SUPL1-12	SUPL1-13	SUPL1-14	SUPL1-15
n:	1	1	3	3	7	8	3
wt. %							
SiO ₂	0.5	0.3	0.30 (0.07)	0.30 (0.08)	0.21 (0.03)	0.3 (0.1)	0.3 (0.1)
TiO ₂	5.2	11.5	10.9 (0.5)	8.1 (0.1)	9.0 (0.3)	13.2 (0.1)	16.9 (0.1)
Al ₂ O ₃	5.7	3.3	3.5 (0.1)	5.3 (0.1)	4.8 (0.1)	3.8 (0.1)	3.1 (0.1)
FeO*	67.0	71.8	70.8 (0.7)	71.4 (0.2)	70.5 (0.7)	70.0 (0.2)	63.8 (0.2)
MnO	0.5	0.4	0.47 (0.02)	0.42 (0.01)	0.46 (0.01)	0.46 (0.01)	0.51 (0.01)
MgO	3.7	2.4	2.37 (0.04)	3.05 (0.02)	2.8 (0.1)	2.43 (0.03)	2.1 (0.1)
CaO	0.2	0.3	0.24 (0.03)	0.2 (0.1)	0.15 (0.01)	0.20 (0.04)	0.25 (0.02)
Total	82.8	90.0	88.6 (0.8)	88.8 (0.3)	88.0 (0.8)	90.4 (0.2)	86.93 (0.02)
FeO ^c	54.0	59.2	58.4 (0.5)	57.7 (0.1)	57.5 (0.5)	58.3 (0.1)	55.3 (0.1)
Fe ₂ O ₃	14.5	14.1	13.8 (0.2)	15.2 (0.1)	14.5 (0.2)	13.0 (0.1)	9.5 (0.1)
X _{usp}	0.24	0.38	0.37(0.01)	0.28 (0.01)	0.31 (0.01)	0.44 (0.01)	0.58 (0.01)

T (°C)	950	950	950	950	950	950	950	950
Charge	SUPL1-28	SUPL1-29	SUPL1-30	SUPL1-31	SUPL1-32	SUPL1-64	SUPL1-65	SUPL1-67
n:	1	1	1	1	1	1	1	2
wt. %								
SiO ₂	0.3	0.4	0.6	0.4	0.3	0.3	0.3	0.2 (0.1)
TiO ₂	15.8	16.2	16.7	15.1	16.0	16.3	7.5	12.0 (0.7)
Al ₂ O ₃	2.9	2.6	2.7	2.7	4.5	2.6	3.8	3.00 (0.05)
FeO*	70.9	68.6	64.8	69.9	63.9	67.0	75.9	72.4 (0.9)
MnO	0.3	0.4	0.4	0.5	0.5	0.4	0.5	0.41 (0.02)
MgO	0.7	1.4	1.4	1.7	2.2	1.4	1.8	1.52 (0.01)
CaO	0.3	0.2	0.3	0.4	0.3	0.3	0.3	0.30 (0.03)
Total	91.2	89.9	87.0	90.7	87.8	88.4	90.3	90 (1)
FeO ^c	57.7	58.8	56.4	59.1	55.0	60.5	61.4	60.2 (0.6)
Fe ₂ O ₃	10.4	10.9	9.3	12.1	9.9	11.5	16.2	13.7 (0.3)
X _{usp}	0.50	0.53	0.57	0.49	0.55	0.54	0.25	0.39 (0.01)

Notes. Fe₂O₃ calculated using the approach by Droop (1987), where $Fe_2O_3 = FeO^* \times (Fe^{3+} / Fe^{2+} + Fe^{3+}) \times 1.1113$. FeO^c = FeO calculated using the approach by Droop (1987), where $FeO^c = FeO^* \times (Fe^{2+} / Fe^{2+} + Fe^{3+})$. Numbers in parentheses refer to 1s of the mean of multiple analyses. Where the 1s is less than the relative error, the relative error is reported instead. b.d. = below detection level.

Fig. 3.6. Variations in experimental mineral compositions of experimental charges compared to natural ones (Plag, Cpx, Opx, and Ol) of the crystal cargo of 1990, 2007, and 2014 eruptions: **a.** An in Plag, **b.** Mg # in Opx, **c.** Mg # in Cpx, and **d.** Fo content in Ol. Coloured solid boxes denote the observed ranges of mineral compositions from the three eruptions, with the same colours as outlined in Fig. 3.5. Opx boxes represent rim compositions of the minerals (Chapter 2 and Table 3.2 of this study).

3.5 Discussion

3.5.1 Geothermobarometry and experimental constraints on magma storage conditions of sub-Plinian eruptions and dome extrusions

Combining the geothermobarometric and experimental results, we find that the pre-eruptive magma storage conditions that match the phenocryst content, natural phase assemblage, and some of the mineral compositions for the three eruptions are at $975 \pm 39^\circ\text{C}$, $175 \pm 25 \text{ MPa}$, with 4-6 wt. % water in the melt and a $f\text{O}_2$ of NNO. These conditions correspond to about 7 km of

storage below the crater if we use a crustal density of 2640 kg m^{-3} . However, this does not mean that all of the crystal cargo grew at this depth, as amphibole geobarometry indicates pressures of up to 400 MPa (up to $\sim 15 \text{ km}$), and hence some these crystals were probably entrained from deeper parts of the magmatic system (Fig. 2.4a; Chapter 2). A key difference between the 1990 and 2014 eruptions and those of the 2007 dome is the much higher phenocryst content of the latter (Table 3.2). This could be due to crystal accumulation in the dome, but the major and trace element compositions of the three eruptions are similar, including incompatible trace elements such as Zr (this study; Jeffery et al., 2013a), meaning that the observed difference in crystal content is due to in situ crystallization. According to experimental results, the lava dome's higher phenocryst content (Fig 3) can be reproduced with $\sim 1 \text{ wt. \%}$ water in the melt for a temperature of about 975°C . Thus we propose that the low apparent water content is likely the result of additional storage at shallower pressures and/or transport towards the surface that led to water loss and cooling, rather than a difference in the initial pre-eruptive conditions. The presence of the pseudomorphs and symplectites that used to be Amph and Ol in the 2007 rocks also indicate that the magma was originally stored at similar conditions to the 1990 and 2014 eruptions, although its slower ascent resulted in phenocryst proportions and compositions to re-equilibrate to shallower depths.

3.5.2 The importance of excess volatiles in determining eruption style

The explosive $\rightarrow$ effusive $\rightarrow$ explosive eruption style transition shown by the 1990-2007-2014 events remains some of the most intriguing aspects of Kelud volcano. Given that the pre-eruptive or “initial” (e.g. before ascent) conditions of temperature, pressure, and water content in the melt are broadly the same for the three events, other variables have played a role in producing the different eruption styles. In Chapter 2, we proposed that the explosive eruptions of the 1990 magma was likely due to excess fluid accumulation, and we calculated that up to 0.12 Mt SO_2 could have resided as a separate fluid phase. Our mass balance calculations for the SO_2 budget of the 2014 eruption also indicate the presence of an exsolved volatile phase at pre-eruptive conditions, with up to 0.1 Mt SO_2 (Table 3.11). Such excess fluid can be developed via progressive magma crystallization and volatile buildup to supersaturation (e.g. Arzilli et al., 2019;

Cassidy et al., 2019a; Tramontano et al., 2017), with additional fluids can also be due to fluid fluxing and degassing from a deep-seated basaltic magma reservoir and/or limestone in the case of Kelud (e.g. Caricchi et al., 2018; Giuffrida et al., 2017; Chapter 2). Although we can only calculate the amount of SO₂, the fluid phase would have certainly included water and CO₂. The presence of an exsolved fluid phase at pre-eruptive conditions means that the magma buoyancy is greatly increased, as fluids can expand from the moment the magma starts its ascent and lithospheric pressure decreases (Gonnermann and Manga, 2013a). The additional buoyancy could lead to significantly faster magma ascent, depending on the distribution of the fluid in the magma and whether there is a one- or two-phase flow, and also lead to much higher explosivity.

Our hypothesis differs from that of Cassidy et al. (2019a), who proposed that the difference in eruption style is dependent on the degree of water saturation in the magma. They further proposed that the 2007-2008 dome extrusion was triggered by an injection of hot, CO₂-rich magma that suppressed the water content, and the 2014 explosive eruption was driven by water saturated magma. Furthermore, our hypothesis also differs significantly from previous work on Nisyros-Yali volcanic system (Popa et al., 2020), where magma with high water content (>4.5 wt. % water in the melt) in the melt can generate lava flows. The high crystallinity magma (>40 vol. %) found at Nisyros and Methana increases bulk viscosity, and the interlocking crystals in the magma mush creates permeable pathways, thereby promoting outgassing and resulting in lava flows. At Kelud, the exsolved fluid phase likely had the opposite effect, where the exsolved fluids phase coexisted with the interstitial melt. This exsolved fluid phase could increase the bulk buoyancy, whereas the crystal cargo likely increases the bulk viscosity; combined, these work together to enhance the magma's potential to erupt explosively.

On the other hand, Jeffery et al. (2013a) invoked additional processes such as crustal contamination, inter-crustal magma mixing, xenolith incorporation, and magma migration, where the volatile content degassed from 8 wt. % to 2-3 wt. % during magma migration. We have as yet no definitive geochemical or textural evidence to suggest that magma mixing is a dominant process at Kelud based on mineral chemistry and textures interpretations presented in Chapter 2.

Table 3.11. *Excess volatile estimates for the 2014 magma using the petrologic method of Devine et al. (1984).*

	14-PUMI-2	Units
Erupted volume (DRE) ^a	0.28	km ³
Rock density	2404	kg/m ³
Mass of magma	673	Mt
Max. concentration of SO ₂ in melt inclusion	547-582	ppm
Max concentration of SO ₂ in interstitial glass	95-126	ppm
Glass proportion	0.66-0.71	
SO ₂ degassed from the melt	0.20-0.22	Mt
Atmospheric SO ₂ ^b	0.30	Mt
Excess SO ₂	0.08-0.10	Mt

Notes. ^aErupted volume from Maeno et al. (2019). ^bSO₂ from Carn (2019)

The accumulation of an excess fluid also requires that the plumbing system behaves as a closed system, or with the mass flux of exsolved fluids that was produced being larger than that which is degassed, implies that there was limited passive degassing between eruptions. Kelud volcano is considered semi-plugged by Whelley et al. (2015). Prior to 1990 eruption, degassing from depth was likely blocked by a plug of crystalline magma from the previous event in 1966 and ~4 million m³ of lake water (Lesage and Surono, 1995a; Vandemeulebrouck et al., 2000a), whereas before the 2014 eruption, the volcano was plugged by the 2007 dome (Global Volcanism Program, 2014a). The 1990 plug and 2007 dome likely provided little permeability for the fluids to escape, in addition to exerting relatively high lithostatic/hydrostatic pressure. These conditions could have effectively decreased the rock's permeability and allowed fluids and overpressure to accumulate before eruption. Minerals such as cristobalite likely formed at shallow pressures (< 50 MPa) during and after dome emplacement and contribute reducing the permeability of the dome (Horwell et al., 2013; Martel and Schmidt, 2003a). In contrast, after the 1990 eruption and up until 2007, there was significant outgassing from arcuate fractures observed, and an “embryonic” dome sealed the conduit (Global Volcanism Program, 1990b). The observed fumarolic activity and outgassing likely stemmed from active degassing of a shallow magma body from a residual magma intrusion, similar to a resurgent dome (Acocella et al., 2000; Global Volcanism Program, 1990b). Between 1990 and 2007, there were also several crises involving two heating episodes, when the lake water increased in temperature from 40°C and 35°C in 1996 and 2001, respectively

to ~50°C (Bernard and Mazot, 2004). The observed post- and inter-eruptive crises between 1990 to 2007 suggest the magma system was partially open, allowing the shallow magma body to further degas volatiles out of the system and thus was not able to accumulate a significant amount of excess fluids.

3.5.3 Relating pre-eruptive processes to unrest signals

Volcanic unrest at Kelud has been monitored using a range of observations, including seismicity, lake chemistry and its temperature, and deformation. Unrest signals preceding all three events started around 2-3 months before eruption, and included seismic swarms with seismic unrest signals spanning volcano-tectonic, shallow VB, low frequency, tremor (e.g. Hidayati, 2009; Hidayati et al., 2018a; Lesage and Surono, 1995a). Seismicity escalated rapidly (e.g. < 24 hours) before the 1990 and 2014 eruptions, and earthquake hypocenters are mostly concentrated around shallow depths beneath the crater (< 7 km) (Hidayati et al., 2018a; Lesage and Surono, 1995a). Sharp increases in lake temperature and input of magmatic volatiles such as Cl₂ and CO₂ into the lake have also been proposed for the unrest prior to the 1990 and 2007 eruptions (Bernard and Mazot, 2004; Caudron et al., 2012; Kunrat, 2009; Vandemeulebrouck et al., 2000). Tiltmeters and interferometric synthetic aperture radar (InSAR) detected changes in local and regional deformation from inflation to rapid deflation preceding 2014 eruption and 2007 dome extrusion, respectively (Hidayati et al., 2018a; Lubis, 2014a). Despite the diverse monitoring data available, it is still difficult to anticipate eruptions at Kelud, including whether the ensuing eruption will be effusive or explosive (Nakamichi et al., 2017a).

Results of our study suggest that the accumulation of an excess volatile phase prior to the eruptions of 1990 and 2014 was a key parameter to their explosivity (Fig. 3.7). Contrasting this with the inter-eruptive period between the 1990 and 2007, where the system was able to degas more freely, which then resulted in the 2007 eruption being effusive. If our hypothesis is correct, identifying monitoring signals that could be related to fluid accumulation and magma degassing or transfer within the plumbing system could be useful in anticipating explosive eruptions. One possibility is to monitor deep long period seismicity using broadband seismometers as this has been interpreted as degassing of volatile-rich magma at depth (Melnik et al., 2020). Another

possibility are microgravity surveys or continuous gravity monitoring, as we can expect that significant fluid accumulation would lead to subtle changes in density of the plumbing system over time, as demonstrated in Masaya volcano (Nicaragua) (e.g. Williams-Jones et al., 2003).

Fig. 3.7. Conceptual model of the magmatic conditions and processes occurring for the 1990-2014 Kelud eruptions. Black rectangles represent the crystal cargo, or crystallization in the conduit. White flattened circles represent accumulation of the pre-eruptive excess fluid phase present before explosive eruptions. Solid white arrows represent fluid fluxing through the system either from a deep-seated degassing basaltic magma, or from limestone assimilation. Dashed white arrows represent fluid release through a semi-permeable conduit leading up to dome extrusion. The 1990 and 2014 magmas were able to accumulate an excess volatile phase and hence the higher explosivity of their eruptions, where as a higher permeability of the system between 1990 and 2007 allowed for extended degassing and slower ascent of the 2007 as a dome. Pressures are converted to depth below the crater using the density calculated in Smyth et al. (2007). The volcanoclastic and carbonate layers are also in Smyth et al. (2007), as represented in Jeffery et al. (2013). Volcano Explosivity Indices (VEI) reported come from Global Volcanism Program (2013). Storage depth constraints come from Cassidy et al. (2019) (2014 eruption) [1], Jeffery et al. (2013) (2007 dome) [2], and Chapter 2 (1990 eruption) [3]. Plume height were reported in Bourdier et al. (1997) for 1990; Global Volcanism Program (2008) for 2007; and Kristiansen et al. (2015) for 2014.

3.6 Conclusions

We present petrological and experimental constraints on the pre-eruptive storage conditions of the basaltic andesite magma feeding the 1990, 2007, and 2014 eruptions of Kelud volcano, which alternated between explosive → effusive → explosive eruption styles. The three events share similar whole rock compositions, mineralogy, implying that their magma storage conditions were also similar. We found that the natural phenocryst content and mineral assemblage can be experimentally reproduced at $975 \pm 39^\circ\text{C}$, $175 \pm 25 \text{ MPa}$ (~7 km below the crater level), NNO, and with 4-6 wt. % water in the melt. We also found that the 1990 and 2014 magmas coexisted with an exsolved volatile phase at pre-eruptive conditions, and we propose that this played a main role to their explosive style. The lava dome was likely a residual magma batch from the 1990 eruption or earlier that had no excess fluids, as the conduit was partially open after the 1990 eruption that allowed gases to be released. Monitoring techniques such as continuous microgravity surveys could help to identify changes in density from fluid accumulation and thus may be able to anticipate eruption styles.

3.7 Acknowledgments

We would like to thank R. Champallier and I. di Carlo from ISTO-Orléans for assistance with experiments and sensor analyses. Hsu Y-J, J. Herrin, and J. Oalman from the Earth Observatory of Singapore are thanked for assistance with analyses on the SEM, EPMA, and discussions around experimental petrology. We would like to acknowledge the Facility for Analysis, Characterisation, Testing and Simulation, Nanyang Technological University, Singapore, for use of their electron microscopy/X-ray facilities. We further thank C. Widiwijayanti, P. Lesage, and P. Allard for discussions on Kelud volcano. We thank S. Jenkins for being part of the thesis advisory committee. This project was funded by the Stephen Riady Geosciences Scholarship 2018-2019 awarded to SBU. The data underlying this project are available at DR-NTU (<https://researchdata.ntu.edu.sg/privateurl.xhtml?token=6981d93f-ea77-4057-88e2-19c0480fa99e>), and available as online supplementary material (Datasets S1 and S2). We are in the process of archiving our data. There are no financial conflicts of interests between any author.

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3.9 Supplementary Material

Fig. S3.1: Map of Kelud volcano in relation to the island of Java, with sample, summit (1731 m above sea level), and the nearest village to Kelud volcano crater (Bambangan), made using Google Earth. Inset map shows the location of Kelud volcano in the island of Java, Indonesia.

Fig. S3.2: Principal component analyses for compositions of experimental phases, showing both experimental and 1990 amphibole compositions (400 MPa-950°C-NNO-XH₂O_{in} = 0.8).

Fig. S3.3: Compilation of BSE images of textures from 2007 lava dome and 2014 pumices.

Table S3.1: Compilation of unrest data for the 2007 and 2014 eruptions, compiled from Cassidy et al. (2019), Caudron et al. (2012), Hidayati et al. (2018), and Lubis (2014).

Year of eruption	Eruption style	Volcano Explosivity Index‡	Pre-eruptive unrest	Unrest/monitoring technique	Timeline of unrest										Eruption date	Observations	Source
					1989					1990							
					1-11 Nov	12-22 Nov	23-30 Nov	1-11 Dec	12-22 Dec	23-31 Dec	1-11 Jan	12-22 Jan	23-31 Jan	Feb			
1990	Explosive (Plinian)	4	seismicity	VT (A)	x	x	x	x	x	x	x	x		x	10-Feb-90	Volcanic activity recorded at background levels three weeks before eruption (after Jan 1990 swarm)	1
				seismic energy released tremor	x	x	x	x	x	x	x	x		x		Additional low magnitude earthquakes 24 hours before eruption (> 400)	1
				seismic multiplets						x	x	x		x			1
				monochromatic events						x	x						1

				Long period							x							1
			lake temperature		x	x	x	x	x	x	x	x	x	x				2
			hydroacoustics	audiometric	x	x			x	x	x	x	x	x		Power supply failure occurred in June/July 1989 and 20 Nov - 10 Dec 1989		2
				ultrasonic	x	x			x	x	x	x	x	x				2
				low frequency	x	x			x	x	x	x	x	x				2
2007																		
					Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Extrusion date	Observations	Source	
2007	Dome emplacement	2	deformation	InSAR	x	x	x	x	x						3-Nov-07	Retroactively detected using ALOS-1 PALSAR satellite		3
				Tiltmeter									x	x				4
			seismicity	VT									x	x		Swarms detected 23 Sep, and several consecutive swarms from 21 Oct to 4 Nov		4

		Tiltmeter (Lirang Selatan)	x	x	x	x	x	x	Unrest started on 27 Oct 2013; no unrest data available 24 Nov to 22 Dec 2013	4
			x	x	x	x	x	x	Unrest started on 17 Nov 2013; no unrest data available 24 Nov to 22 Dec 2013	4
		Tiltmeter (Lirang Utara)					x	x	Unrest started on 8 Feb 2014	4
							x	x	Unrest started on 8 Feb 2014	4
seismicity	VT		x	x	x	x	x	x	swarms recorded on 17-21 Jan 2014 and 27 Jan 2014	4
	VB (shallow)		x	x	x	x	x	x	swarm 15-17 Jan 2014	4
	RSAM		x	x	x	x	x	x		4
	tremor		x	x	x	x	x	x		4
	low frequency		x	x	x	x	x	x		4
	felt earthquake							x	M 4.5 on 11 Feb 2014 at 13:46 WIB	4

Bladak outlet	water temperature						x	x	x	x	x	x		Crater lake temperature increased from Sep 2013 to Feb 2014 by up to 9.5°C. Bladak Outlet temperature varied around 52°C until jump observed on 5 Jan 2014.	4
Observations	gas emission from top of dome	x	x	x	x	x	x	x	x	x	x	x			4

‡ From Global Volcanism Program (2013)

x = recorded observation of unrest signal above background activity

References: [1] Lesage and Surono (1995); [2] Vandemeulebrouck et al. (2000); [3] Lubis (2014); [4] Hidayati et al. (2018); [5] Caudron et al. (2018); [6] Cassidy et al. (2019)

Fig. S3.2: Whole rock SiO₂ content vs. Sr/Zr ratio for the 1990, 2007, and 2014 eruptions. In addition to the 2007 samples studied in this thesis, 2007 samples from Jeffery et al. (2013) were included.

For the following Supplementary Material, see the Thesis Appendix:

Fig. S3.4: Compilation of BSE images of plagioclase textures, plagioclase traverse analyses, and elemental maps of plagioclase and cristobalite from the 2007 dome

Table S3.2: Natural glass and mineral compositions analyzed by EPMA and XRF for Kelud, 1990-2014

- **Table S3.2.1:** glass and whole rock
- **Table S3.2.2:** orthopyroxene
- **Table S3.2.3:** clinopyroxene
- **Table S3.2.4:** plagioclase
- **Table S3.2.5:** olivine
- **Table S3.2.6:** amphibole

Table S3.3: Plagioclase traverse chemistry from 2007 dome rock.

Table S3.4: Whole rock trace element of the 2007 and 2014 eruption samples.

**CHAPTER 4: Contrasting magma ascent rates of explosive eruptions and dome
emplacement at Kelud volcano, Indonesia**

Contrasting magma ascent rates of explosive eruptions and dome emplacement at Kelud volcano, Indonesia

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Abstract

Magma ascent rate can control the explosivity and thus hazard potential of a given eruption, but it is notoriously difficult to determine from natural samples or geophysical datasets. Here we investigate the variations in timescales of magma ascent and associated magma ascent rates of the last three historical eruptions of Kelud volcano (Indonesia) using the zoning of volatile elements in apatite. Most of the apatite crystals of the three eruptions (1990, 2007, and 2014) show significant overlap in volatile contents (OH, Cl, F), but those from the explosive eruptions in 1990 and 2014 are unzoned, whereas those from the 2007 dome are reversely zoned in chlorine and/or fluorine. Best fit timescales modelled from zoned apatite of the 2007 dome give magma ascent times of up to 250 days, and overlap with those of seismic unrest. The inferred maximum magma ascent and degassing times from apatite of the 1990 and 2014 are < 2 days. Using pre-eruptive storage depth estimates we obtain mean magma ascent rates calculated for the 2007 dome event of $0.0003\text{--}0.05\text{ m s}^{-1}$, which are at least one to three orders of magnitude slower than those inferred for 1990 and 2014 explosive eruptions ($> 0.1\text{ m s}^{-1}$). Such ascent rates correspond well with independently determined magma discharge rates for the three eruptions. Our study illustrates the robustness of using apatite zoning in volatile elements to constrain magma ascent dynamics and highlights the major control of magma ascent on eruptive styles.

Keywords: Kelud, Kelut, magma ascent rates, timescales, eruption, apatite

4.1 Introduction

Eruptive styles of volcanoes are notoriously difficult to anticipate, but they are key for proper hazards assessment and planning of actions in response to the eruptions. Kelud volcano in East Java, Indonesia has historically produced some of the most hazardous eruptions in Southeast Asia. Explosive eruptions such as that in 2014, have wreaked havoc across the island of Java, generating life-threatening hazards from building collapse from tephra accumulation to lahars that have destroyed infrastructure (Blake et al., 2015; Global Volcanism Program, 2013b; Jenkins et al., 2015). On the other hand, dome emplacements such as in 2007 are not immediately hazardous, yet are still challenging to anticipate (Goode et al., 2018; Nakamichi et al., 2017b). At Kelud and many other volcanoes, eruptions can transition from effusive to explosive and vice versa between consecutive eruptions, as observed in Merapi (Costa et al., 2013b; Preece et al., 2013), or within one eruption such as at Redoubt volcano (Bull and Buurman, 2013b). Such transitions in eruption styles may be the result of different volatile contents, storage depths, magma compositions and crystallinity, and/or magma ascent rates. All these parameters control the physical properties of the magma and how they change during ascent including viscosity, buoyancy, vesicularity, volatile solubility, and crystallinity, which ultimately determine whether magma flows or blows (Cassidy et al., 2018; Dingwell et al., 1993; Rutherford, 2008). Therefore, estimating magma ascent rates for volcanic eruptions provides a measure of the hazardous potential of that eruption, and thus are highly important in volcanology and volcanic hazard mitigation.

Magma ascent rates can be constrained through petrologic and mineralogic studies of the erupted crystal cargo as well as some volcano monitoring (e.g. seismicity). Modeling the chemical zoning of volatile elements in crystals or glass inclusions can be used to obtain magma ascent times (e.g. Costa et al., 2020). Other methods to constrain ascent rates include quantitative analysis of size distribution variations of the erupted crystal cargo and microlites (Couch et al., 2003; Hammer and Rutherford, 2002), as well as experimental approaches involving decompression experiments (Martel and Schmidt, 2003b). Petrologic studies of natural samples provide magma ascent times can then be converted to ascent rates if magma storage depths are

known. These depths can be typically obtained from phase equilibria experiments (Hammer et al., 2002; Pichavant et al., 2007; Chapter 3) or from mineral-melt geobarometry from the erupted crystal cargo (e.g. Blundy and Cashman, 2008; Putirka, 2008; Chapter 2). Alternatively, geophysical studies employing tomography can be used to calculate storage depth of many volcanoes (Puspito and Shimazaki, 1995; Widiyantoro et al., 2018), although the uncertainty of magma storage depths of some of these studies yield larger ranges of potential magma ascent rates.

A mineral that has gained popularity to constrain volatile budgets and magma ascent rates is apatite (e.g. Li et al., 2021, 2020; Stock et al., 2016). Apatite can incorporate several volatile elements in its structure $[\text{Ca}_5(\text{PO}_4)_3(\text{Cl}, \text{F}, \text{OH})]$, and has been used to investigate the record of metasomatism and fluid movement (Harlov, 2015), estimate lunar water contents (Boyce et al., 2014), and record carbonate assimilation into magma (Wang et al., 2014). Moreover, trace elements in apatite was used to track arc magma evolution (Nathwani et al., 2020), constrain pre-eruptive melt volatile concentrations (Scott et al., 2015); volatile budgets and ascent rates (Li et al., 2021; Li and Costa, 2019), and record evidence for volatile dominating processes such as fluxing and degassing (Boyce and Hervig, 2009; Li et al., 2020; Stock et al., 2016). In this study, we characterized the volatile chemistry recorded in apatite crystals from the 1990, 2007, and 2014 eruptions of Kelud volcano and we also model the zoning of Cl, F, and OH to obtain timescales of ascent (Li et al., 2020), and calculate ascent rates to gain further insights in parameters controlling contrasting eruptive styles.

4.2 Summary of the 1990, 2007, and 2014 Kelud eruptions, unrest, and previous petrological studies

Kelud (Kelut) is a basaltic andesite stratovolcano in East Java, Indonesia with a prolific record of >30 explosive eruptions and effusive dome extrusions since 1000 CE, with a mean recurrence interval of ~23 years (Global Volcanism Program, 2013b). Given the hazardous nature of its explosive eruptions, the volcano is continuously monitored with a dedicated observatory (cf. Hidayati et al., 2018b). Explosive eruptions, such as in 1990 and 2014, were short-lived and unrest indicators (e.g. seismicity) escalated within hours from the onset of unrest, making these

eruptions especially challenging to forecast (Global Volcanism Program, 2014b, 1990c; Nakamichi et al., 2017b). In contrast, the 2007 dome extruded effusively over the course of several weeks, 17 years after the 1990 eruption (Hidayati et al., 2018b). Unrest signals for all three events were recorded around two to three months before their respective eruptions, and consisted of heightened seismicity, deformation, and changes of the lake temperature above background levels (Table 4.1). However, both the 1990 and 2014 events were preceded with an almost exponential increase in seismic unrest around 12 hours before their respective eruption, which was not observed in the 2007 dome (Hidayati et al., 2018b; Lesage and Surono, 1995b). Several short-lived unrest episodes were observed after the 1990 eruption (Global Volcanism Program, 1991), and later on in 1996 and 2001, yet these did not lead to an eruption (Global Volcanism Program, 2001, 1996).

Previous studies aimed at constraining the timescales of magmatic processes have used the Mg-Fe interdiffusion in reversely zoned orthopyroxenes, seismicity, and run-up times, as summarized in Chapter 2. Timescales of Mg-Fe diffusion in Opx were attributed to degassing and fluid accumulation rather than solely on ascent Chapter 2. These timescales overlapped with the onset of seismic and hydro-acoustic unrest around three months before eruption (Lesage and Surono, 1995b; Vandemeulebrouck et al., 2000b). However, only the ascent rate estimated from the onset of seismicity in the run-up to the eruption ~ 12 hours yield ascent rates of $\sim 0.2 \text{ m s}^{-1}$ (Chapter 2), which is consistent with ascent rates for explosive eruptions (Rutherford, 2008). Previous constraints on magma ascent rates for the 2014 eruption based on an experimental approach yield around $4\text{--}5 \text{ m s}^{-1}$, and suggests that ascent times could be as short as minutes (Cassidy et al., 2019b).

4.3 Methodology

We studied apatite crystals from one main-stage and one late-stage pumices of the 1990 deposits (Chapter 1), one fragment from the 2007 lava dome, and two pumices from the sub-Plinian phase of the 2014 eruption (Chapter 2). More details about sample locations and descriptions can also be found at Chapters 2 and 3.

4.3.1 Chemical Analyses of Apatite

We obtained backscattered electron (BSE) images of apatite crystals and Electron Dispersive Spectra (EDS) to identify apatite in carbon-coated thin sections from each sample using a JEOL-JSM 7800F scanning electron microscope (SEM) at the Nanyang Technological University (NTU). We further mapped apatite grains for Mg, Fe, Cl, F, and S in Wavelength Dispersive Spectra (WDS) mode on the JEOL JXA-8530F field emission electron microprobe (EPMA) at the Facility for Analysis Characterisation Testing and Simulation (FACTS), Nanyang Technological University, Singapore (FACTS; NTU). Guided by these elemental maps, we selected target crystals for EPMA analyses. The selected zoned apatite grains were analyzed in spot and traverse mode using a 10 nA current beam with 4 mm beam size, following the methodology outlined in Li et al. (2021). Traverses of apatite grains from the 1990, 2007, and 2014 eruptions were analyzed using a 10 nA current and 2 mm beam size. The structural formulae of apatite was calculated using the approach 1 of Ketchum (2015), which was adapted based on an estimate of the [OH] content. Additionally, we used a threshold of < 5% deviation from the ideal cation ratio of 5/3 to discard non-stoichiometric apatite analyses. The mole fraction of volatile elements in the M2 column anion sites are given as X_{Cl} , X_F , and X_{OH} , respectively. The OH cation was calculated by subtracting the atom per unit formula of Cl and F from the site total and normalizing the value according to: $X_{OH} = \frac{1}{2} \times [2 - (Cl + F)]$.

Relative errors from the EPMA analyses are 1-3% for X_{Cl} , 1-4% for X_F , and the propagated errors are 1-33% for the calculated X_{OH} . Some of the compositional traverses in the 1990 apatite crystals had major element oxide totals that were < 98 wt. % perhaps due to thicker carbon coating (> 15 nm) than thin sections. We determined the orientation of the crystallographic axes of apatite (a and g for a and c-axes, respectively) using the Electron Back-Scatter Diffraction (EBSD) mode in the SEM at the Earth Observatory of Singapore. We then used an in-house EBSD conversion code utilizing the MTEX Texture Analyses Toolbox to calculate the angle between each EPMA traverse and the crystallographic axes (e.g. Costa et al., 2008).

4.3.2 Modelling timescales and ascent rates from apatite

We modelled the concentrations of Cl, F, and OH in apatite assuming volume diffusion through the apatite by using the ApTimer application (Li et al., 2020). Due to the strong anisotropy of diffusion for many elements in apatite, we used the acute angles between the traverses and the crystallographic *a*- and *c*-axes (*a* and *g*, respectively) to correct for Cl, F, and OH diffusion coefficients from Li et al. (2020). The anisotropy is such that the diffusion parallel to the *c*-axis is considerably faster than parallel to the *a*-axes, and thus a correction factor was applied to the diffusion coefficients traverses parallel to the *a*-axes:

$$D_{Cl \parallel a} = 166 \times D_{Cl \parallel c}, \text{ where } D_{Cl \parallel a} = D_{Cl \parallel b} \quad (1)$$

$$D_{F \parallel a} = 19 \times D_{F \parallel c}, \text{ where } D_{F \parallel a} = D_{F \parallel b} \quad (2)$$

$$D_{OH \parallel a} = 46 \times D_{OH \parallel c}, \text{ where } D_{OH \parallel a} = D_{OH \parallel b} \quad (3)$$

These factors were determined by first calculating the diffusion coefficients at 950°C for Cl, F, and OH parallel to the *c*-axis (Li et al., 2020), and then dividing their values by diffusion coefficients parallel to the *a*-axis at the same temperature. This was necessary because Li et al. (2020) only determined the diffusion coefficients of these volatile elements parallel to *a*-axis at 950°C, and it assumes that the activation energy for these elements does not change with crystallographic orientation, which is the case for some minerals and elements (e.g. Fe-Mg in olivine). We mostly used the Cl traverse to obtain best fit timescales as it was the most prominently zoned and precisely measured, but in a few cases we used the F traverse instead. The initial boundary conditions were chosen by visual inspection of the 1-D profile shape and used to determine the most suitable core and rim compositions. The rim composition was fixed with respect to time, and diffusion smoothing towards the core generating the observed concentration gradient (Li et al., 2020). This is a simplification of the process as the composition of the crystal likely changed during magma ascent due to loss of volatile from the magma. Notwithstanding, using a constant composition as opposed to compositions that change with time would give somewhat shorter times (Costa et al., 2008; Humphreys et al., 2021). Temperatures for the diffusion coefficients (1990 and 2014 eruptions: $T = 975 \pm 39^\circ\text{C}$; 2007 dome: $T = 979^\circ\text{C}$) were selected either from the orthopyroxene-melt or two-pyroxene geothermometers from Putirka (2008b) as previously calculated in Chapter 3.

Where no EBSD data was available, angles between traverses were inferred by the relative position of the traverses to the crystals shape. All inputs into the ApTimer application are listed in Table 4.1. For unzoned apatite from the 1990 and 2014 eruption, we obtained the maximum time of diffusion using the Cl concentration and the condition that if there was a given diffusion length (see below), we would have seen it in our elemental Cl maps and EPMA traverses. We used a simplified diffusion equation for the penetration depth from the crystal rim towards the interior to calculate time (Costa et al., 2008):

$$x = 4 \sqrt{D_{Cl}t} \quad (4)$$

Where x is the diffusion distance, which we chose to be a minimum of three spots or 6 mm, given the spacing of 2 mm. D_{Cl} is the diffusion coefficient for Cl from Li et al. (2020a); no correction factor necessary as several grains we investigated had some sections that were parallel to the c -axis. The timescales were combined with magma storage depths estimated from a combined phase equilibria and geothermobarometry results to calculate magma ascent rates for all three eruption..

4.3.3 Viscosity calculations

To quantitatively compare the magma physical properties between the different eruptions, we calculated the viscosity of the melt using the formulation of Giordano et al. (2008b). For this, we used the interstitial glass composition for a range of temperatures and water content in the melt. For this we used 4 wt. % water in the melt and temperature of $975 \pm 39^\circ\text{C}$ (Chapter 3). We did a first approximation on the effects of crystals and calculated the effective viscosity for all three eruptions using the Einstein-Roscoe equation (Gonnermann and Manga, 2013b):

$$\eta_{eff} = \eta_{melt} \times \left(1 - \frac{\phi}{\omega}\right)^{-2.5} \quad (5)$$

Where η_{eff} is the effective viscosity, η_{melt} is the melt viscosity, ϕ is the volume fraction of crystals, and ω is the threshold volume fraction of crystals required for to transition to a rigid system. For the latter parameter, we used ω of 0.6, which was found to be suitable for the explosive eruptions. However, the crystal proportion of the 2007 dome was found to be higher than 0.6 (~ 0.69), and thus we used an arbitrarily chosen higher threshold volume fraction of crystals (0.7) that enabled

estimation of the effective viscosity for the dome rocks.

There are viscosity models that are capable of calculating the effective viscosity for volume fraction up to 0.8 (Costa et al., 2009), or provide estimates for a more conceptually accurate model (Faroughi and Huber, 2015). However, each of them has their own limitations related to maximum volume fraction of packing similar to the Einstein-Roscoe equation, or require complex justification of individual parameter values that are not based on geological evidence or may be arbitrary.

4.4 Results

4.4.1 Apatite textures and composition

Apatite from the 1990 main-stage pumices is found in the groundmass (Fig 1a), and as inclusions in pyroxenes and partially reacted amphibole phenocrysts (Fig. 1b-c). Typically, these apatite crystals are subhedral with rounded edges to euhedral, measuring around 100-500 μm . We find apatite in similar textural positions in the late-stage pumice, except for the apatite found in the quartz bearing enclaves, which could have previously been groundmass apatite (Fig. 1d-f). Some apatite crystals are found in close association with magnetite and ilmenite or are found attached to phenocrysts. Apatite from the 2014 eruption share many textural environments as in the 1990 main-stage pumices (Fig. 1j-l), but it is also found as a small daughter mineral inside of melt inclusions. Groundmass apatite crystals in the 2007 dome are significantly larger (up to 1 mm) than either of the 1990 and 2014 eruption deposits (Fig. 1g-h). Apatite in the 2007 dome rocks is also subhedral to euhedral and are found as inclusions in melt embayments in gloms (Fig. 1g) or wedged between phenocrysts (Fig. 1h).

Fig. 4.1: BSE/SEI images of apatite crystals in various textural environments in the 1990, 2007, and 2014 rocks. Abbreviations are as follows: Ap = apatite; Gm = groundmass; Amph = amphibole (pseudo = pseudomorph); Cpx = clinopyroxene; Opx = orthopyroxene; Mag = magnetite; Ilm = ilmenite; MI = melt inclusion. In 1990 main- and late-stage pumices, apatite is found in: (a) the groundmass; (b) as Amph-hosted inclusion; (c) Cpx-hosted inclusion; (d) Opx-hosted inclusion; (e) inclusions in Amph pseudomorphs; (f) as inclusions in quartz-bearing enclaves; (g) gloms; (h) embedded between phenocrysts; (i) groundmass phase; (j) Cpx-hosted inclusions; (k) melt inclusion daughter phase; and (l) Amph-hosted inclusions. White scale bars are 10 μ m, whereas red scale bars are 100 μ m.

The volatile composition of apatite from all three eruptions largely overlaps with each other in Cl, F, and OH ternary diagrams, but there are some noteworthy trends. Individual 2007 dome apatite crystals overlap with those from most other eruptions in F (1.4-1.7 wt. %) and Cl (0.6-1.0 wt. %) with only two grains recording lower Cl than all others (0.6-0.8 wt. %). Notably the 2007 dome apatite crystals in contact with the melt, for example in groundmass or wedged in between phenocrysts, show reverse apatite zoning where rims are generally slightly higher in Cl than in cores (Fig 2b). This is confirmed in elemental maps, where we see that Cl increases from core to rim (Fig 2c, e). For apatite inclusions not in contact with the melt, there is no growth zoning (Fig. 2d).

Fig. 4.2: Ternary plots of volatile compositions (in mol %) of point analysis and traverses of apatite and elemental maps from the 2007 dome. Note that the crystals show significant chemical zoning. Ternary plot of volatile compositions (in mol. %) of 2007 apatite point analyses, with white symbols are the 2007 apatite and black symbols are apatite from other eruptions. (b) Ternary plot showing cores and rims compositions of apatite traverses, where rims are relatively more enriched in Cl compared to cores.

Elemental maps show spatial variations in Cl and F concentrations: (c) apatite wedged between two phenocrysts; (d) Cpx-hosted apatite, and (e) groundmass apatite.

Apatite from the 1990 and 2014 explosive eruptions show different populations (See Supplementary Material). The 1990 main-stage apatite volatile contents largely overlap with each other and with the groundmass apatite, regardless of the host mineral and range from 0.9-1.6 wt. % F and 0.6-0.9 wt. % Cl. Apatite in the late-stage pumice is enriched in F (2.0-2.4 wt.%), and in Cl (1.1-1.3 wt. %) compared to the main-stage apatite (Fig 4.3a). This is consistent with previous evidence of the late-stage interstitial melt being more evolved than in the main-stage pumice (Chapter 2). The 2014 apatite volatile compositions overlap with those of the 1990 main-stage apatite in F (1.0-1.7 wt. %) and Cl (0.6-1.7 wt. %). The apatite also overlaps with each other, regardless of whether they are found as inclusions or not. The exception are amphibole-hosted apatite crystals that have significantly higher Cl concentrations (1.7 wt. %) compared to the rest (0.6-1.0 wt. %). None of the apatite crystals from the 1990 nor the 2014 pumices are visibly zoned with the range of analytical techniques we have used (Fig.3b-e). The 2007 dome apatite crystals are different from the 1990 and 2014 eruption because they are reversely zoned in Cl, F, and OH over lengths of about 9-25 mm. Rim compositions of zoned apatite are 0.9-3.2 wt. % F and 0.5-1.6 wt. % Cl, whereas core compositions have 1.4-1.7 wt. % F and 0.6-0.9 wt. % Cl. We identified two main types of zoning in the 2007 apatite crystals (Table 4.1; Supplementary Material). One common feature in groundmass apatite is reverse zoning, with an increase in Cl towards the rims (reverse zoning). F and OH are mirror images in concentration from core to rim (Fig 4.4a-d). Other apatite crystals show a reverse zoning with an increase in F towards the rims (Fig. 4.4e-h), alongside a slight increase in Cl, whereas OH decreases. This zoning is found in crystals that are not exposed to the melt or only partly exposed (e.g. wedged between phenocrysts, melt tubes/re-entrants, or unsealed melt pockets in gloms).

Comparing the 1990, 2007, and 2014 apatite populations, we find that for most crystals, they overlap regardless of where they are found (Fig. 4.2-3). Only the apatite crystals from the 1990 late-stage pumice and the amphibole-hosted apatite from 2014 show significant outlier composition.

Fig. 4.3: Ternary plots of volatile compositions (in mol %) of point analysis and traverses of apatite and elemental maps from the 1990 and 2014 eruptions. Note that the crystals show limited to no chemical zoning of these elements. (a) Ternary plot of volatile compositions (in mol. %) of 1990 apatite point analyses, with white symbols are the 1990 apatite and black symbols are apatite from other eruptions. Circles are main-stage apatite, and squares are late-stage apatite. (b) Ternary plot of volatile compositions (in mol. %) of 2014 apatite point analyses. Below this plot is ternary plot showing cores and rims compositions of apatite traverses. Elemental maps show Cl and F concentrations. (c) Cpx-hosted inclusions (2014); (d) Amph-hosted apatite (2014), and (e) groundmass apatite (1990).

Fig. 4.4: Two representative examples of compositional traverses of apatite crystals for the 2007 dome, with diffusion timescales calculated using ApTimer Matlab code from Li et al. (2020). Blue dashed profile on each traverse is the initial profile before diffusion. Red solid line shows the diffused model profile. (a) SEI image of groundmass apatite, with red arrow showing the traverse. Inset shows a pole figure with the c-axis and a-axes.

Orientation of the start of the traverse is given as 'trv'. (b) XCl traverse from rim to core. (c) XF traverse from rim to core. (d) XOH traverse from rim to core, which is a mirror image of XF. (e) BSE image of apatite embedded in phenocrysts, with red arrow showing the traverse. Inset shows pole figure with similar information as in (a). (f) XCl traverse from rim to core. (g) XF traverse from rim to core. (h) XOH traverse from rim to core, which increases as in XF.

4.5 Discussion

4.5.1 Interpretation of the volatile zoning patterns in apatite

Zoning of Cl, F, and OH in apatite during magma ascent can be related to the combined effect of magma degassing during ascent and microlite crystallization, but due to the coupled partitioning and uphill diffusion of OH, Cl, and F into the same crystallographic site (Li et al., 2020), their concentration gradients are not straightforward to interpret. Water loss from exsolution typically leads to crystallization of microlites of minerals including plagioclase, pyroxenes, and Fe-Ti oxides (e.g. Toramaru et al., 2008). Given that they do not incorporate significant amounts of Cl and F, the concentrations of these elements will likely increase in the melt and thus would also tend to increase in apatite. However, the amount of increase can also depend on the value of the partitioning coefficient of these elements in apatite, and their dependence on other parameters such as temperature (Li et al., 2021). These relationships would also change if there is partitioning of these elements between the melt and apatite, and their dependence on other parameters such as temperature (Li et al., 2021). These relationships would also change if there is partitioning of these elements between the melt and exsolved fluid phase or brine (Li et al., 2021). Despite this range of possibilities, their zoning will likely be driven by magmatic processes, including magma ascent. Similar zoning patterns and interpretations have been made in apatite from the 2006 dome rocks of Merapi volcano (Li et al., 2021, 2020). Crystals with F reverse zoning found as inclusion in other minerals, or only partly open to the melt may behave similar to melt inclusion embayment (e.g. Myers et al., 2014), and the zoning may not be fully controlled by degassing induced crystallization. Rather, the zoning could reflect a temperature decrease, as F partitioning between apatite and melt is more temperature dependent than Cl and OH (Li et al., 2021; Li and Costa, 2019).

4.5.2 Apatite timescales and their relation to unrest

19 diffusion timescales obtained from apatite of the 2007 dome yield best fit timescales of up to 250 days, and about half (42%) of the timescales are less than 25 days (Table 4.1). The traverses parallel to the a -axes systematically record longer timescales (17-250 days) than parallel to c -axes (4-104 days), although this may be an artifact as we have limited data on diffusion coefficients of volatile elements along the a -axis. There is no systematic difference between the times obtained from crystals that are mainly reversely zoned in Cl vs. those that are mainly zoned in F. Moreover, due to potential kinetic delays between magma degassing, microlite crystallization, and reaction of the apatite F-Cl-OH concentrations to these processes, the calculated times are likely to be the minima, especially for those crystals that are not directly in contact with the external melt.

Table 4.1: *Input information for the ApTimer input (Li et al., 2020) for the 2007 dome apatite traverses, spanning textures, temperatures, angles between traverses, traverse lengths, boundary conditions, and calculated diffusion coefficients for Cl, F, and OH. In the same table there is also minimum, best fit, and maximum timescales calculated using the Cl diffusion. The diffusion coefficient for the 1990 and 2014 apatite are calculated assuming the fastest diffusion parallel to the c -axis. In rare cases where the F concentration traverses show less fluctuation than the Cl, the F concentration is used instead (see Fig 4.4e-g for an example). Also included are magma ascent rates calculated using the saturation depth from Plag-melt hygrometry in Chapter 3, divided by the best fit timescale.*

Style	Year	label	Texture	T (°C)	Angle between major axis and traverse (°)		Traverse length for Cl/F (mm)	Min ascent rate (m/s)	Max ascent rate (m/s)	Boundary condition (rim)			Boundary condition (core)			Diffusion timescale (day)		
					Type	a	g			XCl	XF	XOH	XCl	XF	XOH	min	best fit	max
Dome	2007	07B-glom1-apa1-long-r2c	glomerocryst	1029	169	98	15	0.02	0.05	0.14	0.46	0.40	0.11	0.31	0.58	2	4	4
		07B-glom3-apa1-long	groundmass	980	81	167	20	0.003	0.003	0.16	0.74	0.10	0.11	0.72	0.17	23	25	29
		07B-glom3-apa1-short	groundmass	980	174	92	15	0.0003	0.0004	0.16	0.75	0.09	0.10	0.74	0.16	208	250	271
		07B-gm1-apa1-long	groundmass	980	93	23	20	0.003	0.005	0.17	0.52	0.31	0.09	0.71	0.19	17	23	25
		07B-gm1-apa1-short	groundmass	980	173	95	9	0.001	0.002	0.15	0.62	0.23	0.08	0.49	0.43	50	58	75
		07B-gm2-apa1-long-r2c	groundmass	980	92	3	23	0.001	0.001	0.25	0.51	0.24	0.08	0.50	0.42	58	63	75
		07B-gm2-apa1-short-r2c	groundmass	980	111	108	19	0.0006	0.001	0.17	0.66	0.17	0.10	0.60	0.30	100	125	133
		07B-gm3-apa1-long-r2c	groundmass	980	94	17	25	0.01	0.03	0.16	0.87	b.d.	0.10	0.71	0.18	3	4	6
		07B-gm3-apa1-short-r2c	groundmass	980	48	43	16	0.003	0.006	0.13	0.74	0.13	0.09	0.52	0.39	13	17	25
		07B-gm4-apa1-short-r2c	groundmass	980	138	48	11	0.003	0.006	0.14	0.63	0.23	0.10	0.50	0.40	13	21	25
		07B-gm5-apa1-long-r2c	groundmass	980	100	115	17	0.0006	0.001	0.15	0.77	0.08	0.10	0.53	0.36	83	104	125
		07B-gm5-apa1-short-r2c	groundmass	980	56	45	10	0.004	0.006	0.19	0.66	0.15	0.15	0.64	0.20	13	20	21
		07B-pseudo1-apa1-r2c	pseudomorph	980	61	55	13	0.002	0.003	0.11	0.50	0.39	0.11	0.20	0.70	17	33	50
		07B-px5-apa1-r2r	groundmass	980	45	117	20	0.002	0.003	0.16	0.48	0.36	0.12	0.43	0.46	25	33	42
		07B-px5-apa2-r2r	groundmass	980	54	108	10	0.0008	0.001	0.15	0.48	0.37	0.12	0.40	0.48	58	75	100
		07B-px6-apa1-r2r	groundmass	980	100	17	20	0.003	0.005	0.17	0.75	0.08	0.08	0.70	0.22	17	21	25
		07B-px15-incl-apa1-r2c	inclusion	1029	57	147	10	0.02	0.02	0.23	0.50	0.27	0.09	0.45	0.45	3	4	5
		07B-px9new-gmox-long-apa1_r2c#	groundmass	980	90	0	10	0.02	0.02	0.35	0.30	0.36	0.20	0.16	0.64	3	4	5
		07B-px9new-gmox-short-apa1_r2c#	groundmass	980	0	90	15	0.0006	0.0008	0.37	0.24	0.39	0.16	0.21	0.64	100	108	133

Style	Year	label	Texture	T (°C)	Angle between major axis and traverse (°)		Traverse length for Cl/F (mm)	Min ascent rate (m/s)	Max ascent rate (m/s)	Boundary condition (rim)			Boundary condition (core)			Diffusion timescale (day)		
					Type	a	g			XCl	XF	XOH	XCl	XF	XOH	min	best fit	max
Plinian	1990	PL1new-px4-apa1-r2r	groundmass	976	90	0	6	0.05	0.3									
		PL1new-gm7-apa-trvlong-r2r	groundmass	976	90	0	6	0.05	0.3									
	2014	14PUM1-1-amph6-apa1_trv1-r2c	pseudomorph	976	90	0	6	0.05	0.3									
		14PUM1-1-amph6-apa1_trv2-r2c	pseudomorph	976	90	0	6	0.05	0.3									
		14PUM1-1-amph-gm-apa1_trv2-r2c	groundmass	976	90	0	6	0.05	0.3									
		14PUM1-1-px7-apa1-r2c	Cpx inclusion	1028	90	0	6	0.05	0.3									
		14PUM2-1-gm1-apa1-tv1short-r2r-4um	groundmass	976	90	0	6	0.2	0.9									
		14PUM2-1-px5-original-apa1-r2c	Cpx inclusion	1028	90	0	6	0.05	0.3									
		14PUM2-1-px1-apa2-trv1-r2c	Cpx inclusion	1028	90	0	6	0.2	0.9									
		14PUM2-1-gm3-apa1-r2c	groundmass	976	90	0	6	0.2	0.9									
		14PUM2-2-px3-apa1-r2c	Cpx inclusion	976	90	0	6	0.05	0.3									

Recalculation of the timescales in absolute times before eruption (using the date of eruption as 3rd November 2007), we find that the diffusion of Cl-F-OH in apatite and thus magma ascent could have begun as early as March 2007, which overlaps with the period of inflation recorded by InSAR between January to May 2007 (Lubis, 2014b). At this time the magma likely migrated towards shallower pressures from the reservoir almost aseismically, which can explain the cluster of timescales between May and October that do not correspond to any seismic events. However, the final stage of magma ascent likely began in October and continued until the eruption date (Fig. 4.5). These dates overlap with the onset of different types of seismic swarms, increases in seismic energy released, and geodetic unrest as reported in Hidayati et al. (2018b) (see Supplementary Data). The dates for the beginning of magma ascent from apatite crystals also overlap with a jump in radial tilt measurements, but not tangential tilt in October 2007 (See Supplementary Data) (Hidayati et al., 2018b). These relationships between the timing from the apatite zoning and the monitoring data indicate magma movement and ascent towards the surface prior to the dome emplacement (See Supplementary Data). Furthermore, our timescales are either comparable or longer than those estimated from the apatite population for the 2006 Merapi dome (12-16 days) (Li et al., 2021).

Fig. 4.5: Time-series of cumulative energy and earthquake depths before the 2007 eruption compared to diffusion timescales obtained from chemical zoning in apatite. Monitoring data and figure are modified after Hidayati et al. (2018).

The 11 apatite crystals from the 1990 and 2014 are unzoned in Cl, F, and OH at the scale of the EPMA maps and traverses, which is likely due to them being primary apatite or they do not have enough time to develop visible zoning. Thus, we can only calculate the time that would be required to generate an observable zoning length with the analytical techniques we have used. Using a length of 6 mm, which further implies a maximum time of diffusion of ~18 hours (Fig. 4.6). The maximum timescales are shorter than the 1990 and 2014 total unrest, but overlaps with the onset of unrest directly proceeding the eruption 12-48 hours before eruption (Hidayati et al., 2018b; Lesage and Surono, 1995b). These unrest signals related to ascent manifested as the escalation of number of VT or VB earthquakes recorded, or a sudden increase in seismic energy released. In particular, the relationship between the maximum timescales and the duration of unrest suggests that for the 1990 and 2014 eruptions, degassing and magma ascent occurred within 12-48 hours before eruption. Such short timescales of ascent could account for the fast escalation of seismicity before eruption.

Fig. 4.6: *Magma ascent rates calculated from Cl diffusion assuming a minimum traverse length of 6 mm, following the approach by Li et al. (2020). Bands represent the temperature constrained from Chapter 3 with the associated uncertainty ($975 \pm 39^\circ\text{C}$). The minimum distance needed for diffusion is chosen to be 6 mm, which would give the maxima timescales and minima ascent rates for the 1990 and 2014 eruptions. The approximate depth calculated from a range of vapour saturation pressures use an average density of 2640 kg m^{-3} from Smyth et al. (2007).*

4.5.3 Magma ascent rates for explosive eruptions and dome emplacements

It is possible to calculate magma ascent rates by combining the timescales from apatite and the estimated magma storage pressure determined by phase equilibria, mineral geobarometers, and volatile saturation pressures (Chapter 2), which can be converted into depth using an average density of the crust of 2640 kg m^{-3} , which was previously proposed for the upper crust under Kelud (Jeffery et al., 2013b; Smyth et al., 2007). Chapter 2 and Chapter 3 reported a range of pressures from about 160 to $> 400 \text{ MPa}$ depending on the minerals, which suggests a melt and mineral distribution across a range of depths. Here we chose a pressure of 175 MPa ($150\text{-}200 \text{ MPa}$) that best matches the phase assemblage and phenocryst content of the three magmas according to phase equilibria experiments (Chapter 3), and which corresponds to a depth of $\sim 6\text{-}7 \text{ km}$ below the crater.

We find that the ascent rates calculated for the 2007 dome vary between $0.0003\text{-}0.05 \text{ m s}^{-1}$ but most are between $0.004\text{-}0.02 \text{ m s}^{-1}$ (Table 4.1). These calculated ascent rates from the apatite crystals are consistent with the extrusive rates from other dome building eruptions such as Mt St Helens and other dome forming eruptions such as at Soufriere Hills lava domes ($0.001\text{-}0.008 \text{ m s}^{-1}$) (Devine et al., 1998). Our calculated ascent rates are indicative of mean values, as we expect the magma ascent rate will change depending on the water exsolution, magma crystallization, and associated changes in buoyancy and viscosity as the magma moves towards the surface.

The ascent rates from the 1990 and 2014 magmas cannot be precisely estimated because we can only obtain maximum timescales from apatite, and thus we calculate minimum ascent rates. We find that the ascent rates for explosive eruptions are $> 0.03 \text{ m s}^{-1}$, which are comparable to

ascent rates estimated from onset of seismicity prior to the 1990 and 2014 explosive eruptions (Hidayati et al., 2018b; Lesage and Surono, 1995b). The rates are also at least two orders of magnitudes higher than ascent rates for the 2007 dome. Such a difference in ascent rates would account for the contrasting eruption styles, where the magmas feeding explosive eruptions would be able to retain their dissolved volatile content, but the slow ascent would allow the dome to release the volatiles through permeable degassing (Gonnermann and Manga, 2013b).

Our ascent rates are minimum estimates and lower than the rates of $4\text{--}5\text{ m s}^{-1}$ previously proposed for the 2014 eruption, and obtained from bubble number density combined with experimental constraints (cf. Cassidy et al., 2019b). Nevertheless, our ascent rates still overlap with the range of the overall ascent rates for explosive eruptions (Rutherford, 2008). We find that ascent rates for explosive eruptions of Kelud overlaps with those of other basaltic andesite volcanoes such as the 2010 explosive eruption at Merapi (Li et al., 2020), 1974 eruption of Volcan de Fuego, the 1986 eruption of Izu-Oshima, and the 2013 eruption of Chaparrastique (Cassidy et al., 2018, and references therein).

4.5.4 Relating ascent rates to eruption styles

Many volcanoes show transitions in eruption style whether it is between consecutive eruptions, or within one single eruption period (Cassidy et al., 2018). Such transitions are controlled by a range of processes, but ultimately magma fragmentation control the explosive eruptions (Dingwell et al., 1993b), a process that is highly dependent on the physical properties of the magma and fluids. We attempt to relate the ascent rates with effective viscosity to investigate the dominant processes controlling explosive and effusive eruptions at Kelud volcano (Fig. 4.7; Gonnermann and Manga, 2013). We find that the 1990 and 2014 eruptions largely overlap, with viscosity and ascent rates that vary from 10^4 to 10^6 Pa s , for a minimum ascent rate of $> 0.1\text{ m s}^{-1}$. This combination of parameters corresponds to a mass discharge rate of $>10^5\text{ kg s}^{-1}$ (Gonnermann and Manga, 2013b), which overlaps with discharge rates ($10^7\text{--}10^8\text{ kg s}^{-1}$) determined by Maeno et al. (2019b) for the same eruptions.

Fig. 4.7: viscosity vs. ascent rate vs. mass discharge rate, with the ascent rate and viscosity calculated for Kelud magmas. Coloured boxes with represent the region outlined by magma viscosity vs. ascent velocity observed for the 1990, 2007, and 2014 eruptions for a range of dissolved water content in the melt. Boxes with dashed lines represent the region outlined by magma velocity vs. average to maximum mass discharge rates, which come from Maeno et al. (2019). The background figure is modified after Gonnerman and Manga (2013).

The results for the explosive events contrast with the slow ascent and the high viscosity we estimated for the 2007 dome, which shows a wide range of effective viscosity of 10^8 to 10^{10} Pa s for the given range of velocity (10^{-4} to 10^{-2} m s⁻¹). From these parameters, we can deduce that the dominating process is permeable outgassing. Comparing the viscosity with the magma discharge rate for the 2007 dome (5.8×10^3 - 1.9×10^4 kg s⁻¹) (Maeno et al., 2019b), we find that the corresponding velocity becomes slightly higher at 10^{-2} m s⁻¹, which overlaps with the upper range of the ascent rates determined from apatite. We note however that these relationships again do not typically consider the presence of an exsolved volatile phase at pre-eruptive conditions as we have proposed for the 1990 and 2014 eruptions (Chapter 3), and that the viscosity values for the 2007 magma are likely also incorrect, given the impossibility of calculating the viscosity of very crystal-rich magmas (e.g. > 70 wt. %). Notwithstanding these limitations, we find it remarkable that the ascent rates derived from apatite are consistent with other parameters such as magma discharge rates, which seems to be characteristic of different eruption styles.

4.6 Conclusions

The duration and rates of magma ascent are considered to be key parameters that control the eruption style, but they are notably difficult to constrain. Here we show that using the volatile zoning (F-Cl-OH) in apatite from the last three eruptions of Kelud volcano (1990, 2007, 2014), it is possible to gain insights into explosive and effusive eruptions at Kelud volcano, Indonesia using apatite. Unzoned apatite from the explosive eruptions of 1990 and 2014 record evidence for fast ascent rates (> 0.1 m s⁻¹). Reversely zoned 2007 apatite record evidence for considerably slower ascent rates (0.0003 - 0.05 m s⁻¹). The estimated ascent rates for explosive eruptions overlap with ascent rates constrained for the same eruption through the onset of almost exponential increase in seismicity directly prior to the eruption. Our ascent rates are consistent with ascent rates from other volcanoes with explosive eruptions, and with this we can establish a lower bound on the ascent rates of explosive eruptions for Kelud and similar eruptions. The reversely zoned apatite from the 2007 dome allows us to estimate timescales of buoyancy driven magma ascent towards dome emplacement, which overlaps with the seismic and geodetic unrest. Whereas the

1990 and 2014 eruptions are typical sub-Plinian eruptions with dominating processes including brittle fragmentation, bubble nucleation, and shear localization, dome emplacement is dominated by permeable outgassing. Our study demonstrates the potency of apatite to shed light on variations in eruption style for Kelud, and record timescales and ascent rates that are representative of volatile driven processes at volcanoes.

4.7 Acknowledgements

We thank Lim Siang Joo for assistance with sample preparation, and Jeffrey Oalman for assisting with the EBSD analyses of apatite and for providing the code to calculate crystallographic angles from EBSD data. We also thank Li Weiran and Christina Widiwijayanti for discussions on apatite and Kelud volcano, respectively. We would like to acknowledge the Facility for Analysis, Characterisation, Testing and Simulation, Nanyang Technological University, Singapore, for use of their EPMA facilities. This research was supported by the Earth Observatory of Singapore via its funding from the National Research Foundation Singapore and the Singapore Ministry of Education under the Research Centres of Excellence initiative.

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4.9 Supplementary Material

Fig. S4.1: Histogram of timescale from zoned apatite grains from the 2007 dome of Kelud.

Fig. S4.2: Time-series of radial and tangential tilt measurements before the 2007 eruption, compared to the diffusion timescales from apatite, modified from Hidayati et al. (2018).

Fig. S3: Time-series of seismicity (RSAM, tremor, low frequency (LF), shallow volcano-tectonic (VB), and volcano-tectonic (VT)) before the 2007 eruption, compared to the diffusion timescales from apatite, modified from Hidayati et al. (2018).

Conclusions and Future Work

The goal of this thesis is to advance our current understanding on the magmatic processes, timescales, storage conditions, and ascent rates and their relation to volcanic unrest for explosive eruptions and effusive eruptions. I have provided as many quantitative constraints and relationships as possible on these processes, yet call on further work to be conducted on Kelud because there are still many unknowns on the system, as detailed below. My work highlights the important role of volatiles in driving a typical explosive eruption at Kelud, especially the presence of an exsolved fluid phase at pre-eruptive conditions. I also demonstrate that the storage conditions of explosive and effusive eruptions may be similar and show that magma ascent rates exert a fundamental control on the eruption style for Kelud.

Such findings are related to the different monitoring signals of explosive and effusive eruptions, and thus have implications on how to anticipate and thus better mitigate impacts of these events. For example, the seismic swarms are interpreted to be fracturing of a brittle plug. I extend this interpretation and proposed that the fracturing could be due to accumulation of fluids from pulses of fluids fluxing through the system. This is consistent with the unrest related to increasing gas input into the lake, ranging from fluctuations in hydroacoustic signals to heating of the lake. I identify further the limitations of current monitoring at Kelud and recommend techniques such as broadband seismic monitoring and gravity surveys to detect and/or track the accumulation of fluids underneath the volcano.

Findings from the petrology of the 1990 eruption indicate that firstly, the pre-eruptive magmatic system at Kelud was vertically elongated and zoned with respect to water content and temperature. The crystal cargo textures and geochemistry for the main- and late-stage pumices record evidence for the accumulation of an excess fluid phase from degassing and CO₂-dominated fluid flushing before the 1990 eruption, with excess gas quantified by comparing the SO₂ content degassed from the magma to that recorded by satellites. Timescales recorded by zoned orthopyroxene span around three months or earlier, meaning these timescales relate to degassing and fluid accumulation. These timescales overlap with the unrest period months before eruption, rather than the escalation period 12 hours prior.

I use a main-stage pumice from the 1990 eruption as representative of the three eruptions and as the starting material for phase equilibrium experiments to constrain the storage conditions of explosive and effusive eruptions. I found that the pre-eruptive magmatic conditions of explosive and effusive eruptions were very similar. However, the 2007 dome magma underwent significant loss of water due to outgassing and re-equilibration to shallower pressures in a partially plugged system after the 1990 eruption, whereas the 1990 and 2014 magma retained a separate excess fluid phase before their eruptions. The magma plumbing system at Kelud from 1990, 2007, and 2014 had a similar starting storage condition to each other. The difference is in the ability for the magmatic system to accumulate an excess fluid phase.

Between 1990 and 2007, the magmatic system was partially open, and the fluid escaped through activity including vigorous fumarolic outgassing and brief spells of outgassing unrest in 1996 and 2001. The loss of fluids likely resulted in more effusive eruption. In contrast, between 2007 and 2014 the magma plumbing system was effectively sealed by the lava dome, meaning that the fluid could accumulate leading to an explosive eruption. Thus, the presence of an excess fluid phase found in the 1990 and 2014 explosive eruptions indicate that it is in fact a common feature driving explosive eruptions at Kelud. Hence volcanoes with this type of eruption style could be monitored by tracking changes in density over time.

Finally, I investigate how ascent rates may control eruption style and uncover the dominant processes using apatite as mineralogical tool. I found that the timescales recorded by zoned apatite crystals from the 2007 dome extrusion overlap with recorded unrest up to nine months beforehand. This contrasts with the timescales of ascent for explosive eruptions, which is much faster and on the order of several hours. The ascent rates constrained for explosive eruptions are comparable to ascent rates calculated from the onset of seismic unrest preceding both 1990 and 2014. Comparison between ascent rates, viscosity, and magma discharge rates reinforce the observation that explosive eruptions differ significantly from dome extrusion, yet there are still unknowns related to the effect of an exsolved volatile phase on parameters such as buoyancy, viscosity, and ascent rates, and how they control eruption styles.

Future Work

Although significant efforts have been made in this PhD thesis towards expanding the state-of-the-art knowledge for explosive eruptions with fast escalation times, more questions still arise based on findings from this work. Here I propose several investigations that could advance our understanding of processes behind explosive and effusive eruptions with a focus on Kelud volcano:

1. An important unknown remains related to the role of magmatic CO₂ content for explosive and effusive eruptions. This could be addressed by analyzing clinopyroxene-hosted melt inclusions for volatiles, including CO₂, using the Fourier Transform Infrared spectroscopy (FTIR). Clinopyroxene-hosted melt inclusions are desirable targets because they underwent little to no post-entrapment modifications compared to plagioclase-hosted melt inclusions. This means volatiles and light elements diffuse out of the melt inclusions more slowly compared to minerals such as plagioclase (Audétat et al., 2018). Moreover, clinopyroxene-hosts come from a wide range of pressures that encompass the total range of pressures bracketed by the saturation pressure and pressures derived from amphibole. Other studies involve constraining on the degassing pathways at Kelud, pressures of melt inclusion entrapment, and to numerically model the expected volatile ratios (e.g. H₂O/CO₂, CO₂/SO₂, halogen ratios) for explosive eruptions. Moreover, given the abundance of limestones in the crustal lithologies where Kelud lies (and many active volcanoes in Java), it is unclear whether the CO₂ comes from the mantle or from crustal limestones, and stable isotopic analysis of C-O should be able to resolve this.
2. Parameters obtained from this thesis, such as pre-eruptive storage conditions, ascent rates, and viscosity can be used to numerically model and simulate the effect of fluid accumulation and degassing on magmatic systems. For example, these effects could be tested using the CONFLOW software to see whether it is possible to retrieve similar magma ascent rates. Other approaches come from experimental determination of ascent rates by decompression experiments. Potential approaches include forward modelling of processes to evaluate the expected seismic pre-eruptive unrest patterns, as well as

timescales recorded by zoned crystals in the system. We can also model the overpressure needed to produce eruptions styles, quantify the exsolved gas for the erupted magma mass to compare with independently measured parameters, and evaluate the role of hydrostatic and lithostatic pressures from the lake and plug, respectively in controlling eruption styles at Kelud. Further improvements are critically needed to calculate the viscosity of crystal-rich magmas such as the lava domes in general. Finally, a comparison between viscosity vs. ascent rates and discharge rates with or without the presence of pre-eruptive volatile phase can shed light on how excess volatiles affect parameters such as viscosity and buoyancy, and eruption style.

3. Findings from this thesis emphasizes consideration of the role volatiles play in producing explosive eruptions at Kelud, which also implies re-evaluation of monitoring strategies. Microgravity surveys can track changes in density over time at volcanoes such as Masaya in Nicaragua, yet they are currently not conducted at Kelud. Conducting continuous, or at minimum long-term campaign, microgravity surveys at Kelud allows us to test whether we can detect fluid accumulation during repose and unrest. Results from this survey would allow evaluation of potential threshold density values for unrest and eruption. The crater lake at Kelud can capture signatures of volatile outgassing during unrest and eruption, and act as an elemental sink for volatiles such as SO₂, CO₂, Cl, and B. Thus, continuous or long-term integrated monitoring focused on the lake, involving hydro-acoustics, lake chemistry, and lake temperature can track volatile dynamics of the magmatic system before eruption. We can also chemically characterize springs close to the volcano to test whether they tap into the two chemically distinct hydrothermal systems present at Kelud. This technique has been done at other active volcanoes such as Soufrière de Guadeloupe (Villemant et al., 2005). From there, it may be possible to monitor spring water chemistry for chemical and temperature changes during repose and unrest. Finally, we can distinguish hydrothermal system fluids based on their relative density, which further underscores the benefit of conducting continuous microgravity surveys at Kelud.

4. The 2007 dome host a plethora of xenoliths including meta-basalts, hornfels, amphibole-bearing cumulates and skarn-type calc-silicates. These xenoliths may record evidence for melt evolution, transport and deformation during ascent, fluid-mush interactions, and deep-seated magma degassing before eruption. Therefore, chemical analyses of possible mantle-derived minerals, and textural and structural analyses of xenoliths can provide valuable insight into deep crustal or upper mantle processes. Xenoliths can also be used to constrain magma ascent rates, which when combined with independently constrained ascent rates, potentially give an important contribution towards understanding magma transport in subduction zones.

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THESIS APPENDIX

Table S2.2: Major element compositions of whole rocks, glasses, and minerals

Table S2.2.1: Major element compositions of minerals (Cpx)

SAMPLE GRAIN ID	Sample	Min	Texture	stage	SiO2	TiO2	Al2O3	FeO*	MnO	MgO	CaO	Na2O	Total	Mg #	FeO	Fe2O3	Mg # (Fe2+ only)	Wo	En	Fs
90-23-glom1	90-23	cpx	glom	main	51.7	0.35	1.78	10.6	0.42	14.44	19.9	0.27	99.5	73	0.30	0.02	73.7	41	42	17
90-23-glom1	90-23	cpx	glom	main	51.54	0.38	1.78	10.45	0.42	14.74	20.04	0.26	99.6	74	0.31	0.03	75.9	41	42	17
90-23-glom11	90-23	cpx	glom	main	51.45	0.44	2.42	11.19	0.43	14.51	19.76	0.28	100.5	72	0.35	0.03	74.3	41	41	18
90-23-glom11	90-23	cpx	glom	main	51.78	0.37	1.84	10.92	0.48	14.35	20.08	0.29	100.1	72	0.31	0.02	73.8	41	41	18
90-23-glom11	90-23	cpx	glom	main	51.8	0.42	2.06	10.75	0.44	14.53	19.91	0.29	100.2	73	0.36	0.02	74.0	41	42	17
90-23-glom11	90-23	cpx	glom	main	52.12	0.37	1.81	10.66	0.4	14.78	20.04	0.27	100.5	73	0.31	0.02	74.7	41	42	17
90-23-glom14	90-23	cpx	glom	main	51.63	0.42	1.96	11.1	0.42	14.39	19.09	0.25	99.3	72	0.39	0.01	71.1	40	42	18
90-23-glom14	90-23	cpx	glom	main	51.5	0.44	2.36	11.21	0.44	14.55	19.47	0.28	100.3	72	0.37	0.03	73.6	40	42	18
90-23-glom14	90-23	cpx	glom	main	51.52	0.42	2.1	11.13	0.44	14.51	19.4	0.29	99.8	72	0.36	0.02	73.3	40	42	18
90-23-glom14	90-23	cpx	glom	main	51.77	0.37	1.88	11.11	0.44	14.64	19.68	0.29	100.2	72	0.30	0.03	74.1	40	42	18
90-23-glom14	90-23	cpx	glom	main	51.42	0.41	2.1	10.83	0.44	14.38	19.75	0.29	99.6	72	0.35	0.02	73.8	41	42	18
90-23-glom14	90-23	cpx	glom	main	52.11	0.37	1.71	11.04	0.48	14.67	19.65	0.28	100.3	72	0.32	0.02	73.3	40	42	18
90-23-glom14	90-23	cpx	glom	main	51.62	0.39	2.08	10.99	0.44	14.74	19.07	0.28	99.6	73	0.34	0.02	73.3	40	43	18
90-23-glom14	90-23	cpx	glom	main	52.28	0.28	1.63	10.91	0.44	14.83	19.49	0.28	100.1	73	0.25	0.01	73.4	40	42	18
90-23-glom14	90-23	cpx	glom	main	51.82	0.37	1.73	10.79	0.41	14.67	19.51	0.28	99.6	73	0.32	0.02	73.5	40	42	17
90-23-glom14	90-23	cpx	glom	main	51.72	0.31	1.95	10.86	0.44	15.09	18.75	0.25	99.4	73	0.27	0.01	73.8	39	44	18
90-23-glom14	90-23	cpx	glom	main	51.48	0.38	2.01	10.6	0.42	14.88	19.27	0.23	99.3	74	0.33	0.02	74.3	40	43	17
90-23-glom14	90-23	cpx	glom	main	51.12	0.36	2.66	10.27	0.36	14.64	19.87	0.27	99.6	74	0.29	0.02	76.0	41	42	17
90-23-glom14-z1-r2c	90-23	cpx	core	main	51.91	0.33	1.68	11.55	0.52	14.36	19.33	0.31	100	71	0.29	0.02	71.9	40	41	19
90-23-glom14-z1-r2c	90-23	cpx	core	main	51.9	0.34	1.74	11.45	0.49	14.39	19.39	0.32	100	71	0.29	0.02	72.2	40	41	18
90-23-glom14-z1-r2c	90-23	cpx	core	main	52.11	0.28	1.57	11.38	0.53	14.58	19.01	0.29	99.8	72	0.25	0.01	71.6	39	42	18

SAMPLE GRAIN ID	Sample	Min	Texture	stage	SiO2	TiO2	Al2O3	FeO*	MnO	MgO	CaO	Na2O	Total	Mg #	FeO	Fe2O3	Mg # (Fe2+ only)	Wo	En	Fs
90-23-glom14-z1-r2c	90-23	cpx	core	main	51.78	0.35	1.69	11.22	0.49	14.5	19.58	0.28	99.9	72	0.30	0.02	73.2	40	42	18
90-23-glom14-z1-r2c	90-23	cpx	core	main	52.05	0.31	1.56	11.44	0.55	14.84	18.97	0.27	100	72	0.27	0.02	72.7	39	43	18
90-23-glom14-z1-r2c	90-23	cpx	core	main	52.22	0.32	1.5	10.96	0.49	14.63	19.68	0.26	100.1	73	0.28	0.01	72.9	41	42	18
90-23-glom14-z1-r2c	90-23	cpx	rim	main	52.23	0.34	1.76	10.74	0.49	14.6	19.41	0.29	99.9	73	0.32	0.01	72.2	40	42	17
90-23-glom14-z1-r2c	90-23	cpx	core	main	52.26	0.26	1.57	10.98	0.52	15.09	19.28	0.23	100.2	73	0.23	0.01	73.9	39	43	18
90-23-glom14-z1-r2c	90-23	cpx	core	main	52.27	0.32	1.45	10.79	0.48	14.85	19.62	0.26	100	73	0.28	0.01	73.7	40	42	17
90-23-glom14-z1-r2c	90-23	cpx	core	main	52.22	0.31	1.53	10.85	0.49	14.99	19.43	0.24	100.1	73	0.27	0.01	73.8	40	43	17
90-23-glom14-z1-r2c	90-23	cpx	core	main	52.36	0.34	1.41	10.83	0.51	15.01	19.54	0.24	100.2	73	0.30	0.02	73.9	40	43	17
90-23-glom14-z1-r2c	90-23	cpx	core	main	52.25	0.32	1.45	10.84	0.49	15.08	19.65	0.24	100.3	73	0.27	0.02	74.8	40	43	17
90-23-glom14-z1-r2c	90-23	cpx	core	main	52.12	0.32	1.59	10.71	0.49	14.91	19.53	0.26	99.9	73	0.28	0.02	74.1	40	43	17
90-23-glom14-z1-r2c	90-23	cpx	rim	main	52.36	0.3	1.6	10.62	0.48	14.84	19.51	0.26	100	73	0.28	0.01	73.1	40	43	17
90-23-glom14-z1-r2c	90-23	cpx	rim	main	52.42	0.3	1.45	10.75	0.47	15.07	19.61	0.25	100.3	74	0.26	0.01	74.3	40	43	17
90-23-glom14-z1-r2c	90-23	cpx	rim	main	52.45	0.31	1.56	10.73	0.46	15.13	19.5	0.25	100.4	74	0.27	0.01	74.2	40	43	17
90-23-glom14-z1-r2c	90-23	cpx	rim	main	52.12	0.3	1.6	10.57	0.47	14.92	19.36	0.26	99.6	74	0.27	0.01	73.7	40	43	17
90-23-glom14-z1-r2c	90-23	cpx	rim	main	52.5	0.28	1.41	10.66	0.49	15.07	19.44	0.23	100.1	74	0.25	0.01	73.5	40	43	17
90-23-glom14-z1-r2c	90-23	cpx	rim	main	52.33	0.29	1.62	10.47	0.47	14.94	19.38	0.25	99.8	74	0.27	0.01	73.3	40	43	17
90-23-glom14-z1-r2c	90-23	cpx	rim	main	52.33	0.32	1.59	10.43	0.45	15.14	19.3	0.24	99.8	74	0.29	0.01	73.8	40	43	17
90-23-glom14-z1-r2c	90-23	cpx	core	main	52.47	0.23	1.55	10.46	0.55	15.21	19.46	0.2	100.1	74	0.21	0.01	74.3	40	43	17
90-23-glom14-z1-r2c	90-23	cpx	core	main	52.06	0.24	1.63	10.41	0.52	15.2	19.61	0.2	99.9	74	0.20	0.01	75.6	40	43	17
90-23-glom14-z1-r2c	90-23	cpx	rim	main	52.42	0.27	1.63	10.38	0.43	15.24	19.53	0.23	100.1	74	0.24	0.01	74.7	40	43	17
90-23-glom14-z1-r2c	90-23	cpx	core	main	52.51	0.3	1.48	10.55	0.47	15.73	19.11	0.19	100.3	75	0.26	0.01	75.4	39	44	17
90-23-glom14-z1-r2c	90-23	cpx	core	main	52.53	0.27	1.52	10.52	0.5	15.71	19.02	0.17	100.2	75	0.24	0.01	74.9	39	45	17
90-23-glom14-z1-r2c	90-23	cpx	core	main	52.28	0.27	1.58	10.4	0.49	15.53	18.94	0.14	99.6	75	0.25	0.01	74.2	39	44	17
90-23-glom14-z1-r2c	90-23	cpx	core	main	52.15	0.26	1.6	10.18	0.49	15.28	19.56	0.21	99.7	75	0.23	0.01	75.6	40	44	16
90-23-glom14-z1-r2c	90-23	cpx	core	main	52.24	0.25	1.73	10.43	0.48	15.68	19.17	0.15	100.1	75	0.22	0.01	75.7	39	44	17

SAMPLE GRAIN ID	Sample	Min	Texture	stage	SiO2	TiO2	Al2O3	FeO*	MnO	MgO	CaO	Na2O	Total	Mg #	FeO	Fe2O3	Mg # (Fe2+ only)	Wo	En	Fs
90-23-glom14-z1-r2c	90-23	cpx	rim	main	52.41	0.25	1.55	10.35	0.47	15.63	19.26	0.2	100.1	75	0.22	0.01	75.7	39	44	16
90-23-glom14-z1-r2c	90-23	cpx	core	main	52.36	0.24	1.6	10.05	0.52	15.22	19.42	0.24	99.7	75	0.22	0.01	74.8	40	44	16
90-23-glom14-z1-r2c	90-23	cpx	core	main	52.3	0.25	1.73	10.28	0.48	15.57	19.6	0.17	100.4	75	0.21	0.01	76.4	40	44	16
90-23-glom14-z1-r2c	90-23	cpx	core	main	52.44	0.24	1.56	10.23	0.49	15.53	19	0.19	99.7	75	0.22	0.01	74.4	39	44	16
90-23-glom14-z1-r2c	90-23	cpx	core	main	52.52	0.28	1.57	10.29	0.5	15.62	19.23	0.18	100.2	75	0.25	0.01	75.1	39	44	16
90-23-glom14-z1-r2c	90-23	cpx	core	main	52.45	0.28	1.62	10.34	0.48	15.73	19.13	0.18	100.2	75	0.25	0.01	75.5	39	45	16
90-23-glom14-z1-r2c	90-23	cpx	rim	main	52.54	0.25	1.49	10.19	0.49	15.59	19.07	0.19	99.8	75	0.23	0.01	74.7	39	45	16
90-23-glom4	90-23	cpx	glom	main	51.36	0.39	1.81	11.32	0.46	14.44	19.28	0.3	99.4	72	0.33	0.03	73.2	40	42	18
90-23-glom4	90-23	cpx	glom	main	51.84	0.33	1.73	11.29	0.48	14.6	19.08	0.28	99.6	72	0.29	0.01	72.2	40	42	18
90-23-glom5	90-23	cpx	glom	main	51.14	0.5	2.49	11.49	0.45	14.21	19.56	0.31	100.2	71	0.41	0.04	73.2	40	41	19
90-23-glom5	90-23	cpx	glom	main	50.66	0.49	3.2	11.12	0.41	14.36	19.8	0.27	100.3	72	0.37	0.05	75.4	41	41	18
90-23-glom5	90-23	cpx	glom	main	51.38	0.36	2.03	11.06	0.42	14.56	19.44	0.29	99.5	72	0.30	0.02	74.1	40	42	18
90-23-glom5	90-23	cpx	glom	main	50.18	0.55	3.6	10.64	0.39	14.13	19.98	0.26	99.7	72	0.42	0.05	75.7	42	41	17
90-23-glom5	90-23	cpx	glom	main	51.57	0.38	2.12	10.83	0.44	14.57	19.67	0.3	99.9	73	0.32	0.02	74.3	41	42	17
90-23-glom5	90-23	cpx	glom	main	51.15	0.34	2.52	10.79	0.4	14.57	19.69	0.28	99.7	73	0.27	0.03	75.3	41	42	17
90-23-glom5	90-23	cpx	glom	main	51.89	0.35	1.83	10.69	0.41	14.69	19.68	0.26	99.8	73	0.31	0.02	73.8	41	42	17
90-23-glom6	90-23	cpx	glom	main	51.73	0.3	1.66	11.32	0.49	14.87	18.81	0.28	99.5	72	0.26	0.02	73.2	39	43	18
90-23-glom6	90-23	cpx	glom	main	51.76	0.37	1.85	10.8	0.41	14.95	19.31	0.26	99.7	73	0.32	0.02	74.4	40	43	17
90-23-glom7	90-23	cpx	glom	main	51.74	0.38	2.12	10.78	0.41	14.46	19.62	0.32	99.8	73	0.33	0.02	73.3	41	42	17
90-23-glom7	90-23	cpx	glom	main	52.32	0.33	1.57	10.97	0.43	14.9	19.37	0.26	100.2	73	0.30	0.01	73.0	40	43	18
90-23-glom7	90-23	cpx	glom	main	52.11	0.33	1.79	10.6	0.41	15.02	19.34	0.26	99.9	74	0.29	0.01	74.0	40	43	17
90-23-px10	90-23	cpx	pheno	main	52.54	0.29	1.43	10.44	0.53	14.74	20.38	0.28	100.6	74	0.25	0.02	74.8	42	42	17
90-23-px16a	90-23	cpx	pheno	main	52.31	0.35	1.72	10.93	0.45	14.67	19.68	0.27	100.4	73	0.31	0.01	72.8	40	42	18
90-23-px16b-z1-r2c	90-23	cpx	core	main	50.66	0.37	2.05	11.71	0.47	13.95	18.78	0.33	98.3	70	0.32	0.02	71.4	40	41	19
90-23-px16b-z1-r2c	90-23	cpx	core	main	51.13	0.38	2.1	11.78	0.45	14.06	18.98	0.33	99.2	70	0.33	0.02	71.3	40	41	19

SAMPLE GRAIN ID	Sample	Min	Texture	stage	SiO2	TiO2	Al2O3	FeO*	MnO	MgO	CaO	Na2O	Total	Mg #	FeO	Fe2O3	Mg # (Fe2+ only)	Wo	En	Fs
90-23-px16b-z1-r2c	90-23	cpx	core	main	51	0.41	2.12	11.86	0.47	14.15	18.99	0.34	99.3	70	0.34	0.03	72.2	40	41	19
90-23-px16b-z1-r2c	90-23	cpx	core	main	51.34	0.39	2.05	11.89	0.46	14.2	19.09	0.33	99.8	70	0.33	0.03	71.8	40	41	19
90-23-px16b-z1-r2c	90-23	cpx	core	main	51.42	0.36	2.04	11.74	0.47	14.09	19.11	0.34	99.6	70	0.31	0.02	71.3	40	41	19
90-23-px16b-z1-r2c	90-23	cpx	core	main	51.28	0.38	2.06	11.79	0.48	14.17	19.08	0.33	99.6	70	0.32	0.02	71.8	40	41	19
90-23-px16b-z1-r2c	90-23	cpx	core	main	51.21	0.37	2.08	11.79	0.48	14.17	19.16	0.34	99.6	70	0.30	0.03	72.3	40	41	19
90-23-px16b-z1-r2c	90-23	cpx	core	main	51.53	0.38	2.03	11.8	0.48	14.19	19.06	0.32	99.8	70	0.33	0.02	71.2	40	41	19
90-23-px16b-z1-r2c	90-23	cpx	core	main	51.36	0.38	2.09	11.7	0.47	14.09	18.97	0.34	99.4	70	0.33	0.02	71.0	40	41	19
90-23-px16b-z1-r2c	90-23	cpx	core	main	51.18	0.39	2.11	11.71	0.48	14.12	19.12	0.33	99.4	71	0.33	0.03	71.9	40	41	19
90-23-px16b-z1-r2c	90-23	cpx	core	main	51.48	0.39	2.07	11.68	0.46	14.1	18.82	0.34	99.3	71	0.35	0.01	70.3	40	41	19
90-23-px16b-z1-r2c	90-23	cpx	core	main	51.57	0.36	1.91	11.63	0.47	14.38	19.06	0.31	99.7	71	0.31	0.02	72.0	40	42	19
90-23-px16b-z1-r2c	90-23	cpx	core	main	51.49	0.39	2.09	11.54	0.46	14.32	19.19	0.31	99.8	71	0.33	0.02	72.1	40	41	19
90-23-px16b-z1-r2c	90-23	cpx	rim	main	52.02	0.27	1.66	10.81	0.49	14.97	19.31	0.26	99.8	73	0.23	0.01	74.2	40	43	17
90-23-px16b-z1-r2c	90-23	cpx	core	main	51.61	0.31	1.97	10.56	0.45	14.79	19.5	0.26	99.5	74	0.26	0.02	74.6	40	43	17
90-23-px16b-z1-r2c	90-23	cpx	rim	main	51.88	0.33	1.64	10.62	0.45	14.93	19.3	0.25	99.4	74	0.29	0.01	74.0	40	43	17
90-23-px16b-z1-r2c	90-23	cpx	rim	main	51.84	0.3	1.75	10.49	0.47	14.89	19.56	0.28	99.6	74	0.25	0.02	75.0	40	43	17
90-23-px16b-z1-r2c	90-23	cpx	rim	main	52.03	0.3	1.64	10.47	0.48	15	19.41	0.23	99.6	74	0.27	0.01	74.2	40	43	17
90-23-px16b-z1-r2c	90-23	cpx	rim	main	52.83	0.28	1.58	10.59	0.5	15.38	19.35	0.24	100.8	74	0.25	0.01	74.1	39	44	17
90-23-px16b-z1-r2c	90-23	cpx	rim	main	52.43	0.29	1.54	10.42	0.46	15.35	19.36	0.22	100.1	74	0.26	0.01	74.7	40	44	17
90-23-px16b-z1-r2c	90-23	cpx	rim	main	52.16	0.34	1.73	10.16	0.46	14.98	19.62	0.26	99.7	75	0.31	0.01	74.5	41	43	16
90-23-px16b-z1-r2c	90-23	cpx	rim	main	52.59	0.28	1.57	10.31	0.48	15.52	19.27	0.24	100.3	75	0.25	0.01	75.1	39	44	16
90-23-px16b-z1-r2c	90-23	cpx	rim	main	52.41	0.29	1.61	10.18	0.46	15.4	19.21	0.21	99.8	75	0.27	0.01	74.5	40	44	16
90-23-px16b-z1-r2c	90-23	cpx	core	main	52.15	0.26	1.69	10.2	0.46	15.53	19.2	0.2	99.7	75	0.23	0.01	75.7	39	44	16
90-23-px16b-z1-r2c	90-23	cpx	rim	main	52.23	0.27	1.48	10.33	0.46	15.73	18.86	0.16	99.5	75	0.24	0.01	75.2	39	45	17
90-23-px16b-z1-r2c	90-23	cpx	rim	main	52.48	0.3	1.65	10.03	0.43	15.32	19.54	0.25	100	75	0.27	0.01	75.1	40	44	16
90-23-px16b-z1-r2c	90-23	cpx	core	main	52.37	0.24	1.66	10.11	0.44	15.59	19.21	0.19	99.8	75	0.22	0.01	75.4	39	44	16

SAMPLE GRAIN ID	Sample	Min	Texture	stage	SiO2	TiO2	Al2O3	FeO*	MnO	MgO	CaO	Na2O	Total	Mg #	FeO	Fe2O3	Mg # (Fe2+ only)	Wo	En	Fs
90-23-px16b-z1-r2c	90-23	cpx	rim	main	52.3	0.25	1.53	10.18	0.45	15.75	19	0.2	99.7	75	0.22	0.01	75.9	39	45	16
90-23-px16b-z1-r2c	90-23	cpx	rim	main	52.27	0.24	1.53	10	0.44	15.68	19.23	0.18	99.6	76	0.21	0.01	76.0	39	45	16
90-23-px16b-z1-r2c	90-23	cpx	core	main	52.28	0.25	1.64	9.95	0.41	15.62	19.17	0.19	99.5	76	0.23	0.01	75.5	39	45	16
90-23-px16b-z1-r2c	90-23	cpx	rim	main	52.11	0.22	1.54	10.01	0.46	15.72	19.41	0.19	99.7	76	0.18	0.01	77.3	40	45	16
90-23-px16b-z1-r2c	90-23	cpx	rim	main	52.34	0.25	1.48	10.02	0.46	15.75	19.03	0.16	99.5	76	0.23	0.01	75.5	39	45	16
90-23-px16b-z1-r2c	90-23	cpx	rim	main	52.48	0.25	1.61	9.85	0.44	15.77	19.28	0.2	99.9	76	0.22	0.01	76.2	39	45	16
90-23-px16b-z1-r2c	90-23	cpx	core	main	52.11	0.24	1.8	9.66	0.41	15.53	19.53	0.18	99.5	76	0.21	0.01	76.4	40	44	15
90-23-px18	90-23	cpx	glom	main	51.75	0.35	1.98	11.03	0.43	14.69	19.42	0.29	99.9	73	0.30	0.02	73.8	40	42	18
90-23-px18	90-23	cpx	glom	main	51.73	0.42	2.28	10.97	0.42	14.81	19.32	0.32	100.3	73	0.35	0.03	74.3	40	42	18
90-23-px18	90-23	cpx	glom	main	51.57	0.33	1.73	10.93	0.43	14.76	19.45	0.27	99.5	73	0.27	0.02	74.5	40	42	18
90-23-px18	90-23	cpx	glom	main	51.79	0.32	1.91	10.78	0.4	14.93	19.23	0.27	99.6	73	0.28	0.02	74.1	40	43	17
90-23-px18	90-23	cpx	glom	main	51.82	0.38	1.58	10.41	0.43	14.72	20.08	0.28	99.7	74	0.31	0.02	75.4	41	42	17
90-23-px18	90-23	cpx	glom	main	52.59	0.3	1.35	10.04	0.47	14.64	20.32	0.27	100	74	0.28	0.01	73.8	42	42	16
90-23-px18	90-23	cpx	glom	main	52.23	0.3	1.41	9.64	0.43	15.06	20.35	0.26	99.7	76	0.25	0.02	76.7	42	43	15
90-23-px1a	90-23	cpx	pheno	main	51.75	0.36	1.81	11.12	0.44	14.57	19.68	0.3	100	72	0.30	0.02	74.0	40	42	18
90-23-px1a	90-23	cpx	pheno	main	51.46	0.39	2.16	11.02	0.42	14.5	19.79	0.29	100	72	0.32	0.03	74.4	41	42	18
90-23-px1a	90-23	cpx	pheno	main	51.37	0.37	1.94	10.98	0.45	14.56	19.65	0.27	99.6	72	0.30	0.03	74.5	41	42	18
90-23-px1a	90-23	cpx	pheno	main	52.06	0.3	1.56	10.78	0.43	14.5	20.15	0.28	100.1	73	0.25	0.02	74.0	41	41	17
90-23-px1a	90-23	cpx	pheno	main	51.92	0.37	1.79	10.83	0.44	14.7	19.4	0.27	99.7	73	0.33	0.02	73.1	40	42	17
90-23-px1a	90-23	cpx	pheno	main	51.75	0.35	1.93	10.53	0.42	14.84	19.71	0.29	99.8	74	0.29	0.02	75.3	41	43	17
90-23-px1a	90-23	cpx	pheno	main	52.1	0.26	1.83	10.38	0.45	15.45	19.45	0.2	100.1	75	0.22	0.02	76.1	40	44	17
90-23-px2-z1-r2c	90-23	cpx	core	main	51.32	0.39	2.15	11.53	0.45	14.12	19.62	0.35	99.9	71	0.32	0.03	73.0	41	41	19
90-23-px2-z1-r2c	90-23	cpx	core	main	51.38	0.44	2.13	11.53	0.43	14.13	19.44	0.33	99.8	71	0.37	0.03	72.1	40	41	19
90-23-px2-z1-r2c	90-23	cpx	core	main	51.55	0.38	2.13	11.51	0.42	14.15	19.52	0.34	100	71	0.32	0.02	72.2	41	41	19
90-23-px2-z1-r2c	90-23	cpx	core	main	51.27	0.4	2.17	11.53	0.48	14.17	19.65	0.35	100	71	0.32	0.03	73.6	41	41	19

SAMPLE GRAIN ID	Sample	Min	Texture	stage	SiO2	TiO2	Al2O3	FeO*	MnO	MgO	CaO	Na2O	Total	Mg #	FeO	Fe2O3	Mg # (Fe2+ only)	Wo	En	Fs
90-23-px2-z1-r2c	90-23	cpx	core	main	51.37	0.38	2.16	11.41	0.42	14.07	19.79	0.35	100	71	0.31	0.03	73.1	41	41	18
90-23-px2-z1-r2c	90-23	cpx	core	main	51.35	0.38	2.17	11.42	0.43	14.15	19.57	0.34	99.8	71	0.31	0.03	72.9	41	41	19
90-23-px2-z1-r2c	90-23	cpx	core	main	51.38	0.41	2.15	11.38	0.42	14.19	19.5	0.32	99.8	71	0.35	0.03	72.5	41	41	18
90-23-px2-z1-r2c	90-23	cpx	core	main	51.58	0.39	2.11	11.34	0.47	14.15	19.56	0.35	100	71	0.33	0.02	72.4	41	41	18
90-23-px2-z1-r2c	90-23	cpx	core	main	51.38	0.38	2.09	11.36	0.45	14.17	19.55	0.32	99.7	71	0.32	0.02	72.7	41	41	18
90-23-px2-z1-r2c	90-23	cpx	core	main	51.46	0.35	2.09	11.33	0.41	14.2	19.61	0.32	99.8	71	0.29	0.02	72.8	41	41	18
90-23-px2-z1-r2c	90-23	cpx	core	main	51.57	0.4	2.01	11.31	0.44	14.21	19.64	0.34	99.9	71	0.34	0.03	72.8	41	41	18
90-23-px2-z1-r2c	90-23	cpx	core	main	51.28	0.38	2.06	11.32	0.43	14.23	19.56	0.31	99.6	71	0.31	0.03	73.1	41	41	18
90-23-px2-z1-r2c	90-23	cpx	core	main	51.55	0.36	2.01	11.31	0.45	14.3	19.63	0.34	100	71	0.30	0.03	73.4	41	41	18
90-23-px2-z1-r2c	90-23	cpx	core	main	51.41	0.38	2.06	11.25	0.43	14.25	19.71	0.34	99.8	72	0.31	0.03	73.6	41	41	18
90-23-px2-z1-r2c	90-23	cpx	core	main	51.69	0.37	1.97	11.23	0.46	14.24	19.59	0.34	99.9	72	0.32	0.02	72.6	41	41	18
90-23-px2-z1-r2c	90-23	cpx	core	main	51.34	0.36	2.18	11.14	0.44	14.16	19.58	0.33	99.5	72	0.30	0.02	72.9	41	41	18
90-23-px2-z1-r2c	90-23	cpx	core	main	51.47	0.35	1.98	11.23	0.43	14.28	19.57	0.31	99.6	72	0.29	0.02	73.0	41	41	18
90-23-px2-z1-r2c	90-23	cpx	core	main	51.52	0.35	1.98	11.08	0.44	14.2	19.6	0.31	99.5	72	0.30	0.02	72.5	41	41	18
90-23-px2-z1-r2c	90-23	cpx	core	main	51.53	0.36	2.11	11.16	0.43	14.34	19.64	0.33	99.9	72	0.30	0.02	73.5	41	41	18
90-23-px2-z1-r2c	90-23	cpx	core	main	51.47	0.36	2.2	11.06	0.41	14.27	19.76	0.33	99.9	72	0.30	0.02	73.6	41	41	18
90-23-px2-z1-r2c	90-23	cpx	core	main	51.56	0.38	2.21	10.93	0.41	14.26	19.61	0.33	99.7	72	0.33	0.02	72.8	41	41	18
90-23-px2-z1-r2c	90-23	cpx	rim	main	51.58	0.35	1.8	11.07	0.48	14.45	19.68	0.31	99.7	72	0.29	0.02	74.0	41	42	18
90-23-px2-z1-r2c	90-23	cpx	rim	main	51.65	0.35	1.82	10.98	0.45	14.34	19.87	0.32	99.8	72	0.29	0.02	73.8	41	41	18
90-23-px2-z1-r2c	90-23	cpx	rim	main	51.82	0.34	1.8	11	0.44	14.4	19.82	0.28	99.9	72	0.29	0.02	73.1	41	41	18
90-23-px2-z1-r2c	90-23	cpx	core	main	51.55	0.38	2.19	10.96	0.41	14.4	19.69	0.32	99.9	72	0.32	0.02	73.7	41	41	18
90-23-px2-z1-r2c	90-23	cpx	rim	main	51.54	0.35	1.77	10.97	0.46	14.44	19.81	0.3	99.6	72	0.29	0.02	74.2	41	41	18
90-23-px2-z1-r2c	90-23	cpx	rim	main	51.59	0.36	1.74	10.95	0.45	14.47	19.99	0.31	99.9	72	0.29	0.03	74.8	41	41	18
90-23-px2-z1-r2c	90-23	cpx	core	main	51.36	0.41	2.23	10.89	0.4	14.41	19.58	0.32	99.6	72	0.34	0.03	73.9	41	42	18
90-23-px2-z1-r2c	90-23	cpx	core	main	51.36	0.41	2.23	10.79	0.44	14.42	19.76	0.31	99.7	73	0.34	0.03	74.4	41	42	17

SAMPLE GRAIN ID	Sample	Min	Texture	stage	SiO2	TiO2	Al2O3	FeO*	MnO	MgO	CaO	Na2O	Total	Mg #	FeO	Fe2O3	Mg # (Fe2+ only)	Wo	En	Fs
90-23-px2-z1-r2c	90-23	cpx	rim	main	51.63	0.35	1.81	10.81	0.45	14.5	19.84	0.29	99.7	73	0.29	0.02	74.3	41	42	17
90-23-px2-z1-r2c	90-23	cpx	rim	main	51	0.31	1.55	10.63	0.47	14.27	20.57	0.27	99.1	73	0.23	0.03	76.7	42	41	17
90-23-px2-z1-r2c	90-23	cpx	rim	main	51.47	0.34	1.87	10.76	0.45	14.47	19.89	0.28	99.5	73	0.28	0.02	74.6	41	42	17
90-23-px2-z1-r2c	90-23	cpx	rim	main	51.66	0.37	1.91	10.78	0.43	14.53	19.83	0.3	99.8	73	0.31	0.02	74.3	41	42	17
90-23-px2-z1-r2c	90-23	cpx	rim	main	51.63	0.34	1.86	10.73	0.44	14.47	19.94	0.29	99.7	73	0.28	0.02	74.4	41	42	17
90-23-px2-z1-r2c	90-23	cpx	core	main	51.38	0.38	2.18	10.75	0.38	14.54	19.69	0.31	99.6	73	0.31	0.03	74.7	41	42	17
90-23-px2-z1-r2c	90-23	cpx	rim	main	51.4	0.37	1.88	10.8	0.46	14.64	19.88	0.29	99.7	73	0.29	0.03	75.7	41	42	17
90-23-px2-z1-r2c	90-23	cpx	rim	main	51.61	0.34	1.88	10.66	0.4	14.46	19.95	0.28	99.6	73	0.29	0.02	74.2	41	42	17
90-23-px2-z1-r2c	90-23	cpx	rim	main	51.77	0.34	1.81	10.84	0.45	14.71	20.02	0.29	100.2	73	0.27	0.03	75.5	41	42	17
90-23-px2-z1-r2c	90-23	cpx	rim	main	51.92	0.34	1.87	10.67	0.43	14.54	19.88	0.28	99.9	73	0.30	0.02	73.7	41	42	17
90-23-px2-z1-r2c	90-23	cpx	rim	main	51.57	0.38	1.73	10.65	0.45	14.53	19.7	0.27	99.3	73	0.33	0.02	73.9	41	42	17
90-23-px2-z1-r2c	90-23	cpx	rim	main	51.93	0.35	1.77	10.75	0.44	14.67	19.76	0.27	99.9	73	0.30	0.02	73.9	41	42	17
90-23-px2-z1-r2c	90-23	cpx	rim	main	51.83	0.34	1.86	10.62	0.42	14.52	19.84	0.28	99.7	73	0.30	0.02	73.7	41	42	17
90-23-px2-z1-r2c	90-23	cpx	rim	main	51.81	0.37	1.84	10.69	0.43	14.64	19.91	0.3	100	73	0.31	0.02	74.7	41	42	17
90-23-px2-z1-r2c	90-23	cpx	rim	main	51.6	0.39	1.82	10.62	0.46	14.56	19.89	0.28	99.6	73	0.33	0.02	74.6	41	42	17
90-23-px2-z1-r2c	90-23	cpx	rim	main	52	0.3	1.65	10.61	0.46	14.56	19.81	0.28	99.7	73	0.26	0.01	73.6	41	42	17
90-23-px2-z1-r2c	90-23	cpx	rim	main	51.99	0.34	1.55	10.66	0.45	14.66	19.8	0.27	99.7	73	0.30	0.02	73.9	41	42	17
90-23-px2-z1-r2c	90-23	cpx	rim	main	52.12	0.32	1.62	10.67	0.44	14.68	19.72	0.27	99.8	73	0.28	0.01	73.5	41	42	17
90-23-px2-z1-r2c	90-23	cpx	rim	main	51.86	0.33	1.8	10.75	0.44	14.8	19.83	0.27	100.1	73	0.27	0.02	75.0	41	42	17
90-23-px2-z1-r2c	90-23	cpx	rim	main	51.77	0.34	1.8	10.67	0.43	14.69	19.76	0.29	99.8	73	0.28	0.02	74.6	41	42	17
90-23-px2-z1-r2c	90-23	cpx	rim	main	52.23	0.32	1.4	10.74	0.48	14.84	19.79	0.25	100.1	73	0.28	0.02	74.1	41	42	17
90-23-px2-z1-r2c	90-23	cpx	rim	main	51.83	0.33	1.62	10.63	0.45	14.72	19.88	0.27	99.7	73	0.27	0.02	74.8	41	42	17
90-23-px2-z1-r2c	90-23	cpx	rim	main	51.87	0.34	1.6	10.59	0.5	14.66	19.61	0.26	99.4	73	0.30	0.01	73.7	41	42	17
90-23-px2-z1-r2c	90-23	cpx	rim	main	52.12	0.29	1.47	10.63	0.46	14.77	19.69	0.26	99.7	73	0.26	0.01	73.8	41	42	17
90-23-px2-z1-r2c	90-23	cpx	rim	main	51.69	0.34	1.79	10.52	0.45	14.68	19.68	0.27	99.4	73	0.29	0.02	74.4	41	42	17

SAMPLE GRAIN ID	Sample	Min	Texture	stage	SiO2	TiO2	Al2O3	FeO*	MnO	MgO	CaO	Na2O	Total	Mg #	FeO	Fe2O3	Mg # (Fe2+ only)	Wo	En	Fs
90-23-px2-z1-r2c	90-23	cpx	rim	main	51.74	0.34	1.68	10.63	0.44	14.83	19.57	0.26	99.5	73	0.29	0.02	74.6	40	43	17
90-23-px2-z1-r2c	90-23	cpx	rim	main	52.19	0.34	1.49	10.54	0.47	14.79	19.68	0.25	99.8	74	0.31	0.01	73.6	41	42	17
90-23-px2-z1-r2c	90-23	cpx	core	main	51.8	0.36	2.07	10.49	0.39	14.73	19.7	0.26	99.8	74	0.31	0.02	74.2	41	42	17
90-23-px2-z1-r2c	90-23	cpx	rim	main	51.89	0.35	1.6	10.52	0.46	14.81	19.72	0.26	99.6	74	0.30	0.02	74.6	41	42	17
90-23-px2-z1-r2c	90-23	cpx	rim	main	52.16	0.32	1.5	10.51	0.47	14.87	19.83	0.26	99.9	74	0.28	0.02	74.6	41	42	17
90-23-px2-z1-r2c	90-23	cpx	core	main	51.77	0.3	2	10.51	0.37	14.93	19.71	0.25	99.8	74	0.25	0.02	75.3	40	43	17
90-23-px2-z1-r2c	90-23	cpx	core	main	51.41	0.35	2.34	10.4	0.37	14.89	19.88	0.19	99.8	74	0.29	0.02	75.8	41	43	17
90-23-px2-z1-r2c	90-23	cpx	core	main	51.66	0.3	2.21	10.37	0.36	14.9	20.02	0.21	100	74	0.25	0.02	75.8	41	42	17
90-23-px2-z1-r2c	90-23	cpx	rim	main	51.87	0.33	1.57	10.5	0.47	15.14	19.72	0.24	99.8	74	0.27	0.02	76.2	40	43	17
90-23-px2-z1-r2c	90-23	cpx	core	main	51.52	0.32	2.4	10.29	0.38	14.9	19.91	0.2	99.9	74	0.26	0.02	75.8	41	43	17
90-23-px2-z1-r2c	90-23	cpx	core	main	51.39	0.3	2.31	10.15	0.35	14.98	19.73	0.19	99.4	75	0.25	0.02	75.9	41	43	16
90-23-px2-z1-r2c	90-23	cpx	rim	main	52.34	0.3	1.41	10.33	0.46	15.3	19.65	0.25	100	75	0.26	0.02	75.7	40	43	16
90-23-px2-z1-r2c	90-23	cpx	rim	main	52.19	0.29	1.65	10.22	0.41	15.19	19.7	0.22	99.9	75	0.25	0.01	75.3	40	43	16
90-23-px2-z1-r2c	90-23	cpx	rim	main	52.49	0.33	1.37	10.2	0.45	15.27	19.68	0.23	100	75	0.29	0.01	75.0	40	43	16
90-23-px2-z1-r2c	90-23	cpx	core	main	51.82	0.29	2.16	10.08	0.35	15.11	19.65	0.18	99.6	75	0.26	0.01	75.2	40	43	16
90-23-px2-z1-r2c	90-23	cpx	core	main	51.76	0.33	2.2	10.03	0.34	15.05	20.02	0.19	99.9	75	0.28	0.02	76.0	41	43	16
90-23-px2-z1-r2c	90-23	cpx	rim	main	52.05	0.3	1.74	10.12	0.4	15.23	19.48	0.22	99.5	75	0.27	0.01	75.2	40	44	16
90-23-px2-z1-r2c	90-23	cpx	rim	main	52.08	0.31	1.51	10.13	0.45	15.26	19.55	0.21	99.5	75	0.27	0.01	75.5	40	44	16
90-23-px2-z1-r2c	90-23	cpx	rim	main	52.15	0.28	1.78	10.13	0.42	15.26	19.74	0.2	100	75	0.24	0.01	75.7	40	43	16
90-23-px2-z1-r2c	90-23	cpx	rim	main	51.98	0.31	1.83	10.12	0.38	15.37	19.59	0.21	99.8	75	0.26	0.02	76.2	40	44	16
90-23-px2-z1-r2c	90-23	cpx	rim	main	52.19	0.27	1.81	10.07	0.42	15.33	19.58	0.2	99.9	75	0.24	0.01	75.5	40	44	16
90-23-px2-z1-r2c	90-23	cpx	rim	main	52.28	0.31	1.84	10.09	0.37	15.41	19.63	0.18	100.1	75	0.28	0.01	75.4	40	44	16
90-23-px2-z1-r2c	90-23	cpx	rim	main	52.06	0.31	1.77	10.05	0.38	15.37	19.51	0.19	99.6	75	0.27	0.01	75.6	40	44	16
90-23-px2-z1-r2c	90-23	cpx	core	main	51.96	0.29	2.05	9.99	0.38	15.26	19.5	0.17	99.6	75	0.26	0.01	75.1	40	44	16
90-23-px2-z1-r2c	90-23	cpx	rim	main	51.96	0.26	1.86	10	0.38	15.42	19.53	0.19	99.6	75	0.22	0.01	76.2	40	44	16

SAMPLE GRAIN ID	Sample	Min	Texture	stage	SiO2	TiO2	Al2O3	FeO*	MnO	MgO	CaO	Na2O	Total	Mg #	FeO	Fe2O3	Mg # (Fe2+ only)	Wo	En	Fs
90-23-px2-z1-r2c	90-23	cpx	rim	main	52.26	0.29	1.82	10.01	0.38	15.45	19.55	0.19	100	75	0.26	0.01	75.6	40	44	16
90-23-px2-z1-r2c	90-23	cpx	rim	main	52.06	0.31	1.82	9.98	0.37	15.44	19.54	0.2	99.7	75	0.27	0.01	76.1	40	44	16
90-23-px2-z1-r2c	90-23	cpx	core	main	52.09	0.31	1.92	9.87	0.36	15.28	19.57	0.18	99.6	75	0.28	0.01	75.1	40	44	16
90-23-px2-z1-r2c	90-23	cpx	core	main	52	0.29	1.89	9.93	0.38	15.41	19.45	0.18	99.5	75	0.26	0.01	75.7	40	44	16
90-23-px2-z1-r2c	90-23	cpx	rim	main	51.91	0.32	1.83	9.84	0.39	15.31	19.64	0.2	99.4	76	0.28	0.01	76.1	40	44	16
90-23-px2-z1-r2c	90-23	cpx	rim	main	52.15	0.29	1.88	9.95	0.36	15.56	19.58	0.19	100	76	0.25	0.01	76.5	40	44	16
90-23-px3	90-23	cpx	pheno	main	51.43	0.37	1.92	10.89	0.41	14.58	19.66	0.29	99.6	73	0.30	0.03	74.6	41	42	18
90-23-px3	90-23	cpx	pheno	main	51.67	0.35	1.8	10.59	0.44	14.75	19.88	0.27	99.8	73	0.29	0.02	75.3	41	42	17
90-23-px3	90-23	cpx	pheno	main	52.04	0.36	1.76	10.6	0.39	15.06	19.37	0.26	99.8	74	0.32	0.02	74.4	40	43	17
90-23-px6	90-23	cpx	pheno	main	51.51	0.42	2.29	11.32	0.45	14.26	19.32	0.31	99.9	71	0.37	0.02	72.0	40	41	18
90-23-px6	90-23	cpx	pheno	main	52.57	0.21	1.38	10.94	0.6	14.26	20.53	0.29	100.8	72	0.18	0.01	73.1	42	41	17
90-23-px6	90-23	cpx	pheno	main	51.65	0.37	1.85	10.56	0.4	14.79	19.65	0.26	99.5	74	0.31	0.02	74.7	41	42	17
90-23-px7	90-23	cpx	pheno	main	51.23	0.46	2.52	11.11	0.45	14.22	19.61	0.27	99.9	72	0.39	0.03	72.8	41	41	18
90-23-px7	90-23	cpx	pheno	main	51.57	0.43	2.31	10.92	0.43	14.37	19.58	0.3	99.9	72	0.38	0.02	73.0	41	42	18
90-23-px7	90-23	cpx	pheno	main	52.25	0.31	1.62	10.87	0.44	15.15	19.16	0.26	100.1	73	0.27	0.01	73.9	39	43	17
90-23-px7	90-23	cpx	pheno	main	51.86	0.35	1.83	10.53	0.42	14.7	20.05	0.28	100	73	0.29	0.02	75.1	41	42	17
90-23-px7	90-23	cpx	pheno	main	52.1	0.37	1.96	10.51	0.44	14.76	19.58	0.27	100	74	0.34	0.01	73.4	41	43	17
90-23-px7a	90-23	cpx	pheno	main	51.71	0.39	1.87	11.07	0.46	14.67	19.59	0.28	100	72	0.32	0.03	74.1	40	42	18
90-23-px7a	90-23	cpx	pheno	main	51.69	0.38	1.93	11.01	0.45	14.78	19.52	0.28	100	73	0.31	0.03	74.5	40	42	18
KELUT90B-glom-cpx1	90B	cpx	glom	main	50.36	0.49	2.41	10.26	0.47	13.95	20.68	0.33	99	71	0.35	0.05	77.4	43	40	17
KELUT90B-glom-cpx1	90B	cpx	glom	main	50.54	0.4	2.07	10.25	0.5	14.35	20.42	0.33	98.9	71	0.27	0.05	78.6	42	41	17
KELUT90B-glom-cpx1	90B	cpx	glom	main	50.5	0.4	2.05	10.18	0.51	14.18	20.44	0.29	98.6	71	0.29	0.04	77.4	42	41	17
KELUT90B-glom-cpx1	90B	cpx	glom	main	50.14	0.38	2.49	10.01	0.5	14.11	21.12	0.32	99.1	72	0.23	0.05	80.5	43	40	16
KELUT90B-glom-cpx1	90B	cpx	glom	main	49.96	0.39	2.52	9.97	0.46	14.24	20.59	0.3	98.4	72	0.25	0.05	79.8	43	41	16

SAMPLE GRAIN ID	Sample	Min	Texture	stage	SiO2	TiO2	Al2O3	FeO*	MnO	MgO	CaO	Na2O	Total	Mg #	FeO	Fe2O3	Mg # (Fe2+ only)	Wo	En	Fs
KELUT90B-glom-cpx1	90B	cpx	glom	main	49.84	0.41	2.2	10.01	0.46	14.34	20.46	0.31	98	72	0.26	0.05	80.3	42	41	16
KELUT90B-glom-cpx1	90B	cpx	glom	main	50.65	0.36	1.72	9.98	0.5	14.46	20.32	0.26	98.3	72	0.27	0.03	77.8	42	42	16
KELUT90B-glom-cpx1	90B	cpx	glom	main	50.18	0.43	2.25	9.95	0.49	14.52	20.39	0.26	98.5	72	0.29	0.05	79.6	42	42	16
KELUT90B-glom-cpx1	90B	cpx	glom	main	51.03	0.36	1.85	9.97	0.51	14.49	20.48	0.31	99	72	0.26	0.03	78.0	42	42	16
KELUT90B-glom-cpx1	90B	cpx	glom	main	50.59	0.33	1.9	9.92	0.5	14.48	20.74	0.31	98.8	72	0.22	0.04	80.0	43	41	16
KELUT90B-glom-cpx1	90B	cpx	glom	main	50.78	0.34	1.86	9.82	0.49	14.38	20.42	0.3	98.4	72	0.25	0.03	77.8	42	42	16
KELUT90B-glom-cpx1	90B	cpx	glom	main	50.81	0.33	1.76	9.84	0.46	14.4	20.73	0.34	98.7	72	0.23	0.04	79.2	43	41	16
KELUT90B-glom-cpx1	90B	cpx	glom	main	49.4	0.39	3.04	9.55	0.4	14.02	21.23	0.29	98.3	72	0.22	0.06	82.1	44	40	15
KELUT90B-glom-cpx1	90B	cpx	glom	main	49.96	0.4	2.54	9.66	0.45	14.2	20.92	0.32	98.5	72	0.25	0.05	80.8	43	41	16
KELUT90B-glom-cpx1	90B	cpx	glom	main	50.53	0.3	1.79	9.79	0.5	14.49	20.7	0.32	98.4	72	0.19	0.04	80.3	43	42	16
KELUT90B-glom-cpx1	90B	cpx	glom	main	50.34	0.34	1.98	9.89	0.49	14.71	20.65	0.28	98.7	73	0.21	0.05	81.4	42	42	16
KELUT90B-glom-cpx1	90B	cpx	glom	main	50.56	0.34	1.95	9.71	0.45	14.62	20.53	0.3	98.5	73	0.23	0.04	80.0	42	42	16
KELUT90B-glom-cpx1	90B	cpx	glom	main	50.57	0.33	2.03	9.66	0.49	14.6	20.85	0.31	98.8	73	0.21	0.04	81.1	43	42	15
KELUT90B-glom-cpx1	90B	cpx	glom	main	50.6	0.35	1.79	9.74	0.49	14.83	20.21	0.27	98.3	73	0.24	0.04	79.7	42	43	16
KELUT90B-glom-cpx1	90B	cpx	glom	main	50.58	0.32	1.82	9.38	0.44	14.79	20.77	0.25	98.4	74	0.21	0.04	81.0	43	42	15
KELUT90B-opxc corecpxrim-1	90B	cpx	overgrowth	main	50.12	0.39	2.24	9.95	0.45	14.51	20.52	0.31	98.5	72	0.24	0.05	80.6	42	42	16
KELUT90B-opxc corecpxrim-1	90B	cpx	overgrowth	main	50.81	0.32	1.82	9.84	0.48	14.53	20.67	0.29	98.8	72	0.22	0.03	79.2	43	42	16
KELUT90B-opxc corecpxrim-1	90B	cpx	overgrowth	main	50.44	0.31	1.76	9.71	0.49	14.69	20.45	0.27	98.1	73	0.21	0.04	80.3	42	42	16
KELUT90B-opxcpx17	90B	cpx	overgrowth	main	50.87	0.35	1.95	10.23	0.51	14.45	20.55	0.29	99.2	72	0.25	0.04	78.2	42	41	16
KELUT90B-opxcpx17	90B	cpx	overgrowth	main	50.59	0.43	2.12	10.1	0.45	14.46	20.72	0.33	99.2	72	0.28	0.05	79.8	43	41	16
KELUT90B-opxcpx17	90B	cpx	overgrowth	main	51.01	0.39	2.05	9.81	0.5	14.21	20.84	0.3	99.1	72	0.30	0.03	77.4	43	41	16

SAMPLE GRAIN ID	Sample	Min	Texture	stage	SiO2	TiO2	Al2O3	FeO*	MnO	MgO	CaO	Na2O	Total	Mg #	FeO	Fe2O3	Mg # (Fe2+ only)	Wo	En	Fs
KELUT90B-opxcpx17	90B	cpx	overgrowth	main	51.33	0.24	1.61	9.82	0.49	14.28	21.19	0.29	99.3	72	0.17	0.02	78.1	43	41	16
KELUT90B-opxcpx17	90B	cpx	overgrowth	main	49.87	0.42	2.06	10.12	0.49	14.72	20.1	0.3	98.1	72	0.26	0.06	81.1	41	42	16
KELUT90B-opxcpx17	90B	cpx	overgrowth	main	51.16	0.35	1.83	9.76	0.44	14.33	20.81	0.31	99	72	0.27	0.03	77.6	43	41	16
KELUT90B-opxcpx17	90B	cpx	overgrowth	main	50.71	0.38	2.04	9.71	0.44	14.54	20.65	0.32	98.8	73	0.26	0.04	79.6	43	42	16
KELUT90B-opxcpx17	90B	cpx	overgrowth	main	50.7	0.38	1.94	9.8	0.46	14.66	20.61	0.31	98.9	73	0.25	0.04	80.1	42	42	16
KELUT90B-opxcpx17	90B	cpx	overgrowth	main	51.05	0.36	1.9	9.68	0.47	14.58	21.02	0.3	99.4	73	0.25	0.04	79.9	43	42	15
KELUT90B-opxcpx17	90B	cpx	overgrowth	main	51.23	0.29	1.69	9.72	0.49	14.55	21.16	0.28	99.4	73	0.20	0.03	79.6	43	41	15
KELUT90B-opxcpx3	90B	cpx	glom	main	48.67	0.81	4.1	10.26	0.45	13.28	20.54	0.32	98.4	70	0.55	0.09	77.3	44	39	17
KELUT90B-opxcpx3	90B	cpx	glom	main	49.95	0.59	3	10.17	0.49	14.07	20.34	0.31	98.9	71	0.42	0.06	77.8	43	41	17
KELUT90B-opxcpx3	90B	cpx	glom	main	50.68	0.42	2.04	9.99	0.5	14.26	20.53	0.27	98.7	72	0.32	0.04	77.3	43	41	16
KELUT90B-opxcpx3	90B	cpx	glom	main	50.22	0.41	2.08	9.97	0.51	14.51	20.35	0.3	98.4	72	0.27	0.05	79.8	42	42	16
KELUT90B-opxcpx3	90B	cpx	glom	main	48.41	0.63	4.84	9.27	0.32	13.6	21.58	0.25	98.9	72	0.35	0.09	82.7	45	40	15
KELUT90B-opxcpx3	90B	cpx	glom	main	49.67	0.53	3.28	9.58	0.41	14.06	20.73	0.3	98.6	72	0.36	0.06	79.6	43	41	16
KELUT90B-opxcpx3	90B	cpx	glom	main	51.23	0.37	2.01	9.86	0.48	14.47	20.79	0.27	99.5	72	0.28	0.03	77.7	43	41	16
KELUT90B-opxcpx3	90B	cpx	glom	main	51.01	0.39	1.9	9.91	0.5	14.59	20.68	0.29	99.3	72	0.28	0.04	78.9	42	42	16
KELUT90B-opxcpx3	90B	cpx	glom	main	50.94	0.33	1.78	9.9	0.54	14.68	20.44	0.29	98.9	73	0.23	0.03	79.1	42	42	16
KELUT90B-opxcpx3	90B	cpx	glom	main	48.7	0.65	4.61	9.12	0.34	13.65	21.23	0.26	98.6	73	0.41	0.08	81.0	45	40	15
KELUT90B-opxcpx3	90B	cpx	glom	main	51.01	0.34	1.78	9.84	0.51	14.7	20.72	0.3	99.2	73	0.23	0.04	79.8	42	42	16
KELUT90B-opxcpx3	90B	cpx	glom	main	50.79	0.39	1.9	9.76	0.47	14.61	20.98	0.27	99.2	73	0.26	0.05	80.3	43	42	16
KELUT90B-opxcpx3	90B	cpx	glom	main	50.74	0.37	1.9	9.97	0.45	15.09	20.8	0.31	99.6	73	0.21	0.06	82.9	42	42	16
KELUT90B-opxcpx3	90B	cpx	glom	main	51.12	0.33	1.62	9.74	0.47	14.79	20.59	0.26	98.9	73	0.24	0.03	79.1	42	42	16
KELUT90B-opxcpx3	90B	cpx	glom	main	50.64	0.42	2.46	9.47	0.46	14.54	20.79	0.27	99.1	73	0.30	0.04	79.6	43	42	15
KELUT90B-opxcpx3	90B	cpx	glom	main	51.25	0.3	1.48	9.54	0.48	14.85	20.79	0.26	99	73	0.21	0.03	79.7	43	42	15
KELUT90B-opxcpx8	90B	cpx	pheno	main	50.75	0.41	2.12	10.08	0.47	14.69	20.56	0.31	99.4	72	0.27	0.05	79.9	42	42	16

SAMPLE GRAIN ID	Sample	Min	Texture	stage	SiO2	TiO2	Al2O3	FeO*	MnO	MgO	CaO	Na2O	Total	Mg #	FeO	Fe2O3	Mg # (Fe2+ only)	Wo	En	Fs
KELUT90B-opxcpx8	90B	cpx	pheno	main	50.83	0.38	2.1	9.76	0.46	14.68	20.66	0.28	99.2	73	0.26	0.04	79.6	42	42	16
KELUT90B-opxcpx8	90B	cpx	pheno	main	51.43	0.31	1.51	9.58	0.53	14.86	20.88	0.26	99.4	73	0.22	0.03	79.7	43	42	15
KELUT90B-opxcpx8	90B	cpx	pheno	main	50.77	0.39	2.08	9.47	0.46	14.8	21.05	0.28	99.3	74	0.25	0.05	81.7	43	42	15
KELUT90B-opxcpx9	90B	cpx	glom	main	50.93	0.37	2.02	9.92	0.48	14.42	20.55	0.29	99	72	0.28	0.03	77.8	42	41	16
KELUT90B-opxcpx9	90B	cpx	glom	main	51.07	0.4	2.02	9.86	0.49	14.46	20.54	0.3	99.1	72	0.30	0.03	77.7	42	42	16
KELUT90B-opxcpx9	90B	cpx	glom	main	51.01	0.36	1.9	9.83	0.5	14.44	20.57	0.27	98.9	72	0.27	0.03	77.6	43	42	16
KELUT90B-opxcpx9	90B	cpx	glom	main	51.2	0.32	1.52	9.7	0.51	14.59	20.66	0.27	98.8	73	0.24	0.03	78.2	43	42	16
PL1-1-2px1	PL1	cpx	pheno	main	51.06	0.48	3.27	10.8	0.41	13.6	20.69	0.38	100.7	71	0.38	0.04	74.0	43	39	18
PL1-1-2px1	PL1	cpx	pheno	main	50.67	0.52	3.47	10.97	0.43	14.07	20.69	0.26	101.1	72	0.37	0.06	76.3	42	40	18
PL1-1-2px2	PL1	cpx	glom	main	51.86	0.38	1.75	10.61	0.44	14.66	20.83	0.27	100.8	73	0.28	0.04	77.0	42	41	17
PL1-1-2px3	PL1	cpx	glom	main	52.35	0.34	1.8	10.73	0.48	14.42	20.56	0.3	101	73	0.28	0.02	74.2	42	41	17
PL1-1-px-20	PL1	cpx	pheno	main	50.39	0.55	3.42	10.83	0.45	13.43	21.15	0.32	100.5	71	0.40	0.06	75.6	44	39	18
PL1-1-px-20	PL1	cpx	pheno	main	51.64	0.4	1.87	10.84	0.5	14.31	20.81	0.27	100.6	72	0.30	0.04	75.8	42	40	17
PL1-1-px-20	PL1	cpx	pheno	main	51.59	0.49	1.8	10.43	0.47	14.04	21.69	0.29	100.8	73	0.35	0.05	77.0	44	40	16
PL1-1-px-21	PL1	cpx	pheno	main	51.28	0.25	1.68	10.45	0.57	14.05	21.68	0.33	100.3	73	0.16	0.03	79.2	44	40	17
PL1-1-px-21-opxcpx	PL1	cpx	glom	main	50.93	0.39	1.69	10.8	0.51	14.34	21.07	0.28	100	72	0.25	0.05	78.9	43	40	17
PL1-1-px-21-opxcpx	PL1	cpx	glom	main	51.8	0.3	1.8	10.45	0.51	13.93	21.4	0.26	100.5	73	0.24	0.02	75.2	44	40	17
PL1-1-px-21-opxcpx	PL1	cpx	glom	main	51.4	0.39	1.95	10.49	0.48	14.24	21.1	0.27	100.3	73	0.28	0.04	76.9	43	40	17
PL1-1-px-21-smallopx	PL1	cpx	glom	main	50.92	0.39	1.92	10.78	0.51	14.42	20.88	0.3	100.1	73	0.25	0.05	79.0	42	41	17
PL1-1-px-22	PL1	cpx	pheno	main	50.91	0.31	1.92	10.71	0.48	14.55	20.69	0.3	99.9	73	0.20	0.04	79.2	42	41	17
PL1-1-px-22	PL1	cpx	pheno	main	52.26	0.28	1.64	10.11	0.45	15.5	20.27	0.19	100.7	75	0.22	0.02	78.0	41	43	16
PL1-1-px-23	PL1	cpx	glom	main	50.62	0.34	1.56	11.05	0.53	15	20.07	0.21	99.4	73	0.21	0.05	79.6	40	42	17
PL1-1-px-23	PL1	cpx	glom	main	48.1	0.67	4.44	10.28	0.29	14.06	20.99	0.25	99.1	73	0.31	0.13	84.1	43	40	17
PL1-1-px-24	PL1	cpx	pheno	main	51.83	0.35	1.97	10.94	0.49	13.82	20.77	0.4	100.6	71	0.28	0.03	74.0	43	40	18

SAMPLE GRAIN ID	Sample	Min	Texture	stage	SiO2	TiO2	Al2O3	FeO*	MnO	MgO	CaO	Na2O	Total	Mg #	FeO	Fe2O3	Mg # (Fe2+ only)	Wo	En	Fs
PL1-1-px-24	PL1	cpx	pheno	main	51.13	0.49	2.29	11.05	0.48	13.93	20.78	0.33	100.5	71	0.36	0.05	75.5	43	40	18
PL1-1-px-glom1	PL1	cpx	glom	main	52.65	0.31	1.58	11.11	0.65	13.96	21.33	0.29	101.9	71	0.25	0.02	73.5	43	39	18
PL1-1-px-glom1	PL1	cpx	glom	main	52.14	0.39	2	11.1	0.57	14.01	20.57	0.3	101.1	71	0.33	0.02	72.7	42	40	18
PL1-1-px-glom1	PL1	cpx	glom	main	52.43	0.32	1.47	11.18	0.59	14.07	20.98	0.28	101.3	71	0.26	0.02	73.4	43	40	18
PL1-1-px-glom1	PL1	cpx	glom	main	52.29	0.39	2.07	11.17	0.5	14.13	20.76	0.28	101.6	72	0.32	0.03	73.1	42	40	18
PL1-1-px-glom1	PL1	cpx	glom	main	52.47	0.37	1.76	11.11	0.52	14.22	20.89	0.32	101.7	72	0.30	0.03	74.0	42	40	18
PL1-1-px-glom1	PL1	cpx	glom	main	52.38	0.31	1.65	10.94	0.54	14.35	20.79	0.29	101.3	72	0.25	0.02	74.5	42	41	17
PL1-1-px-glom1	PL1	cpx	glom	main	52.22	0.36	1.9	10.95	0.47	14.49	20.84	0.28	101.5	72	0.28	0.03	75.4	42	41	17
PL1-1-px-glom1	PL1	cpx	glom	main	52.2	0.36	1.9	10.64	0.49	14.32	20.86	0.29	101.1	73	0.29	0.02	74.8	42	41	17
PL1-1-px-glom1	PL1	cpx	glom	main	51.62	0.49	3.3	10.51	0.35	14.25	20.69	0.29	101.5	73	0.40	0.03	74.9	42	41	17
PL1-1-px-glom1	PL1	cpx	glom	main	52.2	0.37	1.89	10.82	0.47	14.62	20.77	0.27	101.4	73	0.29	0.03	75.8	42	41	17
PL1-1-px-glom1	PL1	cpx	glom	main	53.2	0.29	1.21	10.13	0.51	14.68	21.22	0.26	101.5	74	0.25	0.01	74.9	43	41	16
PL1-1-px-glom1	PL1	cpx	glom	main	52.35	0.33	2.38	8.98	0.27	15.71	21.09	0.17	101.3	78	0.25	0.02	80.5	42	44	14
PL1-1-px-MX1	PL1	cpx	glom	main	51.6	0.39	1.85	11.12	0.53	14.25	20.6	0.31	100.7	72	0.29	0.04	75.5	42	40	18
PL1-1-px-MX1	PL1	cpx	glom	main	51.48	0.41	1.88	11.11	0.49	14.43	20.57	0.3	100.7	72	0.29	0.04	76.5	42	41	18
PL1-1-px-MX1	PL1	cpx	glom	main	51.32	0.41	1.97	11.08	0.54	14.5	20.45	0.27	100.5	72	0.29	0.05	76.7	42	41	18
PL1-1-px-MX1	PL1	cpx	glom	main	51.79	0.36	1.7	10.8	0.49	14.48	20.61	0.29	100.5	73	0.27	0.03	76.0	42	41	17
PL1-1-px-MX1	PL1	cpx	glom	main	52.05	0.38	1.81	10.75	0.46	14.58	20.9	0.27	101.2	73	0.29	0.03	76.3	42	41	17
PL1-1-px-MX1	PL1	cpx	glom	main	51.25	0.45	2.25	10.66	0.46	14.51	20.87	0.28	100.7	73	0.31	0.05	78.0	42	41	17
PL1-1-px-pseudoz8-r2c	PL1	cpx	core	main	52.93	0.29	1.6	11.25	0.46	16.55	18.5	0.16	101.7	74	0.24	0.02	76.4	37	46	17
PL1-1-px-pseudoz8-r2c	PL1	cpx	core	main	53.17	0.3	1.58	11.08	0.49	16.59	18.58	0.18	102	75	0.25	0.02	76.5	37	46	17
PL1-1-px-Z14-r2c	PL1	cpx	core	main	54.84	0.49	5.13	9.34	0.4	11.46	16.69	0.53	98.9	71	1.09	-0.21	47.7	42	40	18
PL1-1-px-Z14-r2c	PL1	cpx	core	main	51.05	0.43	2.35	11.09	0.47	14.21	20.68	0.29	100.6	72	0.30	0.05	76.6	42	40	18
PL1-1-px-Z14-r2c	PL1	cpx	core	main	51.02	0.42	2.33	11.2	0.47	14.3	20.25	0.28	100.3	72	0.31	0.04	75.8	41	41	18

SAMPLE GRAIN ID	Sample	Min	Texture	stage	SiO2	TiO2	Al2O3	FeO*	MnO	MgO	CaO	Na2O	Total	Mg #	FeO	Fe2O3	Mg # (Fe2+ only)	Wo	En	Fs
PL1-1-px-Z14-r2c	PL1	cpx	core	main	51.28	0.47	2.31	11.21	0.49	14.43	19.83	0.28	100.3	72	0.37	0.04	74.6	41	41	18
PL1-1-px-Z14-r2c	PL1	cpx	core	main	51.41	0.45	2.32	11.18	0.49	14.39	19.81	0.29	100.3	72	0.36	0.03	74.1	41	41	18
PL1-1-px-Z14-r2c	PL1	cpx	core	main	51.42	0.38	1.89	11.02	0.51	14.31	20.67	0.29	100.5	72	0.28	0.04	76.3	42	40	17
PL1-1-px-Z14-r2c	PL1	cpx	core	main	51.45	0.41	1.89	10.95	0.51	14.2	20.84	0.29	100.5	72	0.30	0.04	76.0	42	40	17
PL1-1-px-Z14-r2c	PL1	cpx	core	main	51.25	0.44	2.28	11.09	0.49	14.51	19.81	0.29	100.2	72	0.34	0.04	75.2	41	41	18
PL1-1-px-Z14-r2c	PL1	cpx	core	main	51.45	0.38	1.85	10.99	0.51	14.37	20.75	0.28	100.6	72	0.27	0.04	76.6	42	41	17
PL1-1-px-Z14-r2c	PL1	cpx	core	main	51.05	0.44	2.32	10.85	0.49	14.19	20.58	0.28	100.2	72	0.32	0.04	76.1	42	40	17
PL1-1-px-Z14-r2c	PL1	cpx	core	main	51.35	0.43	2.05	10.87	0.47	14.27	20.86	0.3	100.6	72	0.31	0.05	76.7	42	40	17
PL1-1-px-Z14-r2c	PL1	cpx	core	main	51.52	0.39	1.91	10.84	0.48	14.25	20.98	0.29	100.7	72	0.28	0.04	76.5	43	40	17
PL1-1-px-Z14-r2c	PL1	cpx	core	main	51.16	0.46	2.22	10.89	0.47	14.32	20.69	0.3	100.5	72	0.33	0.05	76.9	42	41	17
PL1-1-px-Z14-r2c	PL1	cpx	core	main	51.19	0.42	2	10.86	0.48	14.25	20.74	0.28	100.2	72	0.30	0.04	76.5	42	40	17
PL1-1-px-Z14-r2c	PL1	cpx	core	main	51.33	0.37	1.9	10.86	0.52	14.28	20.79	0.29	100.3	72	0.26	0.04	76.7	42	40	17
PL1-1-px-Z14-r2c	PL1	cpx	core	main	51.59	0.36	2.07	10.88	0.5	14.35	20.83	0.29	100.9	72	0.26	0.04	76.5	42	41	17
PL1-1-px-Z14-r2c	PL1	cpx	core	main	51.09	0.45	2.32	11.03	0.49	14.52	19.92	0.3	100.1	72	0.33	0.04	76.0	41	41	18
PL1-1-px-Z14-r2c	PL1	cpx	core	main	51.23	0.44	2.11	10.89	0.47	14.33	20.75	0.29	100.5	72	0.31	0.05	76.9	42	41	17
PL1-1-px-Z14-r2c	PL1	cpx	core	main	51.52	0.37	1.98	10.81	0.5	14.32	20.46	0.27	100.2	72	0.29	0.03	75.2	42	41	17
PL1-1-px-Z14-r2c	PL1	cpx	core	main	51.81	0.36	1.77	10.89	0.49	14.38	20.63	0.27	100.6	72	0.28	0.03	75.3	42	41	17
PL1-1-px-Z14-r2c	PL1	cpx	core	main	51.12	0.41	2.25	10.77	0.47	14.21	20.84	0.29	100.4	72	0.29	0.04	76.9	43	40	17
PL1-1-px-Z14-r2c	PL1	cpx	core	main	51.28	0.37	2.18	10.75	0.46	14.28	20.98	0.28	100.6	72	0.26	0.04	77.2	43	40	17
PL1-1-px-Z14-r2c	PL1	cpx	core	main	51.41	0.42	2.08	10.78	0.44	14.25	20.63	0.29	100.3	72	0.32	0.04	75.6	42	41	17
PL1-1-px-Z14-r2c	PL1	cpx	core	main	51.71	0.37	1.88	10.76	0.49	14.28	20.83	0.29	100.6	72	0.28	0.03	75.8	42	40	17
PL1-1-px-Z14-r2c	PL1	cpx	core	main	51.6	0.38	1.99	10.71	0.5	14.22	20.77	0.27	100.4	72	0.30	0.03	75.4	42	40	17
PL1-1-px-Z14-r2c	PL1	cpx	core	main	51.3	0.41	2.04	10.78	0.5	14.33	20.7	0.3	100.4	73	0.29	0.04	76.8	42	41	17
PL1-1-px-Z14-r2c	PL1	cpx	core	main	51.68	0.39	1.82	10.67	0.49	14.32	20.78	0.29	100.4	73	0.30	0.03	75.9	42	41	17
PL1-1-px-Z14-r2c	PL1	cpx	core	main	52.45	0.47	3.06	10.16	0.45	13.63	19.4	0.31	99.9	73	0.56	-0.03	66.6	42	41	17

SAMPLE GRAIN ID	Sample	Min	Texture	stage	SiO2	TiO2	Al2O3	FeO*	MnO	MgO	CaO	Na2O	Total	Mg #	FeO	Fe2O3	Mg # (Fe2+ only)	Wo	En	Fs
PL1-1-px-Z14-r2c	PL1	cpx	core	main	50.91	0.52	2.82	10.61	0.43	14.38	20.62	0.25	100.5	73	0.38	0.05	77.0	42	41	17
PL1-1-px-Z14-r2c	PL1	cpx	rim	main	50.05	0.64	3.73	10.54	0.37	14.36	20.35	0.23	100.3	73	0.44	0.07	77.9	42	41	17
PL1-1-px-Z14-r2c	PL1	cpx	rim	main	50.56	0.59	3.21	10.66	0.38	14.56	20.33	0.24	100.5	73	0.41	0.06	77.7	42	41	17
PL1-1-px-Z14-r2c	PL1	cpx	rim	main	50.23	0.61	3.62	10.59	0.39	14.46	20.27	0.25	100.4	73	0.42	0.07	78.0	42	41	17
PL1-1-px-Z14-r2c	PL1	cpx	rim	main	50.43	0.64	3.47	10.58	0.42	14.44	20.21	0.24	100.4	73	0.47	0.06	77.0	42	41	17
PL1-1-px-Z14-r2c	PL1	cpx	rim	main	50.58	0.58	3.32	10.56	0.39	14.51	20.26	0.25	100.5	73	0.42	0.06	77.3	42	41	17
PL1-1-px-Z14-r2c	PL1	cpx	core	main	51	0.44	2.74	10.43	0.42	14.25	20.94	0.27	100.5	73	0.32	0.04	77.4	43	41	17
PL1-1-px-Z14-r2c	PL1	cpx	rim	main	49.85	0.63	4.1	10.28	0.34	14.18	20.84	0.23	100.5	73	0.42	0.08	78.9	43	41	17
PL1-1-px-Z14-r2c	PL1	cpx	rim	main	49.6	0.67	4.25	10.18	0.31	14.07	20.96	0.24	100.3	73	0.43	0.08	79.4	43	40	16
PL1-1-px-Z14-r2c	PL1	cpx	rim	main	49.8	0.65	4.2	10.2	0.3	14.11	20.72	0.25	100.2	73	0.44	0.07	78.4	43	41	16
PL1-1-px-Z14-r2c	PL1	cpx	core	main	50.81	0.53	3.04	10.54	0.42	14.55	20.35	0.23	100.5	73	0.39	0.05	77.1	42	41	17
PL1-1-px-Z14-r2c	PL1	cpx	rim	main	50.16	0.64	3.94	10.35	0.36	14.34	20.46	0.24	100.5	73	0.45	0.07	77.9	42	41	17
PL1-1-px-Z14-r2c	PL1	cpx	rim	main	49.95	0.63	3.82	10.37	0.35	14.45	20.51	0.24	100.3	73	0.41	0.08	79.2	42	41	17
PL1-1-px-Z14-r2c	PL1	cpx	rim	main	50.8	0.54	3.04	10.46	0.41	14.48	20.58	0.24	100.6	73	0.39	0.05	77.5	42	41	17
PL1-1-px-Z14-r2c	PL1	cpx	core	main	50.89	0.51	2.92	10.38	0.43	14.42	20.5	0.24	100.3	73	0.38	0.05	76.8	42	41	17
PL1-1-px-Z14-r2c	PL1	cpx	rim	main	49.46	0.61	4.52	10.13	0.3	14.04	21.11	0.23	100.4	73	0.38	0.08	80.1	43	40	16
PL1-1-px-Z14-r2c	PL1	cpx	rim	main	48.96	0.65	4.8	9.86	0.26	13.78	21.44	0.22	100	73	0.38	0.09	80.9	44	40	16
PL1-1-px-Z14-r2c	PL1	cpx	rim	main	50.71	0.57	3.37	10.45	0.39	14.59	20.38	0.23	100.7	73	0.41	0.06	77.5	42	42	17
PL1-1-px-Z14-r2c	PL1	cpx	rim	main	49.6	0.63	4.07	10.23	0.32	14.26	20.83	0.24	100.2	73	0.39	0.08	80.1	43	41	16
PL1-1-px-Z14-r2c	PL1	cpx	rim	main	49.99	0.65	4.03	10.26	0.34	14.34	20.69	0.21	100.5	73	0.44	0.07	78.6	43	41	16
PL1-1-px-Z14-r2c	PL1	cpx	rim	main	49.27	0.63	4.51	10.01	0.28	14.01	21.22	0.2	100.1	74	0.39	0.08	80.4	44	40	16
PL1-1-px-Z14-r2c	PL1	cpx	core	main	51.61	0.44	2.33	10.32	0.42	14.51	20.53	0.24	100.4	74	0.36	0.03	75.5	42	41	17
PL1-1-px-Z14-r2c	PL1	cpx	rim	main	49.11	0.69	4.79	9.94	0.26	13.94	21.3	0.2	100.2	74	0.42	0.09	80.6	44	40	16
PL1-1-px-Z14-r2c	PL1	cpx	rim	main	49.4	0.61	4.39	9.99	0.3	14.07	21.08	0.21	100.1	74	0.38	0.08	80.1	44	40	16
PL1-1-px-Z14-r2c	PL1	cpx	core	main	51.07	0.47	2.55	10.27	0.41	14.51	20.61	0.25	100.1	74	0.35	0.04	77.3	42	41	16

SAMPLE GRAIN ID	Sample	Min	Texture	stage	SiO2	TiO2	Al2O3	FeO*	MnO	MgO	CaO	Na2O	Total	Mg #	FeO	Fe2O3	Mg # (Fe2+ only)	Wo	En	Fs
PL1-1-px-Z14-r2c	PL1	cpx	core	main	51.22	0.46	2.32	10.28	0.42	14.52	20.77	0.24	100.2	74	0.34	0.04	77.3	42	41	16
PL1-1-px-Z14-r2c	PL1	cpx	rim	main	49.1	0.63	4.7	9.93	0.3	14.01	21.36	0.21	100.2	74	0.36	0.09	81.6	44	40	16
PL1-1-px-Z14-r2c	PL1	cpx	rim	main	50.22	0.54	3.64	10.02	0.34	14.19	21.21	0.24	100.4	74	0.36	0.06	79.4	43	40	16
PL1-1-px-Z14-r2c	PL1	cpx	core	main	50.97	0.47	2.68	10.22	0.43	14.47	20.67	0.25	100.2	74	0.35	0.04	77.6	42	41	16
PL1-1-px-Z14-r2c	PL1	cpx	rim	main	49	0.68	4.79	9.84	0.28	13.91	21.28	0.21	100	74	0.41	0.09	80.9	44	40	16
PL1-1-px-Z14-r2c	PL1	cpx	rim	main	49.64	0.64	4.33	9.94	0.3	14.07	21.02	0.21	100.2	74	0.43	0.07	79.1	43	40	16
PL1-1-px-Z14-r2c	PL1	cpx	rim	main	49.68	0.62	4.32	10.08	0.3	14.26	21.09	0.21	100.6	74	0.39	0.08	80.3	43	41	16
PL1-1-px-Z14-r2c	PL1	cpx	rim	main	49.29	0.64	4.46	9.89	0.27	14.1	21.26	0.22	100.1	74	0.38	0.09	81.2	44	40	16
PL1-1-px-Z14-r2c	PL1	cpx	rim	main	49.34	0.63	4.63	9.96	0.27	14.18	21.28	0.23	100.5	74	0.36	0.09	81.7	44	40	16
PL1-1-px-Z14-r2c	PL1	cpx	rim	main	49.64	0.62	4.32	9.99	0.28	14.14	21.23	0.22	100.4	74	0.39	0.08	80.3	44	40	16
PL1-1-px-Z14-r2c	PL1	cpx	rim	main	49.11	0.68	4.7	9.83	0.28	14.03	21.12	0.21	100	74	0.42	0.09	80.7	44	40	16
PL1-1-px-Z14-r2c	PL1	cpx	rim	main	49.28	0.61	4.7	9.73	0.27	13.98	21.48	0.22	100.3	74	0.36	0.08	81.3	44	40	16
PL1-1-px-Z14-r2c	PL1	cpx	core	main	51.48	0.48	2.42	10.18	0.42	14.62	20.81	0.24	100.7	74	0.36	0.04	77.2	42	41	16
PL1-1-px-Z14-r2c	PL1	cpx	rim	main	49.58	0.59	4.21	9.79	0.28	14.12	21.18	0.23	100	74	0.37	0.07	80.4	44	41	16
PL1-1-px-Z14-r2c	PL1	cpx	rim	main	49.31	0.69	4.76	9.68	0.28	13.96	21.3	0.21	100.2	74	0.44	0.08	80.2	44	40	16
PL1-1-px-Z14-r2c	PL1	cpx	rim	main	49.68	0.61	4.32	9.83	0.32	14.25	21.04	0.23	100.3	74	0.39	0.08	80.4	43	41	16
PL1-1-px-Z14-r2c	PL1	cpx	rim	main	49.76	0.64	4.3	9.86	0.29	14.26	21.19	0.2	100.5	74	0.41	0.08	80.2	43	41	16
PL1-1-px-Z14-r2c	PL1	cpx	rim	main	49.21	0.57	4.77	9.68	0.26	13.96	21.32	0.22	100	74	0.35	0.07	81.0	44	40	16
PL1-1-px-Z14-r2c	PL1	cpx	rim	main	49.41	0.63	4.72	9.67	0.27	14.02	21.46	0.22	100.4	74	0.38	0.08	81.0	44	40	16
PL1-1-px12	PL1	cpx	pheno	main	51.28	0.43	2.41	11.14	0.47	14.22	20.61	0.33	100.9	72	0.31	0.05	76.2	42	40	18
PL1-1-px12	PL1	cpx	pheno	main	49.07	0.74	4.3	10.86	0.38	13.91	20.37	0.26	99.9	72	0.47	0.10	78.4	42	40	18
PL1-1-px12	PL1	cpx	pheno	main	51.4	0.37	1.94	10.93	0.49	14.24	20.99	0.31	100.7	72	0.26	0.04	77.1	43	40	17
PL1-1-px12	PL1	cpx	pheno	main	49.06	0.66	4.59	10.39	0.33	14.21	20.78	0.24	100.3	73	0.37	0.10	81.3	43	41	17
PL1-1-px6	PL1	cpx	pheno	main	52.48	0.33	1.71	10.85	0.52	14.57	20.75	0.3	101.5	73	0.26	0.03	75.3	42	41	17
PL1-1-px6	PL1	cpx	pheno	main	52.55	0.36	1.8	10.72	0.48	14.52	20.7	0.28	101.4	73	0.30	0.02	74.3	42	41	17

SAMPLE GRAIN ID	Sample	Min	Texture	stage	SiO2	TiO2	Al2O3	FeO*	MnO	MgO	CaO	Na2O	Total	Mg #	FeO	Fe2O3	Mg # (Fe2+ only)	Wo	En	Fs
PL1-1-px6	PL1	cpx	pheno	main	52.76	0.36	1.64	10.59	0.5	14.49	20.83	0.3	101.5	73	0.31	0.02	74.2	42	41	17
PL1-1-px6	PL1	cpx	pheno	main	52.54	0.36	1.86	10.59	0.5	14.55	20.94	0.28	101.6	73	0.29	0.02	75.2	42	41	17
PL1-1-px6	PL1	cpx	pheno	main	53.03	0.31	1.55	10.41	0.45	16.11	19.36	0.16	101.4	75	0.27	0.02	76.3	39	45	16
PL1-1-px6	PL1	cpx	pheno	main	52.83	0.28	1.81	9.77	0.44	15.32	20.83	0.2	101.5	76	0.23	0.02	77.3	42	43	15
PL1-1-pxz19	PL1	cpx	pheno	main	49.46	0.55	4.03	10.08	0.34	14.32	21.06	0.22	100.1	74	0.32	0.08	81.6	43	41	16
PL1-1-z-px4-point	PL1	cpx	glom	main	50.48	0.54	2.84	11.34	0.5	14	20.52	0.29	100.5	71	0.37	0.07	76.4	42	40	18
PL1-1-z-px4-point	PL1	cpx	glom	main	49.02	0.64	4.57	9.98	0.3	14.1	21.4	0.23	100.2	74	0.34	0.10	82.7	44	40	16
PL1-1-z-px4-point	PL1	cpx	glom	main	52.32	0.27	1.59	10.7	0.49	16.36	18.89	0.16	100.8	75	0.21	0.02	78.1	38	46	17
PL1-site1-px10	PL1	cpx	microlite	main	51.09	0.41	2.04	10.31	0.44	14.83	20.3	1.63	101.1	74	0.05	0.13	95.6	41	42	16
PL1-site1-px8	PL1	cpx	microlite	main	51.23	0.37	1.59	10.06	0.48	14.73	20.27	1.38	100.1	74	0.10	0.10	91.1	42	42	16
KELUD1990-2PX1-c-only	PL2	cpx	pheno	late	48	0.77	4.71	9.68	0.36	13.4	21.32	0.32	98.6	71	0.40	0.13	82.6	45	39	16
KELUD1990-2PX1-c-only	PL2	cpx	pheno	late	50.1	0.41	2.24	9.24	0.39	14.4	21.2	0.29	98.3	74	0.25	0.05	81.9	44	41	15
KELUD1990-2PX1-c-only	PL2	cpx	pheno	late	50.42	0.45	2.42	9.33	0.39	14.62	20.76	0.26	98.6	74	0.31	0.05	80.3	43	42	15
KELUD1990-2PX2-c-only	PL2	cpx	pheno	late	51.19	0.38	2.1	9.37	0.46	14.23	21	0.33	99.1	73	0.30	0.03	77.8	44	41	15
KELUD1990-2PX3-c-only	PL2	cpx	glom	late	51.41	0.35	1.7	9.7	0.41	14.86	20.79	0.29	99.5	73	0.25	0.03	79.4	42	42	15
KELUD1990-2PX3-c-only	PL2	cpx	glom	late	51	0.42	2.23	9.36	0.41	14.55	21.23	0.26	99.5	73	0.30	0.04	79.8	44	42	15
KELUD1990-2PX5-c-only	PL2	cpx	glom	late	51.8	0.3	1.67	9.17	0.44	14.64	21.17	0.28	99.5	74	0.24	0.02	78.3	43	42	15
KELUD1990-2PX6b-c-only	PL2	cpx	pheno	late	50	0.49	3.89	9.52	0.37	13.45	20.75	0.27	98.7	72	0.41	0.03	74.9	44	40	16
KELUD1990-2PX6b-c-only	PL2	cpx	pheno	late	50.61	0.48	3.67	9.68	0.36	13.81	20.97	0.27	99.9	72	0.39	0.03	75.9	44	40	16
KELUD1990-2PX6b-c-only	PL2	cpx	pheno	late	51.56	0.34	1.79	9.42	0.44	14.39	20.78	0.28	99	73	0.29	0.02	76.4	43	42	15
KELUD1990-2PX6b-c-only	PL2	cpx	pheno	late	51.67	0.39	1.92	9.4	0.41	14.76	20.82	0.28	99.7	74	0.31	0.03	78.0	43	42	15
KELUD1990-glom1-c-only	PL2	cpx	glom	late	51.42	0.47	1.8	10.57	0.5	13.56	21.05	0.29	99.7	70	0.40	0.03	73.1	44	39	17
KELUD1990-glom1-c-only	PL2	cpx	glom	late	51.72	0.37	1.97	9.63	0.45	14.41	20.94	0.31	99.8	73	0.30	0.02	76.8	43	41	15

SAMPLE GRAIN ID	Sample	Min	Texture	stage	SiO2	TiO2	Al2O3	FeO*	MnO	MgO	CaO	Na2O	Total	Mg #	FeO	Fe2O3	Mg # (Fe2+ only)	Wo	En	Fs
KELUD1990-glom1-c-only	PL2	cpx	glom	late	51.6	0.51	2.23	9.36	0.42	15.14	20.69	0.25	100.2	74	0.39	0.04	79.3	42	43	15
KELUD1990-glom1-c-only	PL2	cpx	glom	late	52.15	0.25	1.76	8.69	0.44	14.59	21.66	0.28	99.8	75	0.20	0.01	78.7	44	42	14
KELUD1990-glom1-c-only	PL2	cpx	glom	late	53.09	0.2	1.17	9.1	0.5	15.41	20.39	0.22	100.1	75	0.19	0.00	76.3	42	44	15
KELUD1990-glom1-c-only	PL2	cpx	glom	late	53.15	0.17	1.3	8.43	0.5	14.86	22.17	0.27	100.9	76	0.14	0.01	79.0	45	42	13
KELUD1990-glom1-c-only	PL2	cpx	glom	late	52.81	0.21	1.12	8.4	0.47	14.8	22.09	0.27	100.2	76	0.17	0.01	79.3	45	42	13
KELUD1990-glom1-c-only	PL2	cpx	glom	late	52.07	0.3	1.66	8.43	0.39	15.11	21.72	0.25	99.9	76	0.22	0.02	81.3	44	43	13
KELUD1990-glom10-c-only	PL2	cpx	glom	late	50.67	0.38	1.75	9.24	0.4	14.3	21.3	0.3	98.3	73	0.26	0.04	80.1	44	41	15
KELUD1990-glom10-c-only	PL2	cpx	glom	late	50.66	0.42	2.21	8.99	0.4	14.25	21.2	0.27	98.4	74	0.31	0.03	79.1	44	41	15
KELUD1990-glom10-rerun-c-only	PL2	cpx	glom	late	51.46	0.29	1.55	11.11	0.47	14.22	19.86	0.26	99.2	72	0.24	0.02	73.2	41	41	18
KELUD1990-glom10-rerun-c-only	PL2	cpx	glom	late	50.18	0.47	2.63	10.5	0.4	13.94	20.17	0.27	98.6	72	0.36	0.04	75.5	42	41	17
KELUD1990-glom10-rerun-c-only	PL2	cpx	glom	late	51.75	0.34	1.57	10.06	0.44	14.46	20.41	0.27	99.3	74	0.29	0.02	75.1	42	42	16
KELUD1990-glom10-rerun-c-only	PL2	cpx	glom	late	51.57	0.29	1.45	9.87	0.39	14.6	20.72	0.27	99.2	75	0.23	0.02	77.2	43	42	16
KELUD1990-glom10-rerun-c-only	PL2	cpx	glom	late	51.94	0.28	1.4	9.79	0.42	14.74	20.63	0.25	99.5	75	0.23	0.02	76.6	42	42	16
KELUD1990-glom12-c-only	PL2	cpx	glom	late	51.36	0.35	1.78	10.08	0.48	13.89	21.07	0.29	99.3	71	0.28	0.02	75.3	44	40	16
KELUD1990-glom12-c-only	PL2	cpx	glom	late	51.25	0.42	1.75	9.85	0.43	13.95	21.26	0.33	99.2	72	0.32	0.03	76.7	44	40	16
KELUD1990-glom12-c-only	PL2	cpx	glom	late	51.36	0.34	1.82	9.83	0.45	14.09	21.21	0.31	99.4	72	0.26	0.03	77.0	44	40	16
KELUD1990-glom12-c-only	PL2	cpx	glom	late	50.83	0.4	1.95	9.62	0.44	14.05	21.09	0.3	98.7	72	0.30	0.03	77.7	44	41	16
KELUD1990-glom12-c-only	PL2	cpx	glom	late	50.41	0.37	1.92	9.58	0.44	14.15	21.15	0.29	98.3	72	0.25	0.04	79.6	44	41	15
KELUD1990-glom12-c-only	PL2	cpx	glom	late	51.68	0.38	1.9	9.67	0.43	14.32	21.18	0.3	99.9	73	0.30	0.03	77.0	44	41	16
KELUD1990-glom12-c-only	PL2	cpx	glom	late	51.69	0.4	1.92	9.63	0.42	14.31	21.19	0.3	99.9	73	0.32	0.03	76.9	44	41	15
KELUD1990-glom12-c-only	PL2	cpx	glom	late	51.76	0.36	1.86	9.71	0.42	14.44	20.94	0.28	99.8	73	0.29	0.02	76.5	43	41	16

SAMPLE GRAIN ID	Sample	Min	Texture	stage	SiO2	TiO2	Al2O3	FeO*	MnO	MgO	CaO	Na2O	Total	Mg #	FeO	Fe2O3	Mg # (Fe2+ only)	Wo	En	Fs
KELUD1990-glom12-c-only	PL2	cpx	glom	late	51.53	0.36	1.8	9.46	0.45	14.35	21.08	0.3	99.3	73	0.29	0.02	77.4	44	41	15
KELUD1990-glom12-c-only	PL2	cpx	glom	late	51.82	0.35	1.72	9.53	0.45	14.51	21.06	0.28	99.7	73	0.28	0.02	77.2	43	41	15
KELUD1990-glom12-c-only	PL2	cpx	glom	late	51.17	0.37	1.84	9.43	0.41	14.62	21.17	0.31	99.3	73	0.25	0.04	80.1	43	42	15
KELUD1990-glom12-c-only	PL2	cpx	glom	late	51.5	0.21	1.59	8.86	0.42	14.56	21.78	0.28	99.2	75	0.15	0.02	80.8	44	41	14
KELUD1990-glom12-c-only	PL2	cpx	glom	late	52.01	0.29	1.59	8.76	0.46	14.55	21.68	0.28	99.6	75	0.23	0.02	78.9	44	42	14
KELUD1990-glom12-c-only	PL2	cpx	glom	late	51.66	0.31	1.47	8.77	0.52	14.72	21.53	0.3	99.3	75	0.22	0.03	80.7	44	42	14
KELUD1990-glom12-c-only	PL2	cpx	glom	late	51.76	0.22	1.5	8.45	0.47	14.38	22.28	0.28	99.3	75	0.16	0.02	80.7	46	41	13
KELUD1990-glom12-c-only	PL2	cpx	glom	late	51.94	0.13	1.22	8.2	0.48	14.29	22.57	0.29	99.1	76	0.10	0.01	81.0	46	41	13
KELUD1990-glom12-c-only	PL2	cpx	glom	late	51.19	0.43	1.78	8.14	0.44	14.63	21.86	0.26	98.7	76	0.31	0.03	81.7	45	42	13
KELUD1990-glom12-c-only	PL2	cpx	glom	late	52.21	0.32	1.21	8.24	0.59	15.17	21.26	0.32	99.3	77	0.25	0.02	81.0	44	43	13
KELUD1990-glom12-c-only	PL2	cpx	glom	late	51.46	0.33	1.87	9.54	0.42	14.49	20.8	0.28	99.2	73	0.26	0.02	77.3	43	42	15
KELUD1990-glom12-core-only	PL2	cpx	glom	late	52.13	0.34	2.06	9.44	0.41	14.74	20.63	0.27	100	74	0.30	0.01	76.1	43	42	15
KELUD1990-glom2-c-only	PL2	cpx	glom	late	49.42	0.36	2.88	11.81	0.79	10.59	22.91	0.46	99.2	62	0.25	0.05	69.7	49	31	20
KELUD1990-glom2-c-only	PL2	cpx	glom	late	49.57	0.46	2.84	11.9	0.7	10.9	22.55	0.46	99.4	62	0.33	0.05	69.6	48	32	20
KELUD1990-glom2-c-only	PL2	cpx	glom	late	49.43	0.4	2.79	11.85	0.74	10.86	22.56	0.46	99.1	62	0.28	0.05	70.1	48	32	20
KELUD1990-glom2-c-only	PL2	cpx	glom	late	49.7	0.48	2.82	11.67	0.71	10.95	22.58	0.45	99.4	63	0.35	0.05	69.5	48	32	19
KELUD1990-glom2-c-only	PL2	cpx	glom	late	49.53	0.39	2.52	11.33	0.75	11.17	22.77	0.44	98.9	64	0.27	0.05	72.2	48	33	19
KELUD1990-glom2-c-only	PL2	cpx	glom	late	50.92	0.39	2.9	11.27	0.75	11.16	22.74	0.45	100.6	64	0.32	0.03	68.1	48	33	19
KELUD1990-glom2-c-only	PL2	cpx	glom	late	51.15	0.17	1.24	11.4	0.96	11.45	22.83	0.31	99.5	64	0.14	0.01	68.9	48	33	19
KELUD1990-glom2-c-only	PL2	cpx	glom	late	50.75	0.19	1.26	11.38	0.93	11.47	22.92	0.32	99.2	64	0.14	0.02	70.4	48	33	19
KELUD1990-glom2-c-only	PL2	cpx	glom	late	50.57	0.2	1.29	11.22	0.93	11.42	22.84	0.32	98.8	64	0.15	0.02	70.4	48	33	18

SAMPLE GRAIN ID	Sample	Min	Texture	stage	SiO2	TiO2	Al2O3	FeO*	MnO	MgO	CaO	Na2O	Total	Mg #	FeO	Fe2O3	Mg # (Fe2+ only)	Wo	En	Fs
KELUD1990-glom2-c-only	PL2	cpx	glom	late	50.83	0.18	1.24	11.19	0.97	11.44	22.82	0.34	99	65	0.14	0.02	70.1	48	34	18
KELUD1990-glom2-c-only	PL2	cpx	glom	late	50.75	0.21	1.3	11.22	0.92	11.5	22.92	0.33	99.1	65	0.16	0.02	70.7	48	34	18
KELUD1990-glom2-c-only	PL2	cpx	glom	late	51	0.21	1.34	11.24	0.85	11.75	22.91	0.34	99.6	65	0.16	0.02	71.4	48	34	18
KELUD1990-glom2-c-only	PL2	cpx	glom	late	50.98	0.21	1.32	11.12	0.87	11.67	22.9	0.34	99.4	65	0.16	0.02	71.0	48	34	18
KELUD1990-glom2-c-only	PL2	cpx	glom	late	50.99	0.16	1.17	10.96	0.92	11.58	23.03	0.33	99.1	65	0.12	0.01	70.9	48	34	18
KELUD1990-glom2-c-only	PL2	cpx	glom	late	50.45	0.18	1.33	10.98	0.86	11.69	22.96	0.35	98.8	65	0.13	0.02	73.0	48	34	18
KELUD1990-glom2-c-only	PL2	cpx	glom	late	50.74	0.28	2.37	10.39	0.71	11.16	22.43	0.43	98.5	66	0.26	0.01	67.5	49	34	18
KELUD1990-glom2-c-only	PL2	cpx	glom	late	51.19	0.16	1.09	10.79	0.89	11.79	22.94	0.34	99.2	66	0.13	0.01	71.4	48	34	18
KELUD1990-glom2-c-only	PL2	cpx	glom	late	51.23	0.17	1.1	10.85	0.91	11.85	23.04	0.33	99.5	66	0.13	0.02	71.8	48	34	18
KELUD1990-glom2-c-only	PL2	cpx	glom	late	51.19	0.17	1.14	10.71	0.82	12	23.02	0.32	99.4	67	0.13	0.02	72.5	48	35	17
KELUD1990-glom2-c-only	PL2	cpx	glom	late	51.31	0.17	1.1	10.64	0.86	12.01	23.22	0.32	99.6	67	0.13	0.02	72.9	48	35	17
KELUD1990-glom2-c-only	PL2	cpx	glom	late	51.3	0.18	1.11	10.35	0.88	12.07	23.26	0.32	99.5	68	0.14	0.02	73.4	48	35	17
KELUD1990-glom2-c-only	PL2	cpx	glom	late	49.9	0.37	2.49	10.36	0.6	12.3	22.69	0.41	99.1	68	0.23	0.05	77.2	47	36	17
KELUD1990-glom2-c-only	PL2	cpx	glom	late	51.28	0.15	1.06	10.19	0.84	12.34	23.11	0.31	99.3	68	0.11	0.01	74.5	48	36	16
KELUD1990-glom2-c-only	PL2	cpx	glom	late	46.97	0.78	6	8.72	0.24	13.01	22.7	0.21	98.6	73	0.31	0.15	87.2	48	38	14
KELUD1990-glom2-c-only	PL2	cpx	glom	late	47.95	0.57	5.89	8.64	0.22	13.13	22.46	0.24	99.1	73	0.29	0.09	84.4	47	38	14
KELUD1990-glom2-c-only	PL2	cpx	glom	late	47.94	0.6	5.96	8.28	0.2	13.08	23.06	0.23	99.3	74	0.27	0.09	86.2	48	38	14
KELUD1990-glom2-c-only	PL2	cpx	glom	late	47.68	0.65	5.57	8.37	0.22	13.3	23.06	0.21	99.1	74	0.25	0.12	88.2	48	38	14
KELUD1990-glom2-c-only	PL2	cpx	glom	late	49.14	0.5	5.04	8.32	0.23	13.31	23.15	0.24	99.9	74	0.27	0.07	84.1	48	38	13
KELUD1990-glom2-c-only	PL2	cpx	glom	late	47.86	0.65	5.48	8.39	0.21	13.47	22.58	0.21	98.9	74	0.29	0.11	86.7	47	39	14
KELUD1990-glom2-c-only	PL2	cpx	glom	late	48.78	0.58	4.61	7.76	0.21	14.13	22.79	0.21	99.1	76	0.25	0.09	88.4	47	41	12

SAMPLE GRAIN ID	Sample	Min	Texture	stage	SiO2	TiO2	Al2O3	FeO*	MnO	MgO	CaO	Na2O	Total	Mg #	FeO	Fe2O3	Mg # (Fe2+ only)	Wo	En	Fs
KELUD1990-glom2-points	PL2	cpx	glom	late	52.07	0.23	1.03	11.13	0.67	13.65	20.69	0.26	99.7	69	0.20	0.01	71.5	43	39	18
KELUD1990-glom2-points	PL2	cpx	glom	late	52.04	0.26	0.92	11.29	0.7	13.99	20.15	0.29	99.6	69	0.22	0.01	72.2	42	40	18
KELUD1990-glom2-points	PL2	cpx	glom	late	52.02	0.31	1.33	10.52	0.57	14.11	20.24	0.25	99.4	71	0.28	0.01	72.3	42	41	17
KELUD1990-glom2-points	PL2	cpx	glom	late	51.7	0.31	1.98	10.01	0.52	14.05	20.92	0.26	99.7	71	0.26	0.02	74.7	43	40	16
KELUD1990-glom2-points	PL2	cpx	glom	late	52.22	0.26	2.23	7.62	0.31	15.61	21.67	0.17	100.1	79	0.20	0.01	82.3	44	44	12
KELUD1990-glom2-points	PL2	cpx	glom	late	51.89	0.25	2.26	7.41	0.27	15.56	21.77	0.18	99.6	79	0.19	0.02	83.4	44	44	12
KELUD1990-glom2-points	PL2	cpx	glom	late	52.01	0.23	2.4	7.3	0.26	15.6	21.8	0.19	99.8	79	0.17	0.01	83.5	44	44	12
KELUD1990-glom2-points	PL2	cpx	glom	late	52.08	0.24	2.48	7.21	0.27	15.54	22.26	0.19	100.3	79	0.17	0.02	84.5	45	44	11
KELUD1990-glom3-c-only	PL2	cpx	glom	late	50.56	0.52	2.81	9.88	0.42	14.09	20.39	0.24	98.9	72	0.43	0.03	75.6	43	41	16
KELUD1990-glom3-c-only	PL2	cpx	glom	late	51.72	0.35	1.92	9.62	0.43	14.33	20.72	0.28	99.4	73	0.30	0.02	75.4	43	41	16
KELUD1990-glom3-c-only	PL2	cpx	glom	late	51.78	0.32	1.9	9.54	0.41	14.36	20.7	0.3	99.3	73	0.28	0.01	75.6	43	42	15
KELUD1990-glom3-c-only	PL2	cpx	glom	late	51.66	0.37	2.04	9.5	0.42	14.47	20.82	0.3	99.6	73	0.30	0.02	76.8	43	42	15
KELUD1990-glom3-c-only	PL2	cpx	glom	late	52.1	0.32	1.83	9.24	0.4	14.44	21.25	0.31	99.9	74	0.27	0.02	76.8	44	41	15
KELUD1990-glom4-c-only	PL2	cpx	glom	late	50.93	0.46	2.37	9.66	0.39	14.08	20.96	0.29	99.2	72	0.36	0.03	76.8	44	41	16
KELUD1990-glom4-c-only	PL2	cpx	glom	late	51.67	0.4	2.07	9.61	0.41	14.25	21.06	0.3	99.8	73	0.33	0.02	76.2	44	41	16
KELUD1990-glom4-c-only	PL2	cpx	glom	late	51.71	0.43	2.15	9.48	0.42	14.33	20.93	0.28	99.7	73	0.37	0.02	75.9	43	41	15
KELUD1990-glom4-c-only	PL2	cpx	glom	late	51.47	0.37	1.97	9.32	0.43	14.52	21.02	0.26	99.4	74	0.29	0.02	77.8	43	42	15
KELUD1990-glom4-c-only	PL2	cpx	glom	late	51.72	0.37	1.95	9.26	0.43	14.59	21.23	0.27	99.8	74	0.29	0.03	78.2	44	42	15
KELUD1990-glom4-c-only	PL2	cpx	glom	late	51.98	0.34	1.84	9.18	0.38	14.54	21.2	0.28	99.8	74	0.29	0.02	77.2	44	42	15
KELUD1990-glom5-c-only	PL2	cpx	pseudo	late	50.03	0.61	2.56	9.79	0.42	13.7	20.8	0.29	98.2	71	0.47	0.05	76.5	44	40	16
KELUD1990-glom5-c-only	PL2	cpx	pseudo	late	51.51	0.48	1.57	9.7	0.47	14.66	20.73	0.26	99.4	73	0.38	0.03	77.4	43	42	16

SAMPLE GRAIN ID	Sample	Min	Texture	stage	SiO2	TiO2	Al2O3	FeO*	MnO	MgO	CaO	Na2O	Total	Mg #	FeO	Fe2O3	Mg # (Fe2+ only)	Wo	En	Fs
KELUD1990-glom5-c-only	PL2	cpx	pseudo	late	50.49	0.45	2.4	8.94	0.38	14.51	21.25	0.26	98.7	74	0.31	0.04	81.0	44	42	14
KELUD1990-glom5-rerun-c-only	PL2	cpx	pseudo	late	50.08	0.64	2.5	11.92	0.48	13.59	20.15	0.3	99.6	69	0.46	0.08	74.0	42	39	19
KELUD1990-glom5-rerun-c-only	PL2	cpx	glom	late	49.99	0.61	2.51	11.68	0.47	13.63	19.96	0.32	99.2	70	0.44	0.07	74.2	42	39	19
KELUD1990-glom5-rerun-c-only	PL2	cpx	pseudo	late	50.48	0.36	1.86	11.4	0.5	13.97	19.96	0.3	98.8	71	0.26	0.04	75.1	41	40	18
KELUD1990-glom5-rerun-c-only	PL2	cpx	pseudo	late	50.37	0.58	2.41	11.23	0.43	14.13	20.21	0.31	99.7	71	0.40	0.07	76.4	42	40	18
KELUD1990-glom5-rerun-c-only	PL2	cpx	pseudo	late	49.77	0.81	3.06	10.82	0.41	13.73	20.28	0.31	99.2	72	0.59	0.08	75.6	42	40	18
KELUD1990-glom5-rerun-c-only	PL2	cpx	glom	late	49.86	0.79	2.99	10.85	0.42	13.78	19.92	0.31	98.9	72	0.61	0.07	74.6	42	40	18
KELUD1990-glom5-rerun-c-only	PL2	cpx	glom	late	50.37	0.49	2.18	10.97	0.42	13.96	19.76	0.3	98.5	72	0.39	0.04	74.3	41	41	18
KELUD1990-glom5-rerun-c-only	PL2	cpx	pseudo	late	50.25	0.6	2.35	10.97	0.44	13.97	20.04	0.3	98.9	72	0.45	0.06	75.3	42	40	18
KELUD1990-glom5-rerun-c-only	PL2	cpx	pseudo	late	50.22	0.55	5.5	9.92	0.38	12.66	19.89	0.45	99.6	72	0.56	-0.00	69.2	44	39	17
KELUD1990-glom5-rerun-c-only	PL2	cpx	glom	late	50.27	0.51	5.72	9.91	0.36	12.71	19.63	0.48	99.6	72	0.52	-0.00	69.0	44	39	17
KELUD1990-glom5-rerun-c-only	PL2	cpx	glom	late	51.51	0.42	1.91	11.07	0.45	14.36	19.65	0.33	99.7	72	0.35	0.03	73.6	41	41	18
KELUD1990-glom5-rerun-c-only	PL2	cpx	glom	late	50.59	0.5	2.16	10.94	0.44	14.2	19.62	0.31	98.8	72	0.39	0.04	74.7	41	41	18
KELUD1990-glom5-rerun-c-only	PL2	cpx	pseudo	late	51.07	0.43	1.88	10.92	0.44	14.37	20.13	0.27	99.5	72	0.33	0.04	75.5	41	41	18
KELUD1990-glom5-rerun-c-only	PL2	cpx	pseudo	late	50.87	0.41	2.1	10.95	0.43	14.45	20.12	0.27	99.6	72	0.30	0.04	76.4	41	41	18
KELUD1990-glom5-rerun-c-only	PL2	cpx	glom	late	51.02	0.37	2.06	10.69	0.42	14.4	19.95	0.3	99.2	73	0.29	0.03	75.7	41	41	17
KELUD1990-glom5-rerun-c-only	PL2	cpx	glom	late	51.48	0.42	1.73	10.73	0.42	14.47	19.83	0.29	99.4	73	0.35	0.03	74.3	41	42	17
KELUD1990-glom6-rerun-c-only	PL2	cpx	glom	late	51.6	0.39	1.87	11.02	0.45	14.34	20.04	0.3	100	72	0.32	0.03	74.1	41	41	18
KELUD1990-glom8-core-only	PL2	cpx	glom	late	50.37	0.43	2.57	9.34	0.38	14.15	21.03	0.31	98.6	73	0.31	0.04	79.3	44	41	15
KELUD1990-glom8-core-only	PL2	cpx	glom	late	50.78	0.37	1.88	9.4	0.42	14.42	21.06	0.29	98.6	73	0.26	0.04	79.6	43	41	15
KELUD1990-glom8-core-only	PL2	cpx	glom	late	50.21	0.48	2.36	9.19	0.4	14.25	21.14	0.31	98.3	73	0.32	0.05	80.6	44	41	15

SAMPLE GRAIN ID	Sample	Min	Texture	stage	SiO2	TiO2	Al2O3	FeO*	MnO	MgO	CaO	Na2O	Total	Mg #	FeO	Fe2O3	Mg # (Fe2+ only)	Wo	En	Fs
KELUD1990-glom8a-c-only	PL2	cpx	glom	late	50.91	0.37	2.4	10.08	0.52	13.89	21.42	0.3	99.9	71	0.26	0.04	77.8	44	40	16
KELUD1990-glom8a-c-only	PL2	cpx	glom	late	51.68	0.14	0.92	10.46	0.78	14.46	19.69	0.18	98.3	71	0.12	0.01	73.5	41	42	17
KELUD1990-glom8a-c-only	PL2	cpx	glom	late	49.83	0.47	2.38	9.56	0.46	14.22	20.85	0.29	98.1	73	0.30	0.06	80.6	43	41	16
KELUD1990-glom8a-c-only	PL2	cpx	glom	late	50.5	0.33	2.21	9.38	0.42	14.01	21.33	0.31	98.5	73	0.23	0.03	79.4	44	40	15
KELUD1990-glom8a-c-only	PL2	cpx	glom	late	50.27	0.35	2.21	9.29	0.41	14.03	21.45	0.31	98.3	73	0.23	0.04	80.5	44	40	15
KELUD1990-glom8a-c-only	PL2	cpx	glom	late	50.51	0.31	1.69	9.11	0.43	14.38	21.52	0.29	98.2	74	0.19	0.04	81.9	44	41	15
KELUD1990-glom8a-c-only	PL2	cpx	glom	late	50.56	0.35	1.73	9.19	0.42	14.9	21.08	0.28	98.5	74	0.21	0.05	82.9	43	42	15
KELUD1990-glom9-c-only	PL2	cpx	glom	late	50.5	0.38	1.84	9.51	0.46	14.22	21.19	0.27	98.4	73	0.26	0.04	79.6	44	41	15
KELUD1990-glom9-c-only	PL2	cpx	glom	late	50.88	0.36	1.7	9.16	0.41	14.53	21.05	0.3	98.4	74	0.26	0.03	80.0	43	42	15
KELUD1990-glom9-c-only	PL2	cpx	glom	late	51.15	0.32	1.66	8.78	0.38	14.83	21.4	0.26	98.8	75	0.22	0.03	81.5	44	42	14
KELUD1990-glom9-rerun-c-only	PL2	cpx	glom	late	51.5	0.32	1.71	10.64	0.46	14.26	19.79	0.3	99	73	0.28	0.02	73.4	41	41	17
KELUD1990-glom9-rerun-c-only	PL2	cpx	glom	late	51.84	0.31	1.54	10.71	0.46	14.79	19.71	0.27	99.6	73	0.26	0.02	74.8	41	42	17
KELUD1990-PL2-2-glom7-1	PL2	cpx	pheno	late	51.69	0.39	1.92	9.02	0.4	14.58	21	0.27	99.3	74	0.33	0.02	77.4	43	42	15
KELUD1990-PL2-2-glom7-2	PL2	cpx	pheno	late	51.17	0.42	2.19	9.37	0.4	14.2	21.06	0.27	99.1	73	0.34	0.03	76.9	44	41	15
KELUD1990-PL2-2-glom7-2	PL2	cpx	pheno	late	50.71	0.47	2.57	9.25	0.38	14.02	21.03	0.31	98.7	73	0.37	0.03	77.5	44	41	15
KELUD1990-PL2-2-glom7-3	PL2	cpx	pheno	late	51.23	0.4	2.15	9.42	0.4	14.32	21.2	0.29	99.4	73	0.31	0.03	78.1	44	41	15
KELUD1990-PL2-2-glom7-3	PL2	cpx	pheno	late	51.31	0.36	1.8	9.12	0.41	14.6	21.39	0.28	99.3	74	0.26	0.03	80.0	44	42	15
KELUD1990-PL2-2-glom7-4	PL2	cpx	pheno	late	51.23	0.36	2	9.38	0.43	14.5	21.07	0.29	99.3	73	0.27	0.03	78.9	43	42	15
KELUD1990-PL2-2-glom7-4	PL2	cpx	pheno	late	51.34	0.37	2.1	9.3	0.42	14.49	21.25	0.31	99.6	74	0.27	0.03	79.2	44	41	15
KELUD1990-PL2-2px4	PL2	cpx	overgrowth	late	51.2	0.34	1.76	9.64	0.42	14.21	21.11	0.31	99	72	0.26	0.03	77.7	44	41	16
KELUD1990-PL2-2px4	PL2	cpx	overgrowth	late	50.28	0.49	2.63	9.52	0.39	14.13	20.99	0.32	98.8	73	0.34	0.05	79.3	44	41	15

SAMPLE GRAIN ID	Sample	Min	Texture	stage	SiO2	TiO2	Al2O3	FeO*	MnO	MgO	CaO	Na2O	Total	Mg #	FeO	Fe2O3	Mg # (Fe2+ only)	Wo	En	Fs
KELUD1990-PL2-2px4	PL2	cpx	overgrowth	late	50.89	0.4	2.09	9.45	0.41	14.4	21.24	0.29	99.2	73	0.28	0.04	79.7	44	41	15
KELUD1990-PL2-2px4	PL2	cpx	overgrowth	late	51.24	0.36	1.7	9.16	0.44	14.62	20.97	0.27	98.8	74	0.27	0.03	79.0	43	42	15
KELUD1990-PL2-2px7	PL2	cpx	overgrowth	late	51.38	0.33	1.84	9.61	0.43	14.37	20.9	0.31	99.2	73	0.26	0.02	77.5	43	41	15
KELUD1990-PL2-2px7	PL2	cpx	overgrowth	late	51.62	0.35	1.74	9.36	0.42	14.65	20.98	0.3	99.4	74	0.27	0.03	78.4	43	42	15
KELUD1990-PL2-2px7	PL2	cpx	overgrowth	late	51.28	0.36	1.89	9.17	0.4	14.6	21.17	0.27	99.2	74	0.27	0.03	79.3	44	42	15
KELUD1990-PL2-glom1	PL2	cpx	glom	late	50.98	0.31	2.05	9.44	0.44	14.51	21.1	0.31	99.1	73	0.21	0.03	80.1	43	41	15
KELUD1990-PL2-glom1	PL2	cpx	glom	late	51.35	0.35	1.93	9.35	0.41	14.59	21.06	0.28	99.3	74	0.26	0.03	78.8	43	42	15
KELUD1990-PL2-glom1	PL2	cpx	glom	late	50.61	0.66	2.72	8.99	0.43	14.51	20.8	0.29	99	74	0.50	0.05	79.2	43	42	15
KELUD1990-PL2-glom1	PL2	cpx	glom	late	51.2	0.48	2.32	8.54	0.38	14.71	21.02	0.29	98.9	75	0.38	0.03	79.5	44	43	14
KELUD1990-PL2-glom1	PL2	cpx	glom	late	52.24	0.26	1.71	8.66	0.4	15.03	21.52	0.28	100.1	76	0.20	0.02	80.2	44	43	14
KELUD1990-PL2-glom1	PL2	cpx	glom	late	51.8	0.3	1.77	8.43	0.42	14.75	21.8	0.28	99.5	76	0.22	0.02	80.8	45	42	13
KELUD1990-PL2-glom1	PL2	cpx	glom	late	51.65	0.22	1.62	8.6	0.43	15.04	21.43	0.29	99.3	76	0.15	0.02	82.0	44	43	14
KELUD1990-PL2-glom1	PL2	cpx	glom	late	52.03	0.31	1.75	8.41	0.42	14.75	21.55	0.29	99.5	76	0.25	0.02	79.5	44	42	13
KELUD1990-PL2-glom7new	PL2	cpx	glom	late	51.13	0.45	2.28	9.61	0.42	14.48	20.69	0.3	99.4	73	0.35	0.03	77.8	43	42	16
KELUD1990-PL2-px7	PL2	cpx	overgrowth	late	51.39	0.35	1.74	9.4	0.41	14.28	21.19	0.3	99.1	73	0.27	0.02	77.6	44	41	15
KELUD1990-PL2-z8-r2c	PL2	cpx	rim	late	52.2	0.23	0.81	12.58	0.64	13.74	19.33	0.3	99.8	68	0.21	0.01	68.4	40	40	20
KELUD1990-PL2-z8-r2c	PL2	cpx	rim	late	51.93	0.24	0.97	12.55	0.66	13.98	19.02	0.28	99.6	69	0.21	0.01	69.3	39	40	20
KELUD1990-PL2-z8-r2c	PL2	cpx	rim	late	52.22	0.23	0.68	12.13	0.67	13.81	19.81	0.29	99.8	69	0.20	0.01	69.9	41	40	20
KELUD1990-PL2-z8-r2c	PL2	cpx	rim	late	51.87	0.26	1.08	12.32	0.64	14.17	19.13	0.26	99.7	70	0.22	0.02	70.4	39	41	20
KELUD1990-PL2-z8-r2c	PL2	cpx	rim	late	51.93	0.27	1.02	12.19	0.65	14.05	19.22	0.29	99.6	70	0.24	0.01	70.2	40	40	20
KELUD1990-PL2-z8-r2c	PL2	cpx	rim	late	52.54	0.2	0.59	11.84	0.65	13.8	19.96	0.3	99.9	70	0.18	0.01	69.6	41	40	19

SAMPLE GRAIN ID	Sample	Min	Texture	stage	SiO2	TiO2	Al2O3	FeO*	MnO	MgO	CaO	Na2O	Total	Mg #	FeO	Fe2O3	Mg # (Fe2+ only)	Wo	En	Fs
KELUD1990-PL2-z8-r2c	PL2	cpx	rim	late	51.99	0.27	1.07	12.19	0.61	14.23	19.15	0.27	99.8	70	0.24	0.01	70.5	40	41	20
KELUD1990-PL2-z8-r2c	PL2	cpx	rim	late	52.53	0.17	0.63	11.79	0.66	13.85	19.76	0.33	99.7	70	0.16	0.01	69.7	41	40	19
KELUD1990-PL2-z8-r2c	PL2	cpx	rim	late	51.88	0.27	1.08	12.06	0.64	14.2	19.05	0.27	99.5	70	0.24	0.01	70.4	40	41	20
KELUD1990-PL2-z8-r2c	PL2	cpx	core	late	52.03	0.25	1.11	12.03	0.62	14.24	19.18	0.28	99.7	70	0.22	0.01	70.7	40	41	19
KELUD1990-PL2-z8-r2c	PL2	cpx	rim	late	51.87	0.27	1.07	11.99	0.62	14.25	19.21	0.27	99.6	70	0.23	0.02	71.1	40	41	19
KELUD1990-PL2-z8-r2c	PL2	cpx	rim	late	52.14	0.23	1.04	12	0.63	14.32	19.3	0.28	99.9	70	0.20	0.01	71.2	40	41	19
KELUD1990-PL2-z8-r2c	PL2	cpx	rim	late	52.06	0.27	1.03	11.86	0.64	14.19	19.25	0.27	99.6	70	0.24	0.01	70.5	40	41	19
KELUD1990-PL2-z8-r2c	PL2	cpx	rim	late	51.96	0.24	1.09	11.96	0.62	14.32	19.15	0.26	99.6	70	0.21	0.01	71.0	40	41	19
KELUD1990-PL2-z8-r2c	PL2	cpx	rim	late	52.2	0.28	0.99	11.85	0.66	14.22	19.3	0.26	99.8	70	0.25	0.01	70.3	40	41	19
KELUD1990-PL2-z8-r2c	PL2	cpx	rim	late	52.13	0.28	1.07	11.87	0.64	14.25	19.13	0.27	99.6	70	0.25	0.01	70.3	40	41	19
KELUD1990-PL2-z8-r2c	PL2	cpx	rim	late	52.14	0.26	1.1	11.92	0.64	14.33	19.14	0.28	99.8	70	0.23	0.01	70.8	40	41	19
KELUD1990-PL2-z8-r2c	PL2	cpx	rim	late	53.89	0.16	0.89	11.47	0.6	13.84	19.89	0.33	101.1	71	0.17	-0.00	66.7	41	40	19
KELUD1990-PL2-z8-r2c	PL2	cpx	rim	late	52.01	0.27	1.04	11.76	0.64	14.26	19.4	0.27	99.7	71	0.24	0.01	71.3	40	41	19
KELUD1990-PL2-z8-r2c	PL2	cpx	rim	late	52.14	0.29	1.03	11.71	0.66	14.22	19.3	0.3	99.6	71	0.26	0.01	70.8	40	41	19
KELUD1990-PL2-z8-r2c	PL2	cpx	core	late	52.16	0.27	1.15	11.66	0.6	14.4	19.07	0.25	99.6	71	0.25	0.01	70.5	40	42	19
KELUD1990-PL2-z8-r2c	PL2	cpx	core	late	51.85	0.31	1.44	11.46	0.51	14.38	19.49	0.26	99.7	71	0.27	0.02	72.1	40	41	18
KELUD1990-PL2-z8-r2c	PL2	cpx	core	late	51.86	0.35	1.84	10.96	0.44	14.68	19.47	0.31	99.9	73	0.30	0.02	73.8	40	42	18
KELUD1990-PL2-z8-r2c	PL2	cpx	core	late	51.75	0.35	1.84	10.87	0.45	14.59	19.58	0.29	99.7	73	0.30	0.02	73.7	40	42	18
KELUD1990-PL2-z8-r2c	PL2	cpx	core	late	51.78	0.29	1.67	10.9	0.46	14.69	19.54	0.28	99.6	73	0.24	0.02	74.1	40	42	18
KELUD1990-PL2-z8-r2c	PL2	cpx	core	late	51.9	0.32	1.54	10.88	0.5	14.67	19.55	0.26	99.6	73	0.28	0.02	73.5	40	42	18
KELUD1990-PL2-z8-r2c	PL2	cpx	core	late	51.8	0.35	1.78	10.86	0.43	14.69	19.59	0.3	99.8	73	0.29	0.02	74.2	40	42	17

SAMPLE GRAIN ID	Sample	Min	Texture	stage	SiO2	TiO2	Al2O3	FeO*	MnO	MgO	CaO	Na2O	Total	Mg #	FeO	Fe2O3	Mg # (Fe2+ only)	Wo	En	Fs
KELUD1990-PL2-z8-r2c	PL2	cpx	core	late	51.74	0.33	1.84	10.85	0.44	14.69	19.63	0.3	99.8	73	0.27	0.02	74.5	40	42	17
KELUD1990-PL2-z8-r2c	PL2	cpx	core	late	51.75	0.35	1.76	10.85	0.46	14.7	19.6	0.29	99.8	73	0.29	0.02	74.4	40	42	17
KELUD1990-PL2-z8-r2c	PL2	cpx	core	late	51.87	0.35	1.73	10.75	0.44	14.66	19.59	0.29	99.7	73	0.30	0.02	73.8	40	42	17
KELUD1990-PL2-z8-r2c	PL2	cpx	core	late	51.82	0.35	1.86	10.8	0.45	14.73	19.59	0.3	99.9	73	0.29	0.02	74.4	40	42	17
KELUD1990-PL2-z8-r2c	PL2	cpx	core	late	51.64	0.33	1.74	10.74	0.42	14.66	19.52	0.3	99.3	73	0.28	0.02	74.3	40	42	17
KELUD1990-PL2-z8-r2c	PL2	cpx	core	late	51.71	0.36	1.71	10.79	0.47	14.83	19.54	0.29	99.7	73	0.30	0.02	75.0	40	42	17
KELUD1990-PL2-z8-r2c	PL2	cpx	core	late	51.94	0.36	1.62	10.76	0.47	14.86	19.72	0.28	100	73	0.30	0.02	74.9	40	42	17
KELUD1990-PL2-z8-r2c	PL2	cpx	core	late	51.97	0.27	1.53	10.5	0.46	14.92	19.59	0.26	99.5	74	0.23	0.01	74.7	40	43	17
KELUD1990-PX1-c-only	PL2	cpx	pheno	late	51.32	0.31	2.08	9.54	0.49	14.16	21.09	0.3	99.3	73	0.24	0.02	77.2	44	41	15
KELUD1990-PX1-c-only	PL2	cpx	pheno	late	51.39	0.36	1.89	9.28	0.38	14.59	21.2	0.28	99.4	74	0.27	0.03	79.0	43	42	15
KELUD1990-PX1-c-only	PL2	cpx	pheno	late	51.36	0.4	2.31	9.18	0.35	14.63	20.93	0.29	99.5	74	0.31	0.03	78.5	43	42	15
KELUD1990-PX3-core-only	PL2	cpx	pheno	late	51.56	0.37	1.91	9.24	0.38	14.75	20.86	0.28	99.4	74	0.29	0.03	78.4	43	42	15
KELUD1990-PX3-core-only	PL2	cpx	pheno	late	51.5	0.36	2	8.87	0.38	14.65	21.18	0.31	99.3	75	0.28	0.03	79.3	44	42	14
KELUD1990-PX3-core-only	PL2	cpx	pheno	late	51.39	0.33	1.83	8.99	0.38	14.89	21.15	0.27	99.2	75	0.24	0.03	80.5	43	42	14
KELUD1990-PX4-core-only	PL2	cpx	glom	late	53.03	0.33	2.84	9.6	0.46	13.28	20.1	0.29	99.9	71	0.43	-0.03	65.3	44	40	16
KELUD1990-PX4-core-only	PL2	cpx	glom	late	51.46	0.33	1.82	9.45	0.45	14.07	21.37	0.31	99.2	73	0.26	0.02	77.1	44	41	15
KELUD1990-PX4-core-only	PL2	cpx	glom	late	52.02	0.35	1.67	9.37	0.43	14.82	21.02	0.27	99.9	74	0.28	0.02	78.0	43	42	15
KELUD1990-PX5-core-only	PL2	cpx	pheno	late	50.36	0.44	2.75	9.34	0.42	14.16	21.03	0.3	98.8	73	0.31	0.04	79.3	44	41	15
KELUD1990-PX5-core-only	PL2	cpx	pheno	late	51.43	0.33	2.03	9.43	0.4	14.59	21.02	0.29	99.5	73	0.25	0.03	78.6	43	42	15
KELUD1990-PX5-core-only	PL2	cpx	pheno	late	51.14	0.36	1.73	9.28	0.38	14.71	21.05	0.28	98.9	74	0.26	0.03	80.0	43	42	15
KELUD1990-PX6-core-only	PL2	cpx	glom	late	51.03	0.61	2.69	9.11	0.44	13.93	21.57	0.34	99.7	73	0.47	0.04	77.9	45	40	15

SAMPLE GRAIN ID	Sample	Min	Texture	stage	SiO2	TiO2	Al2O3	FeO*	MnO	MgO	CaO	Na2O	Total	Mg #	FeO	Fe2O3	Mg # (Fe2+ only)	Wo	En	Fs
KELUD1990-PX8- core-only	PL2	cpx	glom	late	51.49	0.32	1.63	9.3	0.49	14.32	21.16	0.29	99	73	0.25	0.02	77.6	44	41	15
KELUD1990-PX8- core-only	PL2	cpx	glom	late	52.06	0.28	1.47	9.08	0.44	14.51	21.01	0.25	99.1	74	0.25	0.01	76.2	44	42	15
KELUD1990-PX8- core-only	PL2	cpx	glom	late	52.24	0.26	1.14	8.77	0.46	14.54	21.69	0.27	99.4	75	0.22	0.01	78.1	44	41	14
KELUD1990-PX9- core-only	PL2	cpx	pheno	late	51.27	0.36	1.93	9.29	0.44	14.34	20.99	0.27	98.9	73	0.29	0.02	77.4	44	41	15
KELUD1990-PX9- core-only	PL2	cpx	glom	late	51.72	0.33	1.63	9.34	0.46	14.6	20.77	0.27	99.1	74	0.28	0.02	77.0	43	42	15
KELUD1990-PX9- core-only	PL2	cpx	glom	late	51.84	0.3	1.5	9.19	0.44	14.71	21.07	0.24	99.3	74	0.24	0.02	77.9	43	42	15
KELUD1990-z13-r2c	PL2	cpx	rim	late	51.96	0.32	1.08	12.57	0.65	13.77	19.26	0.29	99.9	68	0.29	0.02	68.7	40	40	20
KELUD1990-z13-r2c	PL2	cpx	rim	late	52.67	0.25	0.7	12.56	0.65	13.85	19.51	0.28	100.5	69	0.23	0.01	68.2	40	40	20
KELUD1990-z13-r2c	PL2	cpx	rim	late	52.25	0.27	0.81	12.39	0.61	13.67	19.76	0.31	100.1	69	0.24	0.01	69.0	41	39	20
KELUD1990-z13-r2c	PL2	cpx	rim	late	52.3	0.26	0.82	12.35	0.64	13.63	19.5	0.31	99.8	69	0.24	0.01	68.1	41	39	20
KELUD1990-z13-r2c	PL2	cpx	rim	late	51.67	0.32	1.37	12.54	0.64	13.86	19.14	0.3	99.8	69	0.28	0.02	69.7	40	40	20
KELUD1990-z13-r2c	PL2	cpx	rim	late	52.41	0.23	0.71	12.41	0.63	13.75	19.69	0.28	100.1	69	0.21	0.01	68.7	41	39	20
KELUD1990-z13-r2c	PL2	cpx	rim	late	52.23	0.23	0.83	12.28	0.65	13.69	19.66	0.3	99.9	69	0.21	0.01	69.0	41	39	20
KELUD1990-z13-r2c	PL2	cpx	rim	late	52.35	0.27	0.82	12.41	0.62	13.84	19.65	0.29	100.3	69	0.24	0.01	69.2	40	40	20
KELUD1990-z13-r2c	PL2	cpx	rim	late	51.91	0.33	1.43	12.57	0.62	14.15	18.85	0.26	100.1	69	0.29	0.02	69.4	39	41	20
KELUD1990-z13-r2c	PL2	cpx	rim	late	52.23	0.23	0.75	12.11	0.67	13.65	19.5	0.31	99.4	69	0.21	0.01	68.5	41	40	20
KELUD1990-z13-r2c	PL2	cpx	rim	late	52.28	0.25	0.73	12.44	0.66	14.11	19.3	0.29	100.1	69	0.22	0.01	69.9	40	40	20
KELUD1990-z13-r2c	PL2	cpx	rim	late	51.83	0.31	1.3	12.4	0.61	14.27	19.16	0.27	100.1	70	0.26	0.02	71.1	39	41	20
KELUD1990-z13-r2c	PL2	cpx	rim	late	52.29	0.22	0.67	11.66	0.61	13.54	20.23	0.31	99.5	70	0.20	0.01	69.5	42	39	19
KELUD1990-z13-r2c	PL2	cpx	rim	late	51.99	0.31	1.31	12.23	0.63	14.2	18.92	0.26	99.8	70	0.28	0.01	69.7	39	41	20
KELUD1990-z13-r2c	PL2	cpx	rim	late	52.8	0.19	0.81	11.4	0.62	13.66	20.15	0.32	100	70	0.18	0.00	68.8	42	40	19
KELUD1990-z13-r2c	PL2	cpx	rim	late	52.25	0.27	1.19	11.48	0.55	14.75	19.04	0.25	99.8	72	0.24	0.01	71.9	39	42	18
KELUD1990-z13-r2c	PL2	cpx	core	late	51.83	0.34	1.48	10.82	0.46	14.83	19.77	0.26	99.8	73	0.28	0.02	75.0	40	42	17
KELUD1990-z13-r2c	PL2	cpx	core	late	51.93	0.32	1.58	10.8	0.48	14.83	19.69	0.28	99.9	73	0.26	0.02	74.8	40	42	17

SAMPLE GRAIN ID	Sample	Min	Texture	stage	SiO2	TiO2	Al2O3	FeO*	MnO	MgO	CaO	Na2O	Total	Mg #	FeO	Fe2O3	Mg # (Fe2+ only)	Wo	En	Fs
KELUD1990-z13-r2c	PL2	cpx	core	late	52	0.31	1.54	10.82	0.47	14.86	19.74	0.27	100	73	0.26	0.02	74.8	40	42	17
KELUD1990-z13-r2c	PL2	cpx	core	late	52.11	0.3	1.42	10.76	0.49	14.82	19.73	0.26	99.9	73	0.26	0.02	74.3	40	42	17
KELUD1990-z13-r2c	PL2	cpx	core	late	52.07	0.31	1.54	10.69	0.49	14.79	19.86	0.27	100	73	0.26	0.02	74.6	41	42	17
KELUD1990-z13-r2c	PL2	cpx	core	late	51.97	0.35	1.69	10.6	0.46	14.75	19.78	0.28	99.9	73	0.30	0.02	74.4	41	42	17
KELUD1990-z13-r2c	PL2	cpx	rim	late	52.1	0.28	1.54	11.43	0.52	15.95	18.16	0.17	100.1	73	0.23	0.02	75.0	37	45	18
KELUD1990-z13-r2c	PL2	cpx	core	late	52	0.32	1.58	10.66	0.46	14.96	19.61	0.29	99.9	74	0.27	0.02	75.1	40	43	17
KELUD1990-z13-r2c	PL2	cpx	core	late	52.02	0.31	1.59	10.52	0.46	14.77	19.8	0.27	99.7	74	0.27	0.02	74.4	41	42	17
KELUD1990-z13-r2c	PL2	cpx	rim	late	52.48	0.28	1.51	11.01	0.47	16.11	17.94	0.17	100	74	0.26	0.01	74.1	37	46	18
KELUD1990-z13-r2c	PL2	cpx	core	late	52.13	0.3	1.61	10.4	0.44	15.61	19.13	0.2	99.8	75	0.26	0.02	75.8	39	44	17
KELUD1990-z13-r2c	PL2	cpx	core	late	52.04	0.32	1.59	10.41	0.41	15.97	18.85	0.16	99.7	75	0.27	0.02	76.6	38	45	17
KELUD1990-z13-r2c	PL2	cpx	core	late	52.35	0.29	1.46	10.28	0.44	15.82	18.98	0.18	99.8	75	0.26	0.01	75.7	39	45	16
KELUD1990-z13-r2c	PL2	cpx	core	late	52.01	0.31	1.64	10.23	0.42	15.9	19.01	0.15	99.7	75	0.26	0.02	76.7	39	45	16
KELUD1990-z13-r2c	PL2	cpx	core	late	52.42	0.27	1.55	10.28	0.44	16.07	18.69	0.14	99.9	76	0.24	0.01	75.7	38	46	16
KELUD1990-z13-r2c	PL2	cpx	rim	late	52.35	0.28	1.6	10.46	0.42	16.38	18.37	0.14	100	76	0.24	0.01	76.4	37	46	17
PL2-site1-px2	PL2	cpx	microlite	late	51.01	0.33	1.55	11.23	0.54	14.4	20.04	1.75	100.9	72	0.04	0.11	94.5	41	41	18

Table S2.2.2: Major element compositions of whole rocks, glasses, and minerals (Opx)

SAMPLE GRAIN ID	Sample	Min	Texture	stage	SiO2	TiO2	Al2O3	FeO*	MnO	MgO	CaO	Na2O	Total	Mg #	FeO	Fe2O3	Mg # (Fe2+ only)
90-23-glom1	90-23	opx	glom	main	53.4	0.19	1.01	21.93	0.76	23.25	1.3	0.02	101.9	68	0.17	0.01	67.49
90-23-glom1	90-23	opx	glom	main	52.41	0.25	1.14	21.78	0.76	23.16	1.41	0.01	100.9	68	0.22	0.02	68.63
90-23-glom1	90-23	opx	glom	main	52.95	0.19	1.06	21.85	0.74	23.48	1.33	0.02	101.6	68	0.17	0.02	68.81
90-23-glom1	90-23	opx	glom	main	52.6	0.19	1	21.6	0.77	23.31	1.39	0.02	100.9	68	0.17	0.02	68.91
90-23-glom1	90-23	opx	glom	main	52.95	0.16	1.07	21.61	0.77	23.36	1.33	0.01	101.3	68	0.14	0.01	68.46
90-23-glom1	90-23	opx	glom	main	52.75	0.19	0.98	21.67	0.78	23.44	1.38	0.01	101.2	68	0.17	0.02	69.03
90-23-glom1	90-23	opx	glom	main	51.61	0.24	1.68	21.28	0.68	23.06	1.53	0.02	100.1	68	0.20	0.03	69.60
90-23-glom1	90-23	opx	glom	main	52.83	0.17	0.9	21.55	0.78	23.46	1.34	0.02	101.1	68	0.15	0.02	68.99
90-23-glom1	90-23	opx	glom	main	52.39	0.21	1.12	21.42	0.73	23.41	1.39	0.01	100.7	68	0.18	0.02	69.37
90-23-glom1	90-23	opx	glom	main	52.15	0.2	1.19	21.37	0.73	23.42	1.39	0.01	100.5	68	0.17	0.02	69.75
90-23-glom1	90-23	opx	glom	main	52.74	0.18	0.94	21.16	0.71	23.64	1.4	0.01	100.8	69	0.16	0.02	69.58
90-23-glom11	90-23	opx	glom	main	53.16	0.18	0.98	22.09	0.82	23.49	1.36	0.02	102.1	68	0.16	0.02	68.71
90-23-glom11	90-23	opx	glom	main	53.26	0.15	1.03	21.29	0.81	24.09	1.14	0.02	101.8	69	0.13	0.01	70.01
90-23-glom11-z1-r2c	90-23	opx	rim	main	50.79	0.25	1.31	22.25	0.82	22.11	1.43	0.02	99	66	0.21	0.03	67.88
90-23-glom11-z1-r2c	90-23	opx	rim	main	53.1	0.19	1.16	22.38	0.83	23.06	1.36	0.01	102.1	67	0.17	0.02	67.47
90-23-glom11-z1-r2c	90-23	opx	rim	main	52.81	0.22	1.15	22.38	0.83	23.33	1.36	0.01	102.1	67	0.19	0.02	68.64
90-23-glom11-z1-r2c	90-23	opx	rim	main	53.08	0.19	1.02	22.22	0.87	23.2	1.33	0.03	101.9	67	0.17	0.02	68.02
90-23-glom11-z1-r2c	90-23	opx	rim	main	53.24	0.19	0.96	22.27	0.82	23.27	1.39	0.01	102.2	67	0.17	0.02	67.93
90-23-glom11-z1-r2c	90-23	opx	rim	main	53.2	0.2	1.06	22.23	0.83	23.35	1.39	0	102.3	68	0.18	0.02	68.17
90-23-glom11-z1-r2c	90-23	opx	rim	main	53.16	0.2	0.91	22.32	0.86	23.49	1.35	0.02	102.3	68	0.17	0.02	68.73
90-23-glom11-z1-r2c	90-23	opx	rim	main	53.04	0.21	1.08	22.25	0.83	23.43	1.35	0.01	102.2	68	0.18	0.02	68.61
90-23-glom11-z1-r2c	90-23	opx	rim	main	52.97	0.2	1.22	22.12	0.82	23.4	1.4	0.01	102.1	68	0.17	0.02	68.69
90-23-glom11-z1-r2c	90-23	opx	rim	main	52.8	0.17	1.2	22.07	0.79	23.38	1.34	0.02	101.8	68	0.15	0.02	68.82
90-23-glom11-z1-r2c	90-23	opx	rim	main	53.01	0.21	1.15	21.89	0.8	23.39	1.37	0.01	101.8	68	0.18	0.02	68.52

SAMPLE GRAIN ID	Sample	Min	Texture	stage	SiO2	TiO2	Al2O3	FeO*	MnO	MgO	CaO	Na2O	Total	Mg #	FeO	Fe2O3	Mg # (Fe2+ only)
90-23-glom11-z1-r2c	90-23	opx	rim	main	53.08	0.21	1.16	21.9	0.79	23.52	1.36	0.02	102	68	0.18	0.02	68.83
90-23-glom11-z1-r2c	90-23	opx	rim	main	52.95	0.19	1.14	21.85	0.78	23.58	1.4	0.01	101.9	68	0.16	0.02	69.21
90-23-glom11-z1-r2c	90-23	opx	rim	main	52.84	0.21	1.36	21.81	0.77	23.6	1.4	0	102	68	0.18	0.02	69.33
90-23-glom11-z1-r2c	90-23	opx	rim	main	53.3	0.22	1.02	21.71	0.82	23.64	1.38	0.02	102.1	68	0.19	0.02	68.93
90-23-glom11-z1-r2c	90-23	opx	rim	main	52.93	0.23	1.25	21.84	0.77	23.81	1.4	0.03	102.3	68	0.19	0.03	69.97
90-23-glom11-z1-r2c	90-23	opx	rim	main	52.92	0.21	1.11	21.7	0.78	23.87	1.38	0.02	102	69	0.18	0.02	70.11
90-23-glom11-z1-r2c	90-23	opx	rim	main	53.03	0.17	1.05	21.29	0.76	23.86	1.36	0.01	101.5	69	0.15	0.02	69.85
90-23-glom11-z1-r2c	90-23	opx	core	main	52.34	0.19	1.96	21.71	0.71	23.69	1.4	0.01	102	68	0.16	0.02	70.31
90-23-glom11-z1-r2c	90-23	opx	core	main	52.48	0.27	1.63	21.56	0.73	23.66	1.4	0.01	101.7	68	0.23	0.03	69.95
90-23-glom11-z1-r2c	90-23	opx	core	main	52.8	0.18	1.1	21.71	0.73	23.87	1.42	0.01	101.8	69	0.15	0.02	70.26
90-23-glom11-z1-r2c	90-23	opx	core	main	52.57	0.24	1.81	21.57	0.74	23.72	1.43	0.02	102.1	69	0.20	0.03	70.15
90-23-glom11-z1-r2c	90-23	opx	core	main	52.48	0.2	1.7	21.54	0.74	23.75	1.44	0.02	101.9	69	0.17	0.02	70.43
90-23-glom11-z1-r2c	90-23	opx	core	main	52.97	0.21	1.28	21.38	0.76	24	1.4	0.02	102	69	0.18	0.02	70.42
90-23-glom12	90-23	opx	glom	main	52.76	0.18	1.03	22.69	0.81	23.73	1.11	0.02	102.3	67	0.15	0.02	69.61
90-23-glom12	90-23	opx	glom	main	52.67	0.11	0.95	22.49	0.87	24.03	1	0.01	102.1	68	0.09	0.02	70.55
90-23-glom12	90-23	opx	glom	main	52.94	0.12	0.81	22.18	0.79	24.07	1.11	0.02	102	68	0.10	0.02	70.39
90-23-glom12	90-23	opx	glom	main	52.84	0.17	0.9	21.69	0.82	24.07	1.1	0.02	101.6	69	0.14	0.02	70.49
90-23-glom12	90-23	opx	glom	main	52.55	0.16	0.83	21.93	0.8	24.37	1.18	0.03	101.9	69	0.12	0.03	71.96
90-23-glom12	90-23	opx	glom	main	52.91	0.18	0.95	21.89	0.79	24.39	1.15	0.02	102.3	69	0.14	0.03	71.37
90-23-glom13	90-23	opx	glom	main	52.02	0.21	1.75	21.9	0.71	23.39	1.34	0.01	101.3	68	0.17	0.03	69.75
90-23-glom13	90-23	opx	glom	main	53.37	0.19	0.94	21.46	0.72	23.88	1.34	0	101.9	69	0.17	0.02	69.28
90-23-glom13	90-23	opx	glom	main	53.19	0.17	1.21	21.22	0.67	24.29	1.27	0.02	102	69	0.14	0.02	70.71
90-23-glom14	90-23	opx	glom	main	52.99	0.19	0.93	22.38	0.85	23.4	1.42	0.03	102.2	67	0.16	0.02	68.85
90-23-glom14	90-23	opx	glom	main	52.55	0.23	0.95	22.04	0.85	23.4	1.3	0.02	101.3	68	0.20	0.03	69.18
90-23-glom14	90-23	opx	glom	main	52.59	0.21	1.09	22.14	0.8	23.61	1.39	0.02	101.9	68	0.17	0.03	69.85

SAMPLE GRAIN ID	Sample	Min	Texture	stage	SiO2	TiO2	Al2O3	FeO*	MnO	MgO	CaO	Na2O	Total	Mg #	FeO	Fe2O3	Mg # (Fe2+ only)
90-23-glom14	90-23	opx	glom	main	52.99	0.15	0.91	21.92	0.78	23.57	1.4	0.02	101.7	68	0.13	0.02	69.22
90-23-glom14	90-23	opx	glom	main	52.74	0.2	1.15	21.9	0.79	23.81	1.35	0.02	102	68	0.17	0.03	70.17
90-23-glom3	90-23	opx	glom	main	52.6	0.16	0.86	22.31	0.82	23.21	1.35	0.02	101.3	67	0.14	0.02	68.66
90-23-glom3	90-23	opx	glom	main	53.02	0.18	1.07	22.45	0.86	23.73	1.08	0.01	102.4	68	0.15	0.02	69.20
90-23-glom3	90-23	opx	glom	main	53.23	0.14	0.76	22.01	0.79	23.54	1.38	0.01	101.9	68	0.12	0.01	68.74
90-23-glom3	90-23	opx	glom	main	53.05	0.13	0.8	22.08	0.77	23.8	1.42	0.02	102.1	68	0.11	0.02	69.87
90-23-glom4	90-23	opx	glom	main	52.01	0.28	2.61	21.88	0.7	23.06	1.5	0.02	102.1	68	0.24	0.03	68.98
90-23-glom4	90-23	opx	glom	main	53.15	0.14	0.88	21.28	0.71	24.14	1.51	0.01	101.8	69	0.12	0.02	70.71
90-23-glom4	90-23	opx	glom	main	51.62	0.28	2.58	20.93	0.64	24	1.51	0.01	101.6	69	0.22	0.04	72.25
90-23-glom5	90-23	opx	glom	main	53.26	0.17	0.89	22.21	0.78	23.78	1.35	0.01	102.5	68	0.14	0.02	69.33
90-23-glom6	90-23	opx	glom	main	52.76	0.17	1.11	22.53	0.8	23.52	1.3	0.02	102.2	67	0.14	0.02	69.27
90-23-glom6	90-23	opx	glom	main	52.77	0.17	1.07	22.34	0.86	23.5	1.32	0.01	102	68	0.14	0.02	69.23
90-23-glom6	90-23	opx	glom	main	52.73	0.2	1.1	22.24	0.78	23.59	1.34	0.01	102	68	0.17	0.02	69.46
90-23-glom6	90-23	opx	glom	main	52.85	0.16	0.86	22.17	0.73	24.26	1.36	0.01	102.4	68	0.13	0.02	71.29
90-23-glom7	90-23	opx	glom	main	52.96	0.2	1.2	22.36	0.75	23.37	1.39	0.02	102.3	67	0.17	0.02	68.58
90-23-glom8	90-23	opx	glom	main	52.86	0.23	1.14	22.18	0.77	23.43	1.32	0.02	102	68	0.20	0.02	68.78
90-23-glom8	90-23	opx	glom	main	53.13	0.12	0.89	21.58	0.7	23.75	1.45	0.02	101.6	69	0.10	0.01	69.56
90-23-glom8	90-23	opx	glom	main	53.09	0.23	1.2	21.38	0.72	23.97	1.34	0.02	102	69	0.20	0.02	70.01
90-23-px1-z1-r2c	90-23	opx	rim	main	52.55	0.27	1.55	22.15	0.77	23.06	1.5	0.01	101.9	67	0.23	0.03	68.27
90-23-px1-z1-r2c	90-23	opx	rim	main	52.74	0.26	1.57	21.87	0.75	22.94	1.68	0.02	101.8	68	0.23	0.02	67.94
90-23-px1-z1-r2c	90-23	opx	rim	main	52.61	0.28	1.54	21.92	0.77	23.14	1.6	0.02	101.9	68	0.24	0.03	68.61
90-23-px1-z1-r2c	90-23	opx	rim	main	52.86	0.24	1.33	22	0.72	23.24	1.45	0	101.8	68	0.21	0.02	68.22
90-23-px1-z1-r2c	90-23	opx	rim	main	52.9	0.24	1.47	21.88	0.75	23.25	1.48	0.02	102	68	0.21	0.02	68.38
90-23-px1-z1-r2c	90-23	opx	rim	main	52.66	0.25	1.42	21.87	0.76	23.26	1.55	0.01	101.8	68	0.22	0.02	68.79
90-23-px1-z1-r2c	90-23	opx	rim	main	52.66	0.23	1.61	21.7	0.71	23.09	1.76	0.01	101.8	68	0.20	0.02	68.55

SAMPLE GRAIN ID	Sample	Min	Texture	stage	SiO2	TiO2	Al2O3	FeO*	MnO	MgO	CaO	Na2O	Total	Mg #	FeO	Fe2O3	Mg # (Fe2+ only)
90-23-px1-z1-r2c	90-23	opx	rim	main	53.24	0.23	1.14	21.93	0.77	23.34	1.37	0.02	102	68	0.21	0.02	68.05
90-23-px1-z1-r2c	90-23	opx	rim	main	53.2	0.23	1.33	21.77	0.78	23.22	1.56	0	102.1	68	0.21	0.02	67.92
90-23-px1-z1-r2c	90-23	opx	rim	main	52.49	0.28	1.61	21.72	0.71	23.25	1.73	0.02	101.8	68	0.24	0.03	69.23
90-23-px1-z1-r2c	90-23	opx	rim	main	52.67	0.2	1.55	21.85	0.72	23.42	1.62	0.01	102	68	0.17	0.02	69.37
90-23-px1-z1-r2c	90-23	opx	rim	main	53.03	0.24	1.23	21.78	0.77	23.35	1.47	0.01	101.9	68	0.21	0.02	68.45
90-23-px1-z1-r2c	90-23	opx	rim	main	52.92	0.25	1.43	21.78	0.73	23.35	1.71	0.03	102.2	68	0.22	0.03	69.01
90-23-px1-z1-r2c	90-23	opx	rim	main	53.21	0.2	1.13	21.69	0.78	23.27	1.35	0.01	101.6	68	0.18	0.01	67.83
90-23-px1-z1-r2c	90-23	opx	rim	main	52.87	0.24	1.56	21.5	0.77	23.1	1.81	0.02	101.9	68	0.21	0.02	68.47
90-23-px1-z1-r2c	90-23	opx	rim	main	52.72	0.2	1.56	21.64	0.74	23.31	1.66	0	101.8	68	0.17	0.02	68.99
90-23-px1-z1-r2c	90-23	opx	rim	main	52.95	0.19	1.33	21.68	0.74	23.42	1.58	0.01	101.9	68	0.17	0.02	68.94
90-23-px1-z1-r2c	90-23	opx	rim	main	53.54	0.22	1.08	21.61	0.75	23.36	1.4	0.01	102	68	0.20	0.01	67.66
90-23-px1-z1-r2c	90-23	opx	rim	main	53.8	0.21	1.29	21.51	0.79	23.26	1.41	0.02	102.3	68	0.20	0.01	67.13
90-23-px1-z1-r2c	90-23	opx	rim	main	52.77	0.19	1.54	21.54	0.71	23.3	1.66	0.02	101.7	68	0.17	0.02	68.97
90-23-px1-z1-r2c	90-23	opx	rim	main	53.6	0.18	1.01	21.55	0.79	23.37	1.37	0.02	101.9	68	0.17	0.01	67.70
90-23-px1-z1-r2c	90-23	opx	rim	main	53.21	0.21	1.15	21.69	0.77	23.52	1.38	0.03	102	68	0.19	0.02	68.71
90-23-px1-z1-r2c	90-23	opx	rim	main	53.7	0.18	0.99	21.65	0.83	23.54	1.36	0.04	102.3	68	0.16	0.01	68.21
90-23-px1-z1-r2c	90-23	opx	rim	main	52.79	0.2	1.49	21.53	0.75	23.45	1.55	0.01	101.8	68	0.17	0.02	69.21
90-23-px1-z1-r2c	90-23	opx	rim	main	53.06	0.2	1.32	21.51	0.69	23.63	1.49	0.01	101.9	69	0.18	0.02	69.21
90-23-px1-z1-r2c	90-23	opx	rim	main	53.19	0.18	1.11	21.4	0.71	23.85	1.51	0.01	102	69	0.16	0.02	69.75
90-23-px1-z1-r2c	90-23	opx	rim	main	53.13	0.2	1.16	21.19	0.71	23.81	1.54	0.01	101.8	69	0.17	0.02	69.73
90-23-px1-z1-r2c	90-23	opx	rim	main	53.38	0.18	0.97	21.36	0.71	24.06	1.49	0.01	102.2	69	0.16	0.02	70.08
90-23-px1-z1-r2c	90-23	opx	rim	main	53.7	0.16	0.93	21.2	0.72	24.15	1.54	0.01	102.4	69	0.14	0.01	70.00
90-23-px1-z1-r2c	90-23	opx	core	main	53.5	0.18	0.84	21.39	0.73	24.16	1.45	0.02	102.3	69	0.15	0.02	70.22
90-23-px1-z1-r2c	90-23	opx	core	main	53.4	0.17	0.91	21.32	0.74	24.18	1.52	0.03	102.3	69	0.14	0.02	70.60
90-23-px1-z1-r2c	90-23	opx	core	main	53.56	0.15	0.87	21.2	0.72	24.08	1.46	0.01	102.1	69	0.13	0.01	69.88

SAMPLE GRAIN ID	Sample	Min	Texture	stage	SiO2	TiO2	Al2O3	FeO*	MnO	MgO	CaO	Na2O	Total	Mg #	FeO	Fe2O3	Mg # (Fe2+ only)
90-23-px1-z1-r2c	90-23	opx	core	main	53.6	0.15	0.77	21.24	0.72	24.19	1.4	0.01	102.1	69	0.13	0.01	70.06
90-23-px1-z1-r2c	90-23	opx	core	main	53.51	0.14	0.93	21.16	0.7	24.12	1.49	0.03	102.1	69	0.12	0.01	70.20
90-23-px1-z1-r2c	90-23	opx	core	main	53.79	0.16	0.73	21.11	0.73	24.27	1.41	0.02	102.2	69	0.14	0.01	70.09
90-23-px1-z1-r2c	90-23	opx	core	main	53.91	0.16	0.79	21.02	0.73	24.23	1.38	0.02	102.2	70	0.14	0.01	69.76
90-23-px1-z1-r2c	90-23	opx	core	main	53.38	0.14	0.66	21.07	0.73	24.3	1.44	0.02	101.7	70	0.12	0.01	70.82
90-23-px1-z1-r2c	90-23	opx	core	main	53.78	0.15	0.71	21.11	0.72	24.48	1.41	0.04	102.4	70	0.13	0.02	70.83
90-23-px1-z1-r2c	90-23	opx	core	main	53.86	0.14	0.67	20.92	0.72	24.39	1.43	0.01	102.1	70	0.12	0.01	70.33
90-23-px10	90-23	opx	pheno	main	53.37	0.17	0.73	21.58	0.76	23.55	1.38	0.01	101.6	68	0.15	0.01	68.49
90-23-px10	90-23	opx	pheno	main	53.46	0.17	1.14	21.34	0.79	23.7	1.23	0.03	101.9	69	0.15	0.01	68.72
90-23-px10	90-23	opx	pheno	main	53.44	0.14	0.74	21.35	0.86	23.8	1.25	0.02	101.6	69	0.12	0.01	69.14
90-23-px10	90-23	opx	pheno	main	53.29	0.15	0.89	20.81	0.72	23.87	1.41	0.01	101.2	69	0.13	0.01	69.54
90-23-px10	90-23	opx	pheno	main	53.51	0.17	0.87	20.9	0.73	24.05	1.42	0.01	101.7	70	0.15	0.01	69.78
90-23-px15-r2c	90-23	opx	rim	main	53.27	0.21	1.77	21.82	0.88	21.95	1.76	0.07	101.7	67	0.20	0.00	64.79
90-23-px15-r2c	90-23	opx	rim	main	52.98	0.18	1	22.38	0.87	23.31	1.3	0.02	102	67	0.16	0.02	68.40
90-23-px15-r2c	90-23	opx	rim	main	53.15	0.2	0.99	22.17	0.87	23.23	1.29	0	101.9	67	0.18	0.02	67.78
90-23-px15-r2c	90-23	opx	rim	main	53.07	0.19	1.01	22.12	0.87	23.37	1.31	0.02	102	68	0.17	0.02	68.45
90-23-px15-r2c	90-23	opx	rim	main	52.89	0.19	1	22.03	0.87	23.35	1.32	0.02	101.7	68	0.16	0.02	68.65
90-23-px15-r2c	90-23	opx	rim	main	53.12	0.2	1.02	22.06	0.84	23.39	1.35	0.01	102	68	0.18	0.02	68.40
90-23-px15-r2c	90-23	opx	rim	main	53	0.21	1	21.99	0.86	23.48	1.34	0.01	101.9	68	0.18	0.02	68.83
90-23-px15-r2c	90-23	opx	rim	main	52.81	0.21	1.08	21.96	0.83	23.63	1.27	0.02	101.8	68	0.18	0.02	69.45
90-23-px15-r2c	90-23	opx	rim	main	52.93	0.2	1.12	21.82	0.79	23.56	1.35	0.01	101.8	68	0.17	0.02	69.10
90-23-px15-r2c	90-23	opx	rim	main	53.19	0.16	0.92	21.85	0.85	23.67	1.29	0.02	102	68	0.14	0.02	69.14
90-23-px15-r2c	90-23	opx	rim	main	53.17	0.19	0.97	21.72	0.85	23.64	1.3	0.01	101.9	68	0.17	0.02	69.01
90-23-px15-r2c	90-23	opx	rim	main	52.86	0.19	1.25	21.8	0.83	23.76	1.29	0.03	102	68	0.16	0.02	69.87
90-23-px15-r2c	90-23	opx	rim	main	52.93	0.17	1.24	21.69	0.79	23.7	1.33	0.02	101.9	68	0.15	0.02	69.57

SAMPLE GRAIN ID	Sample	Min	Texture	stage	SiO2	TiO2	Al2O3	FeO*	MnO	MgO	CaO	Na2O	Total	Mg #	FeO	Fe2O3	Mg # (Fe2+ only)
90-23-px15-r2c	90-23	opx	rim	main	53.06	0.17	1.19	21.57	0.77	23.82	1.27	0	101.9	69	0.15	0.02	69.52
90-23-px15-r2c	90-23	opx	rim	main	53.12	0.17	1.12	21.58	0.82	23.85	1.37	0.02	102.1	69	0.15	0.02	69.84
90-23-px15-r2c	90-23	opx	rim	main	53.02	0.16	1.25	21.43	0.8	23.88	1.33	0.01	101.9	69	0.14	0.02	69.94
90-23-px15-r2c	90-23	opx	rim	main	52.99	0.16	1.14	21.36	0.78	23.85	1.33	0.02	101.6	69	0.14	0.02	69.92
90-23-px15-r2c	90-23	opx	core	main	52.46	0.08	0.76	24.61	1.3	22.19	0.74	0.02	102.2	64	0.07	0.01	65.62
90-23-px15-r2c	90-23	opx	core	main	52.39	0.09	0.76	24.37	1.25	22.25	0.74	0.02	101.9	64	0.08	0.01	65.82
90-23-px15-r2c	90-23	opx	core	main	52.55	0.09	0.87	24.07	1.25	22.23	0.74	0.01	101.8	65	0.08	0.01	65.48
90-23-px15-r2c	90-23	opx	core	main	52.27	0.06	0.94	23.99	1.28	22.2	0.76	0.01	101.5	65	0.05	0.01	65.85
90-23-px15-r2c	90-23	opx	core	main	52.2	0.09	1.01	23.87	1.24	22.19	0.76	0.02	101.4	65	0.08	0.01	65.89
90-23-px15-r2c	90-23	opx	core	main	52.29	0.11	1.11	23.92	1.22	22.33	0.78	0.02	101.8	65	0.09	0.01	66.18
90-23-px15-r2c	90-23	opx	core	main	52.5	0.12	1.13	24	1.21	22.46	0.82	0.01	102.3	65	0.10	0.01	66.27
90-23-px15-r2c	90-23	opx	core	main	52.39	0.12	1.07	24.04	1.22	22.49	0.8	0	102.1	65	0.10	0.01	66.44
90-23-px15-r2c	90-23	opx	core	main	52.1	0.1	1.13	23.83	1.22	22.34	0.8	0.01	101.5	65	0.09	0.01	66.45
90-23-px15-r2c	90-23	opx	core	main	52.5	0.11	1.1	23.84	1.22	22.36	0.78	0.01	101.9	65	0.10	0.01	65.93
90-23-px15-r2c	90-23	opx	core	main	52.12	0.12	1.07	23.67	1.24	22.22	0.79	0.01	101.2	65	0.10	0.01	66.04
90-23-px15-r2c	90-23	opx	core	main	52.3	0.12	1.12	23.72	1.25	22.27	0.8	0.01	101.6	65	0.10	0.01	65.98
90-23-px15-r2c	90-23	opx	core	main	52.35	0.11	1.13	23.85	1.22	22.45	0.82	0	101.9	65	0.09	0.01	66.41
90-23-px15-r2c	90-23	opx	core	main	52.32	0.12	1.13	23.74	1.18	22.43	0.79	0.01	101.7	65	0.10	0.01	66.34
90-23-px15-r2c	90-23	opx	core	main	52.19	0.14	1.13	23.72	1.23	22.4	0.81	0.01	101.6	65	0.12	0.02	66.49
90-23-px15-r2c	90-23	opx	core	main	52.52	0.08	1.15	23.66	1.19	22.42	0.79	0	101.8	65	0.07	0.01	66.04
90-23-px15-r2c	90-23	opx	core	main	52.48	0.12	1.14	23.69	1.19	22.46	0.82	0.02	101.9	65	0.10	0.01	66.32
90-23-px15-r2c	90-23	opx	core	main	52.47	0.09	1.11	23.72	1.19	22.65	0.82	0.02	102.1	65	0.08	0.01	66.93
90-23-px15-r2c	90-23	opx	core	main	52.52	0.11	1.15	23.53	1.22	22.62	0.82	0	102	66	0.09	0.01	66.68
90-23-px15-r2c	90-23	opx	core	main	52.58	0.11	1.13	23.38	1.19	22.69	0.88	0	102	66	0.10	0.01	66.85
90-23-px15-r2c	90-23	opx	core	main	52.39	0.13	1.09	23.23	1.18	22.71	1.01	0.01	101.8	66	0.11	0.02	67.38

SAMPLE GRAIN ID	Sample	Min	Texture	stage	SiO2	TiO2	Al2O3	FeO*	MnO	MgO	CaO	Na2O	Total	Mg #	FeO	Fe2O3	Mg # (Fe2+ only)
90-23-px15-r2c	90-23	opx	core	main	52.65	0.13	1.06	22.97	1.17	22.79	1.05	0.01	101.8	66	0.11	0.01	67.30
90-23-px15-r2c	90-23	opx	core	main	52.49	0.11	1.03	22.6	1.12	22.89	1.13	0.02	101.4	67	0.09	0.01	67.94
90-23-px15-r2c	90-23	opx	core	main	52.6	0.13	1.07	22.63	1.08	22.98	1.12	0.01	101.6	67	0.11	0.01	67.92
90-23-px15-r2c	90-23	opx	core	main	52.66	0.14	1.09	22.57	1.05	23.08	1.2	0.02	101.8	67	0.12	0.02	68.27
90-23-px15-r2c	90-23	opx	core	main	52.83	0.12	1.09	22.16	1.04	23.3	1.28	0.01	101.8	68	0.10	0.01	68.75
90-23-px15-r2c	90-23	opx	core	main	52.46	0.13	1.1	21.94	1	23.27	1.31	0.01	101.2	68	0.11	0.01	69.16
90-23-px15-r2c	90-23	opx	core	main	52.72	0.15	1.14	22.01	0.95	23.47	1.34	0.02	101.8	68	0.13	0.02	69.41
90-23-px15-r2c	90-23	opx	core	main	52.89	0.17	1.14	21.83	0.88	23.63	1.33	0.01	101.9	68	0.15	0.02	69.47
90-23-px15-r2c	90-23	opx	core	main	52.99	0.15	1.12	21.63	0.83	23.72	1.34	0.01	101.8	68	0.13	0.02	69.57
90-23-px15-r2c	90-23	opx	core	main	52.71	0.17	1.16	21.55	0.87	23.67	1.37	0.02	101.5	69	0.14	0.02	69.94
90-23-px16a	90-23	opx	pheno	main	52.94	0.19	1.03	21.7	0.75	23.53	1.33	0.01	101.5	68	0.17	0.02	68.93
90-23-px16a-z1-r2c	90-23	opx	rim	main	52.93	0.26	1.27	21.98	0.88	22.9	1.38	0.03	101.6	67	0.24	0.02	67.32
90-23-px16a-z1-r2c	90-23	opx	rim	main	52.83	0.22	1.3	22.11	0.82	23.12	1.32	0.01	101.7	67	0.19	0.02	67.90
90-23-px16a-z1-r2c	90-23	opx	rim	main	52.53	0.23	1.23	22.05	0.79	23.36	1.35	0.02	101.6	68	0.20	0.03	69.09
90-23-px16a-z1-r2c	90-23	opx	rim	main	52.8	0.24	1.16	22.05	0.77	23.42	1.34	0.02	101.8	68	0.21	0.02	68.85
90-23-px16a-z1-r2c	90-23	opx	rim	main	52.9	0.18	1.02	22.03	0.81	23.51	1.31	0.03	101.8	68	0.15	0.02	69.09
90-23-px16a-z1-r2c	90-23	opx	rim	main	52.71	0.18	1.03	21.78	0.82	23.27	1.32	0.02	101.1	68	0.16	0.02	68.60
90-23-px16a-z1-r2c	90-23	opx	rim	main	52.77	0.2	0.98	21.66	0.79	23.51	1.31	0.03	101.3	68	0.17	0.02	69.22
90-23-px16a-z1-r2c	90-23	opx	rim	main	52.67	0.18	0.94	21.69	0.77	23.65	1.32	0.02	101.2	68	0.15	0.02	69.74
90-23-px16a-z1-r2c	90-23	opx	rim	main	52.74	0.18	1.04	21.63	0.77	23.72	1.32	0.01	101.4	68	0.15	0.02	69.79
90-23-px16a-z1-r2c	90-23	opx	rim	main	52.81	0.19	1.21	21.66	0.74	23.92	1.34	0.02	101.9	69	0.16	0.02	70.33
90-23-px16a-z1-r2c	90-23	opx	rim	main	52.63	0.2	1.22	21.58	0.77	23.87	1.35	0.02	101.6	69	0.17	0.02	70.47
90-23-px16a-z1-r2c	90-23	opx	rim	main	52.63	0.19	1.12	21.42	0.73	23.76	1.33	0.02	101.2	69	0.16	0.02	70.07
90-23-px16a-z1-r2c	90-23	opx	rim	main	52.8	0.19	1.25	21.56	0.72	23.95	1.39	0.02	101.9	69	0.16	0.02	70.48
90-23-px16a-z1-r2c	90-23	opx	rim	main	52.83	0.19	1.25	21.41	0.76	23.96	1.37	0.02	101.8	69	0.16	0.02	70.48

SAMPLE GRAIN ID	Sample	Min	Texture	stage	SiO2	TiO2	Al2O3	FeO*	MnO	MgO	CaO	Na2O	Total	Mg #	FeO	Fe2O3	Mg # (Fe2+ only)
90-23-px16a-z1-r2c	90-23	opx	rim	main	52.79	0.2	1.27	21.37	0.74	24.01	1.35	0.02	101.8	69	0.17	0.02	70.62
90-23-px16a-z1-r2c	90-23	opx	rim	main	52.86	0.18	1.26	21.24	0.72	24.18	1.35	0.02	101.8	69	0.15	0.02	71.02
90-23-px16a-z1-r2c	90-23	opx	rim	main	52.93	0.19	1.24	21.09	0.73	24.08	1.31	0.02	101.6	69	0.16	0.02	70.56
90-23-px16a-z1-r2c	90-23	opx	core	main	52.36	0.19	1.57	21.51	0.67	23.92	1.29	0.02	101.5	69	0.16	0.02	70.80
90-23-px16a-z1-r2c	90-23	opx	core	main	52.51	0.21	1.6	21.5	0.69	23.93	1.33	0.02	101.8	69	0.17	0.03	70.68
90-23-px16a-z1-r2c	90-23	opx	core	main	52.54	0.2	1.65	21.48	0.73	23.97	1.36	0.01	101.9	69	0.17	0.03	70.81
90-23-px16a-z1-r2c	90-23	opx	core	main	52.61	0.2	1.5	21.51	0.71	24.12	1.33	0.02	102	69	0.16	0.03	71.14
90-23-px16a-z1-r2c	90-23	opx	core	main	53.08	0.21	1.23	21.37	0.7	24.03	1.29	0.01	101.9	69	0.18	0.02	70.07
90-23-px16a-z1-r2c	90-23	opx	core	main	52.62	0.18	1.37	21.38	0.69	24.07	1.37	0.04	101.7	69	0.15	0.02	71.14
90-23-px16a-z1-r2c	90-23	opx	core	main	52.93	0.19	1.23	21.31	0.69	24.06	1.37	0.01	101.8	69	0.16	0.02	70.49
90-23-px16a-z1-r2c	90-23	opx	core	main	52.94	0.2	1.1	21.33	0.72	24.09	1.37	0.02	101.8	69	0.17	0.02	70.65
90-23-px16a-z1-r2c	90-23	opx	core	main	52.89	0.17	1.24	21.23	0.72	24.19	1.36	0.01	101.8	69	0.14	0.02	70.98
90-23-px16a-z1-r2c	90-23	opx	core	main	52.96	0.19	1.32	21	0.72	23.93	1.33	0.03	101.5	69	0.17	0.02	70.14
90-23-px16a-z1-r2c	90-23	opx	core	main	52.98	0.16	1.11	21.22	0.7	24.2	1.32	0.02	101.7	69	0.13	0.02	70.86
90-23-px16a-z1-r2c	90-23	opx	core	main	52.98	0.2	1.23	21.04	0.71	24.03	1.3	0.02	101.5	69	0.17	0.02	70.29
90-23-px16a-z1-r2c	90-23	opx	core	main	52.82	0.18	1.23	21.04	0.69	24.1	1.25	0.01	101.3	69	0.15	0.02	70.59
90-23-px16a-z1-r2c	90-23	opx	core	main	53.05	0.17	1	21.17	0.71	24.25	1.36	0.02	101.7	69	0.14	0.02	70.97
90-23-px16a-z1-r2c	90-23	opx	core	main	52.79	0.17	1.21	21.16	0.7	24.3	1.35	0.02	101.7	69	0.14	0.02	71.46
90-23-px16a-z1-r2c	90-23	opx	core	main	52.93	0.18	1.26	21.13	0.7	24.3	1.3	0.02	101.8	70	0.15	0.02	71.17
90-23-px16b	90-23	opx	overgrowth	main	52.7	0.16	1.38	22.15	0.76	23.68	1.31	0.02	102.2	68	0.13	0.02	69.79
90-23-px16b	90-23	opx	overgrowth	main	52.53	0.18	1.37	21.31	0.7	24.22	1.35	0	101.7	69	0.15	0.02	71.48
90-23-px16b	90-23	opx	overgrowth	main	52.31	0.19	1.69	20.83	0.66	24.7	1.39	0.01	101.8	70	0.15	0.03	73.27
90-23-px18	90-23	opx	glom	main	53.39	0.14	0.59	22.19	0.85	23.92	1.05	0.02	102.2	68	0.12	0.01	69.28
90-23-px18	90-23	opx	glom	main	52.58	0.18	1.05	21.46	0.68	23.84	1.44	0.02	101.3	69	0.15	0.02	70.50
90-23-px19	90-23	opx	glom	main	52.78	0.17	0.88	22.07	0.77	23.36	1.46	0.02	101.5	68	0.15	0.02	68.95

SAMPLE GRAIN ID	Sample	Min	Texture	stage	SiO2	TiO2	Al2O3	FeO*	MnO	MgO	CaO	Na2O	Total	Mg #	FeO	Fe2O3	Mg # (Fe2+ only)
90-23-px19	90-23	opx	glom	main	52.91	0.19	0.95	22.5	0.81	23.84	1.22	0.01	102.4	68	0.16	0.03	69.82
90-23-px19	90-23	opx	glom	main	52.74	0.21	1.45	22.17	0.72	23.57	1.35	0.03	102.2	68	0.18	0.02	69.42
90-23-px19	90-23	opx	glom	main	52.99	0.17	0.99	21.62	0.8	24.03	1.26	0.02	101.9	69	0.14	0.02	70.37
90-23-px19	90-23	opx	glom	main	53.29	0.13	0.6	21.3	0.75	24.31	1.19	0.03	101.6	69	0.11	0.01	70.70
90-23-px1a	90-23	opx	pheno	main	51.69	0.23	2.12	23.09	0.79	23.04	1.23	0.03	102.2	66	0.18	0.04	69.22
90-23-px1a	90-23	opx	pheno	main	52.22	0.22	1.55	22.66	0.75	23.36	1.34	0.01	102.1	67	0.18	0.03	69.44
90-23-px1a	90-23	opx	pheno	main	52.9	0.15	0.87	22.18	0.78	23.68	1.27	0.01	101.8	68	0.13	0.02	69.43
90-23-px1a	90-23	opx	pheno	main	52.64	0.19	1.12	21.74	0.74	23.54	1.38	0.01	101.4	68	0.16	0.02	69.44
90-23-px1a	90-23	opx	pheno	main	53.27	0.15	0.82	21.55	0.83	23.76	1.33	0.01	101.7	69	0.13	0.01	69.28
90-23-px1a	90-23	opx	pheno	main	53.02	0.17	1.14	21.18	0.7	23.94	1.36	-0.01	101.5	69	0.15	0.02	69.91
90-23-px20-z1-r2c	90-23	opx	rim	main	52.51	0.2	1.31	22.58	0.8	23.48	1.39	0.02	102.3	67	0.16	0.03	69.60
90-23-px20-z1-r2c	90-23	opx	rim	main	52.82	0.2	0.96	22.52	0.89	23.51	1.34	0.01	102.3	67	0.17	0.03	69.23
90-23-px20-z1-r2c	90-23	opx	rim	main	51.84	0.2	1.27	22.09	0.76	23.12	1.35	0.02	100.7	67	0.17	0.03	69.34
90-23-px20-z1-r2c	90-23	opx	rim	main	52.77	0.18	1.21	22.2	0.84	23.31	1.38	0	101.9	68	0.15	0.02	68.66
90-23-px20-z1-r2c	90-23	opx	rim	main	52.73	0.21	1.15	22.19	0.84	23.51	1.4	0.02	102.1	68	0.18	0.03	69.42
90-23-px20-z1-r2c	90-23	opx	rim	main	53.08	0.17	0.87	22.25	0.82	23.65	1.31	0.01	102.2	68	0.14	0.02	69.18
90-23-px20-z1-r2c	90-23	opx	rim	main	52.52	0.19	1.11	22.18	0.81	23.66	1.34	0.01	101.8	68	0.16	0.03	70.01
90-23-px20-z1-r2c	90-23	opx	rim	main	52.86	0.2	1.18	21.85	0.75	23.45	1.38	0	101.7	68	0.17	0.02	68.81
90-23-px20-z1-r2c	90-23	opx	rim	main	53.06	0.19	0.95	21.91	0.81	23.62	1.33	0.02	101.9	68	0.16	0.02	69.16
90-23-px20-z1-r2c	90-23	opx	rim	main	52.55	0.17	1.3	21.87	0.79	23.63	1.36	0.02	101.7	68	0.14	0.02	69.95
90-23-px20-z1-r2c	90-23	opx	rim	main	52.75	0.18	1.17	21.71	0.82	23.75	1.34	0.02	101.7	68	0.15	0.02	70.01
90-23-px20-z1-r2c	90-23	opx	rim	main	52.84	0.2	1.09	21.6	0.75	23.85	1.41	0.03	101.8	69	0.17	0.02	70.24
90-23-px20-z1-r2c	90-23	opx	rim	main	52.81	0.22	1.18	21.52	0.75	23.87	1.38	0.02	101.8	69	0.19	0.02	70.21
90-23-px20-z1-r2c	90-23	opx	rim	main	53.07	0.18	1.11	21.34	0.71	24.06	1.38	0.02	101.9	69	0.15	0.02	70.40
90-23-px20-z1-r2c	90-23	opx	rim	main	53.09	0.2	1.09	20.97	0.73	24.22	1.38	0.02	101.7	70	0.17	0.02	70.84

SAMPLE GRAIN ID	Sample	Min	Texture	stage	SiO2	TiO2	Al2O3	FeO*	MnO	MgO	CaO	Na2O	Total	Mg #	FeO	Fe2O3	Mg # (Fe2+ only)
90-23-px20-z1-r2c	90-23	opx	rim	main	52.72	0.2	1.42	20.99	0.7	24.35	1.34	0	101.7	70	0.17	0.02	71.55
90-23-px20-z1-r2c	90-23	opx	rim	main	52.69	0.21	1.61	20.86	0.67	24.39	1.31	0.01	101.8	70	0.17	0.03	71.67
90-23-px20-z1-r2c	90-23	opx	rim	main	53.11	0.18	1.24	20.17	0.65	24.75	1.32	0.01	101.4	71	0.15	0.02	72.13
90-23-px20-z1-r2c	90-23	opx	rim	main	53.37	0.18	1.17	20.15	0.63	25.01	1.34	0.01	101.9	71	0.15	0.02	72.53
90-23-px20-z1-r2c	90-23	opx	rim	main	53.41	0.21	1.2	19.75	0.63	25.05	1.38	0.01	101.6	72	0.18	0.02	72.60
90-23-px20-z1-r2c	90-23	opx	rim	main	53.31	0.2	1.29	19.77	0.61	25.29	1.35	0.01	101.8	72	0.17	0.02	73.40
90-23-px20-z1-r2c	90-23	opx	rim	main	53.19	0.16	1.16	19.65	0.63	25.2	1.34	0.01	101.3	72	0.13	0.02	73.35
90-23-px20-z1-r2c	90-23	opx	rim	main	53.27	0.18	1.22	19.67	0.59	25.25	1.33	0.02	101.5	72	0.15	0.02	73.36
90-23-px20-z1-r2c	90-23	opx	rim	main	53.51	0.16	1.08	19.26	0.63	25.19	1.36	0	101.2	72	0.14	0.01	72.82
90-23-px20-z1-r2c	90-23	opx	core	main	53.11	0.18	0.81	22.02	0.83	23.75	1.07	0.01	101.8	68	0.16	0.02	69.07
90-23-px20-z1-r2c	90-23	opx	core	main	52.87	0.18	2.39	20.01	0.63	22.04	1.33	0.01	99.5	69	0.20	-0.01	64.30
90-23-px20-z1-r2c	90-23	opx	core	main	53.25	0.17	0.99	21.62	0.79	23.87	1.27	0.03	102	69	0.15	0.02	69.59
90-23-px20-z1-r2c	90-23	opx	core	main	52.98	0.18	0.94	21.42	0.8	24.55	1.2	0.01	102.1	69	0.15	0.02	71.76
90-23-px20-z1-r2c	90-23	opx	core	main	52.83	0.19	1.09	20.86	0.76	24.35	1.27	0.01	101.4	70	0.16	0.02	71.42
90-23-px20-z1-r2c	90-23	opx	core	main	53.12	0.22	1.21	20.58	0.68	24.82	1.32	0.03	102	71	0.18	0.03	72.44
90-23-px20-z1-r2c	90-23	opx	core	main	52.96	0.21	2.38	20.05	0.56	24.28	1.24	0.01	101.7	71	0.19	0.01	70.68
90-23-px20-z1-r2c	90-23	opx	core	main	52.39	0.2	1.81	20.36	0.64	24.9	1.35	0.02	101.7	71	0.16	0.03	73.70
90-23-px20-z1-r2c	90-23	opx	core	main	52.89	0.19	2.2	20	0.6	24.87	1.27	0.02	102	71	0.16	0.02	72.70
90-23-px20-z1-r2c	90-23	opx	core	main	52.01	0.21	2.76	20.19	0.59	25.25	1.25	0.02	102.3	71	0.16	0.04	75.07
90-23-px20-z1-r2c	90-23	opx	core	main	52.71	0.17	1.74	19.59	0.6	24.83	1.29	0.01	100.9	72	0.14	0.02	72.83
90-23-px20-z1-r2c	90-23	opx	core	main	52.65	0.19	2.22	19.59	0.57	25.76	1.29	0.01	102.3	72	0.14	0.03	75.61
90-23-px21-r2c	90-23	opx	rim	main	52.62	0.24	1.22	22.44	0.84	23.27	1.6	0.02	102.3	67	0.20	0.03	69.13
90-23-px21-r2c	90-23	opx	rim	main	52.8	0.18	1.08	22.51	0.8	23.41	1.3	0.02	102.1	67	0.15	0.02	68.87
90-23-px21-r2c	90-23	opx	rim	main	52.49	0.24	1.74	22.16	0.74	23.17	1.71	0.03	102.3	67	0.20	0.03	69.11
90-23-px21-r2c	90-23	opx	rim	main	52.76	0.21	1.12	22.47	0.78	23.57	1.29	0.03	102.2	68	0.17	0.03	69.39

SAMPLE GRAIN ID	Sample	Min	Texture	stage	SiO2	TiO2	Al2O3	FeO*	MnO	MgO	CaO	Na2O	Total	Mg #	FeO	Fe2O3	Mg # (Fe2+ only)
90-23-px21-r2c	90-23	opx	rim	main	52.83	0.19	1.15	22.43	0.78	23.57	1.3	0.01	102.3	68	0.16	0.02	69.22
90-23-px21-r2c	90-23	opx	rim	main	52.26	0.27	1.66	22.26	0.76	23.39	1.67	0.02	102.3	68	0.22	0.04	69.98
90-23-px21-r2c	90-23	opx	rim	main	52.87	0.24	1.14	22.2	0.83	23.41	1.38	0.01	102.1	68	0.21	0.03	68.80
90-23-px21-r2c	90-23	opx	rim	main	52.56	0.22	1.34	22.2	0.78	23.43	1.57	0.02	102.1	68	0.18	0.03	69.60
90-23-px21-r2c	90-23	opx	rim	main	52.79	0.21	1.09	22.15	0.79	23.49	1.43	0.01	102	68	0.18	0.02	69.21
90-23-px21-r2c	90-23	opx	rim	main	52.77	0.2	1.17	22.22	0.75	23.56	1.43	0.01	102.1	68	0.17	0.02	69.41
90-23-px21-r2c	90-23	opx	rim	main	52.71	0.21	1.24	22.11	0.79	23.44	1.48	0.02	102	68	0.18	0.02	69.30
90-23-px21-r2c	90-23	opx	rim	main	52.78	0.18	1.13	22.13	0.81	23.5	1.29	0.02	101.8	68	0.15	0.02	69.15
90-23-px21-r2c	90-23	opx	rim	main	52.61	0.21	1.21	22.17	0.8	23.59	1.42	0.02	102	68	0.17	0.03	69.81
90-23-px21-r2c	90-23	opx	rim	main	52.79	0.21	1.27	22.1	0.73	23.62	1.48	0.02	102.2	68	0.18	0.03	69.65
90-23-px21-r2c	90-23	opx	rim	main	52.58	0.21	1.36	22.14	0.77	23.68	1.52	0.02	102.3	68	0.17	0.03	70.24
90-23-px21-r2c	90-23	opx	rim	main	52.56	0.24	1.32	22.09	0.76	23.68	1.56	0.01	102.2	68	0.20	0.03	70.23
90-23-px21-r2c	90-23	opx	rim	main	52.72	0.26	1.26	21.87	0.77	23.5	1.44	0.01	101.8	68	0.22	0.03	69.27
90-23-px21-r2c	90-23	opx	rim	main	53.06	0.18	0.98	22.03	0.75	23.87	1.34	0.01	102.2	68	0.15	0.02	69.81
90-23-px21-r2c	90-23	opx	rim	main	53.03	0.2	1.13	21.94	0.8	23.78	1.44	0.02	102.3	68	0.17	0.02	69.82
90-23-px21-r2c	90-23	opx	rim	main	52.91	0.19	1.19	21.92	0.79	24.05	1.31	0.01	102.4	68	0.16	0.02	70.54
90-23-px21-r2c	90-23	opx	rim	main	53.21	0.21	1.17	21.64	0.73	23.81	1.43	0	102.2	69	0.18	0.02	69.43
90-23-px21-r2c	90-23	opx	rim	main	52.75	0.26	1.46	21.5	0.74	23.67	1.62	0.01	102	69	0.22	0.03	69.95
90-23-px21-r2c	90-23	opx	rim	main	52.65	0.23	1.55	21.6	0.72	23.79	1.61	0.03	102.2	69	0.19	0.03	70.56
90-23-px21-r2c	90-23	opx	rim	main	52.32	0.22	1.61	21.71	0.71	23.91	1.54	0.01	102	69	0.18	0.03	71.18
90-23-px21-r2c	90-23	opx	rim	main	52.93	0.21	1.5	21.34	0.69	24.08	1.56	0	102.3	69	0.18	0.02	70.77
90-23-px21-r2c	90-23	opx	rim	main	53.24	0.18	1.05	20.84	0.69	24.45	1.44	0.01	101.9	70	0.15	0.02	71.31
90-23-px21-r2c	90-23	opx	core	main	52.73	0.22	1.2	22.25	0.82	23.33	1.44	0.02	102	68	0.19	0.02	68.91
90-23-px21-r2c	90-23	opx	core	main	52.8	0.2	1.05	22.56	0.76	23.65	1.32	0.02	102.4	68	0.16	0.03	69.55
90-23-px21-r2c	90-23	opx	core	main	52.69	0.22	1.13	22.39	0.81	23.6	1.37	0.03	102.2	68	0.18	0.03	69.72

SAMPLE GRAIN ID	Sample	Min	Texture	stage	SiO2	TiO2	Al2O3	FeO*	MnO	MgO	CaO	Na2O	Total	Mg #	FeO	Fe2O3	Mg # (Fe2+ only)
90-23-px21-r2c	90-23	opx	core	main	52.59	0.21	1.28	22.25	0.78	23.47	1.46	0.02	102.1	68	0.17	0.03	69.52
90-23-px21-r2c	90-23	opx	core	main	52.75	0.17	1.08	22.31	0.8	23.56	1.35	0.01	102	68	0.14	0.02	69.41
90-23-px21-r2c	90-23	opx	core	main	52.71	0.22	1.21	22.1	0.77	23.77	1.41	0.02	102.2	68	0.18	0.03	70.15
90-23-px21-r2c	90-23	opx	core	main	52.94	0.22	1.13	21.87	0.76	23.97	1.34	0	102.2	68	0.18	0.03	70.18
90-23-px21-r2c	90-23	opx	core	main	53.07	0.17	1.08	21.9	0.71	24.16	1.35	0.02	102.5	69	0.14	0.02	70.68
90-23-px21-r2c	90-23	opx	core	main	52.33	0.24	1.92	20.88	0.66	23.65	2.03	0.01	101.7	69	0.20	0.03	71.03
90-23-px21-r2c	90-23	opx	core	main	52.45	0.21	1.72	21.08	0.69	24.05	1.45	0.02	101.7	69	0.17	0.03	71.30
90-23-px21-r2c	90-23	opx	core	main	53.18	0.21	1.16	21.32	0.71	24.38	1.35	0.01	102.3	69	0.18	0.02	71.06
90-23-px21-r2c	90-23	opx	core	main	53.06	0.22	1.28	21.29	0.68	24.42	1.43	0	102.4	69	0.18	0.03	71.37
90-23-px21-r2c	90-23	opx	core	main	52.68	0.23	1.48	21.1	0.68	24.32	1.45	0.01	102	70	0.19	0.03	71.68
90-23-px21-r2c	90-23	opx	core	main	53.11	0.18	1.13	21.11	0.68	24.55	1.33	0	102.1	70	0.15	0.02	71.57
90-23-px3	90-23	opx	pheno	main	53	0.19	0.96	22.02	0.76	23.69	1.37	0.01	102	68	0.16	0.02	69.40
90-23-px3	90-23	opx	pheno	main	52.73	0.18	1.18	22.01	0.72	23.76	1.36	0.02	102	68	0.15	0.02	69.99
90-23-px5	90-23	opx	pheno	main	52.07	0.23	1.46	22.72	0.75	22.75	1.31	0.01	101.3	66	0.20	0.03	67.76
90-23-px5	90-23	opx	pheno	main	52.54	0.2	1.17	22.54	0.81	22.94	1.36	0.01	101.6	67	0.17	0.02	67.85
90-23-px5	90-23	opx	pheno	main	52.49	0.18	1.11	22.49	0.77	23.01	1.22	0.03	101.3	67	0.16	0.02	68.00
90-23-px5	90-23	opx	pheno	main	52.79	0.17	1.06	22.23	0.75	23.35	1.29	0.02	101.7	68	0.15	0.02	68.63
90-23-px5	90-23	opx	pheno	main	52.66	0.16	1.03	22.12	0.78	23.31	1.33	0.02	101.4	68	0.14	0.02	68.80
90-23-px5	90-23	opx	pheno	main	52.84	0.18	1.21	21.42	0.88	23.25	1.26	0.02	101.1	68	0.16	0.01	68.33
90-23-px5	90-23	opx	pheno	main	53.41	0.17	0.75	20.51	0.74	24.28	1.48	0.03	101.4	70	0.15	0.01	70.80
90-23-px5-z1-r2c	90-23	opx	rim	main	53.18	0.23	1.47	21.47	0.83	22.53	1.88	0.04	101.6	68	0.22	0.01	66.60
90-23-px5-z1-r2c	90-23	opx	rim	main	52.62	0.26	1.21	21.75	0.86	23.22	1.67	0.04	101.6	68	0.22	0.03	69.18
90-23-px5-z1-r2c	90-23	opx	rim	main	52.88	0.24	1.23	21.64	0.86	23.43	1.65	0.03	102	68	0.21	0.02	69.38
90-23-px5-z1-r2c	90-23	opx	rim	main	52.79	0.24	1.26	21.24	0.81	23.8	1.44	0.02	101.6	69	0.21	0.03	70.17
90-23-px5-z1-r2c	90-23	opx	rim	main	52.79	0.2	1.35	21.18	0.75	23.93	1.38	0.02	101.6	69	0.17	0.02	70.43

SAMPLE GRAIN ID	Sample	Min	Texture	stage	SiO2	TiO2	Al2O3	FeO*	MnO	MgO	CaO	Na2O	Total	Mg #	FeO	Fe2O3	Mg # (Fe2+ only)
90-23-px5-z1-r2c	90-23	opx	core	main	52.06	0.25	1.86	22.06	0.8	23.07	1.63	0.03	101.8	67	0.21	0.03	69.35
90-23-px5-z1-r2c	90-23	opx	core	main	52.1	0.22	1.89	21.93	0.76	23.03	1.69	0.03	101.7	68	0.18	0.03	69.24
90-23-px5-z1-r2c	90-23	opx	core	main	52.16	0.22	1.73	22.1	0.8	23.29	1.7	0.02	102	68	0.18	0.03	69.96
90-23-px5-z1-r2c	90-23	opx	core	main	51.94	0.25	1.89	21.12	0.76	22.79	2.47	0.02	101.2	68	0.21	0.03	69.83
90-23-px5-z1-r2c	90-23	opx	core	main	52.76	0.22	1.32	21.72	0.77	23.56	1.5	0.02	101.9	68	0.19	0.02	69.57
90-23-px5-z1-r2c	90-23	opx	core	main	52.51	0.21	1.63	21.57	0.76	23.45	1.67	0.01	101.8	68	0.18	0.02	69.79
90-23-px5-z1-r2c	90-23	opx	core	main	52.95	0.23	1.19	21.65	0.77	23.88	1.34	0.01	102	69	0.20	0.03	69.95
90-23-px5-z1-r2c	90-23	opx	core	main	52.63	0.19	1.23	21.45	0.8	23.79	1.34	0.02	101.5	69	0.16	0.02	70.26
90-23-px5-z1-r2c	90-23	opx	core	main	52.9	0.19	1.23	21.12	0.74	23.7	1.86	0.01	101.8	69	0.16	0.02	70.26
90-23-px5-z1-r2c	90-23	opx	core	main	53.33	0.12	0.88	21.3	0.76	24.17	1.45	0.02	102	69	0.10	0.01	70.59
90-23-px5-z1-r2c	90-23	opx	core	main	52.99	0.21	1.16	21.09	0.77	24.01	1.31	0.02	101.6	69	0.18	0.02	70.29
90-23-px5-z1-r2c	90-23	opx	core	main	52.99	0.21	1.31	21.13	0.76	24.11	1.41	0.01	101.9	69	0.18	0.02	70.67
90-23-px5-z1-r2c	90-23	opx	core	main	52.91	0.21	1.44	20.91	0.75	24.03	1.51	0.02	101.8	69	0.18	0.02	70.74
90-23-px5-z1-r2c	90-23	opx	core	main	53.3	0.11	0.87	21.03	0.74	24.32	1.48	0.02	101.9	70	0.09	0.01	71.10
90-23-px5-z1-r2c	90-23	opx	core	main	53.38	0.13	0.86	20.78	0.69	24.6	1.45	0.01	101.9	70	0.11	0.01	71.62
90-23-px5-z1-r2c	90-23	opx	core	main	53.59	0.12	0.83	20.63	0.69	24.59	1.52	0.01	102	70	0.10	0.01	71.41
90-23-px7a	90-23	opx	pheno	main	53.62	0.15	0.92	20.78	0.65	24.66	1.39	0.03	102.2	70	0.13	0.02	71.41
90-23-px7a-z1-r2c	90-23	opx	rim	main	53.52	0.24	1.19	21.87	0.88	22.76	1.85	0.02	102.3	67	0.22	0.01	66.75
90-23-px7a-z1-r2c	90-23	opx	rim	main	52.53	0.22	0.96	21.88	0.88	23.14	1.96	0.03	101.6	68	0.18	0.03	69.52
90-23-px7a-z1-r2c	90-23	opx	rim	main	52.63	0.25	1.25	21.71	0.87	22.97	1.88	0.03	101.6	68	0.22	0.02	68.69
90-23-px7a-z1-r2c	90-23	opx	rim	main	52.09	0.24	1.12	21.75	0.89	23.03	2.19	0.01	101.3	68	0.20	0.03	70.05
90-23-px7a-z1-r2c	90-23	opx	rim	main	52.3	0.23	1.34	21.58	0.88	23.17	1.86	0.03	101.4	68	0.19	0.03	69.77
90-23-px7a-z1-r2c	90-23	opx	rim	main	52.59	0.22	1.25	21.66	0.83	23.48	1.61	0.02	101.7	68	0.19	0.03	69.81
90-23-px7a-z1-r2c	90-23	opx	rim	main	52.56	0.22	1.22	21.08	0.83	23.7	1.57	0.02	101.2	69	0.19	0.02	70.43
90-23-px7a-z1-r2c	90-23	opx	rim	main	52.61	0.21	1.19	21.1	0.8	24	1.47	0.02	101.4	69	0.17	0.03	71.08

SAMPLE GRAIN ID	Sample	Min	Texture	stage	SiO2	TiO2	Al2O3	FeO*	MnO	MgO	CaO	Na2O	Total	Mg #	FeO	Fe2O3	Mg # (Fe2+ only)
90-23-px7a-z1-r2c	90-23	opx	rim	main	52.69	0.21	1.22	21.02	0.76	24.06	1.47	0.01	101.4	69	0.18	0.02	71.04
90-23-px7a-z1-r2c	90-23	opx	rim	main	52.85	0.21	1.15	21.09	0.8	24.16	1.38	0.03	101.7	69	0.18	0.02	71.13
90-23-px7a-z1-r2c	90-23	opx	rim	main	52.78	0.19	1.19	20.69	0.76	24.17	1.44	0.02	101.2	70	0.16	0.02	71.26
90-23-px7a-z1-r2c	90-23	opx	core	main	52.35	0.24	1.36	22.03	0.81	22.95	1.81	0.03	101.6	67	0.20	0.03	68.87
90-23-px7a-z1-r2c	90-23	opx	core	main	52.51	0.25	1.38	22.23	0.78	23.29	1.64	0.04	102.1	67	0.21	0.03	69.43
90-23-px7a-z1-r2c	90-23	opx	core	main	52.6	0.21	1.34	22.19	0.73	23.25	1.55	0.03	101.9	67	0.18	0.02	68.97
90-23-px7a-z1-r2c	90-23	opx	core	main	52.37	0.25	1.4	21.94	0.79	23.06	1.72	0.01	101.5	68	0.21	0.03	68.89
90-23-px7a-z1-r2c	90-23	opx	core	main	52.7	0.25	1.28	21.84	0.81	23.19	1.69	0.03	101.8	68	0.21	0.03	68.90
90-23-px7a-z1-r2c	90-23	opx	core	main	52.64	0.21	1.21	21.92	0.76	23.32	1.48	0.01	101.6	68	0.18	0.02	68.94
90-23-px7a-z1-r2c	90-23	opx	core	main	52.92	0.2	1.14	22.01	0.77	23.51	1.5	0.02	102.1	68	0.17	0.02	69.23
90-23-px7a-z1-r2c	90-23	opx	core	main	52.82	0.22	1.24	21.69	0.75	23.37	1.65	0.04	101.8	68	0.19	0.02	69.23
90-23-px7a-z1-r2c	90-23	opx	core	main	52.73	0.23	1.19	21.74	0.8	23.58	1.57	0.02	101.9	68	0.19	0.03	69.80
90-23-px7a-z1-r2c	90-23	opx	core	main	52.75	0.25	1.14	21.61	0.75	23.62	1.5	0.01	101.6	68	0.21	0.03	69.65
90-23-px7a-z1-r2c	90-23	opx	core	main	52.29	0.23	1.59	21.24	0.77	23.31	1.62	0.04	101.1	69	0.20	0.02	69.75
90-23-px7a-z1-r2c	90-23	opx	core	main	53.11	0.2	1.16	21.46	0.79	23.62	1.48	0.04	101.9	69	0.17	0.02	69.37
90-23-px7a-z1-r2c	90-23	opx	core	main	52.63	0.21	1.13	21.29	0.76	23.63	1.45	0.02	101.1	69	0.18	0.02	69.87
90-23-px7a-z1-r2c	90-23	opx	core	main	52.94	0.19	1.06	21.32	0.78	23.79	1.43	0.02	101.5	69	0.16	0.02	69.93
90-23-px7a-z1-r2c	90-23	opx	core	main	53.08	0.2	0.99	21.41	0.76	23.96	1.34	0.02	101.8	69	0.17	0.02	70.07
90-23-px7a-z1-r2c	90-23	opx	core	main	53.13	0.18	1.15	21.21	0.78	23.8	1.34	0.01	101.6	69	0.16	0.02	69.51
90-23-px7a-z1-r2c	90-23	opx	core	main	52.92	0.21	1.08	21.24	0.76	23.85	1.38	0.01	101.5	69	0.18	0.02	69.96
90-23-px7a-z1-r2c	90-23	opx	core	main	53.19	0.22	1.02	21.26	0.75	23.93	1.37	0.01	101.8	69	0.19	0.02	69.78
90-23-px7a-z1-r2c	90-23	opx	core	main	52.86	0.24	1.17	21.26	0.77	23.96	1.5	0.01	101.8	69	0.20	0.03	70.53
90-23-px7a-z1-r2c	90-23	opx	core	main	53.1	0.17	1.03	21.15	0.78	23.99	1.4	0.02	101.6	69	0.15	0.02	70.27
90-23-px7a-z1-r2c	90-23	opx	core	main	52.81	0.2	1.23	20.81	0.75	24.03	1.42	0.03	101.3	70	0.17	0.02	70.81
90-23-px9-z1-r2c	90-23	opx	rim	main	52.25	0.21	1.08	21.81	0.85	22.16	1.53	0.04	99.9	67	0.19	0.01	66.30

SAMPLE GRAIN ID	Sample	Min	Texture	stage	SiO2	TiO2	Al2O3	FeO*	MnO	MgO	CaO	Na2O	Total	Mg #	FeO	Fe2O3	Mg # (Fe2+ only)
90-23-px9-z1-r2c	90-23	opx	rim	main	53	0.24	1.11	22.03	0.8	23	1.56	0.02	101.8	67	0.21	0.02	67.67
90-23-px9-z1-r2c	90-23	opx	rim	main	52.96	0.19	0.97	22.11	0.83	23.13	1.33	0.01	101.5	67	0.17	0.02	67.81
90-23-px9-z1-r2c	90-23	opx	rim	main	53.06	0.18	0.98	22.05	0.8	23.2	1.32	0.01	101.6	68	0.16	0.01	67.84
90-23-px9-z1-r2c	90-23	opx	rim	main	52.84	0.23	1.06	21.96	0.86	23.17	1.55	0.03	101.7	68	0.20	0.02	68.52
90-23-px9-z1-r2c	90-23	opx	rim	main	52.85	0.23	1.14	22.05	0.89	23.29	1.56	0.05	102.1	68	0.20	0.03	69.03
90-23-px9-z1-r2c	90-23	opx	rim	main	52.81	0.21	1.09	21.81	0.86	23.06	1.49	0.02	101.4	68	0.19	0.02	68.10
90-23-px9-z1-r2c	90-23	opx	rim	main	53.05	0.18	1.01	21.94	0.84	23.4	1.3	0.01	101.7	68	0.16	0.02	68.47
90-23-px9-z1-r2c	90-23	opx	rim	main	53.08	0.19	0.98	21.8	0.82	23.33	1.35	0.01	101.6	68	0.17	0.02	68.25
90-23-px9-z1-r2c	90-23	opx	rim	main	53.13	0.19	0.97	21.49	0.84	23.44	1.34	0.01	101.4	68	0.17	0.01	68.51
90-23-px9-z1-r2c	90-23	opx	rim	main	53.19	0.2	0.91	21.42	0.81	23.69	1.35	0	101.6	69	0.18	0.02	69.08
90-23-px9-z1-r2c	90-23	opx	rim	main	53.46	0.18	0.88	21.47	0.8	23.78	1.34	0	101.9	69	0.16	0.01	68.97
90-23-px9-z1-r2c	90-23	opx	rim	main	53.53	0.17	0.85	21.17	0.8	23.94	1.35	0.02	101.8	69	0.15	0.01	69.47
90-23-px9-z1-r2c	90-23	opx	rim	main	53.6	0.16	0.84	21	0.8	24.02	1.38	0.02	101.8	69	0.14	0.01	69.65
90-23-px9-z1-r2c	90-23	opx	rim	main	53.7	0.18	0.8	20.85	0.8	24.1	1.37	0.02	101.8	70	0.16	0.01	69.71
90-23-px9-z1-r2c	90-23	opx	rim	main	53.61	0.17	0.77	20.87	0.8	24.16	1.43	0.03	101.8	70	0.15	0.01	70.17
90-23-px9-z1-r2c	90-23	opx	core	main	53.13	0.23	1.22	21.48	0.79	23.26	1.44	0.02	101.6	68	0.21	0.02	68.07
90-23-px9-z1-r2c	90-23	opx	core	main	53	0.16	1.02	21.56	0.82	23.39	1.42	0.01	101.4	68	0.14	0.01	68.67
90-23-px9-z1-r2c	90-23	opx	core	main	53.06	0.22	0.96	21.58	0.85	23.51	1.36	0.02	101.6	68	0.19	0.02	68.88
90-23-px9-z1-r2c	90-23	opx	core	main	53.55	0.18	0.84	21.48	0.84	23.42	1.46	0.02	101.8	68	0.16	0.01	68.11
90-23-px9-z1-r2c	90-23	opx	core	main	53.28	0.18	0.96	21.54	0.83	23.54	1.32	0.01	101.7	68	0.16	0.01	68.57
90-23-px9-z1-r2c	90-23	opx	core	main	53.24	0.2	1.11	21.58	0.74	23.58	1.41	0.01	101.9	68	0.18	0.02	68.75
90-23-px9-z1-r2c	90-23	opx	core	main	53.39	0.18	0.96	21.5	0.8	23.5	1.35	0.01	101.7	68	0.16	0.01	68.30
90-23-px9-z1-r2c	90-23	opx	core	main	53.3	0.2	0.97	21.43	0.83	23.44	1.36	0.01	101.5	68	0.18	0.01	68.28
90-23-px9-z1-r2c	90-23	opx	core	main	53.2	0.18	0.89	21.47	0.83	23.5	1.35	0.02	101.4	68	0.16	0.01	68.65
90-23-px9-z1-r2c	90-23	opx	core	main	53.3	0.19	0.93	21.46	0.79	23.51	1.36	0.01	101.6	68	0.17	0.01	68.45

SAMPLE GRAIN ID	Sample	Min	Texture	stage	SiO2	TiO2	Al2O3	FeO*	MnO	MgO	CaO	Na2O	Total	Mg #	FeO	Fe2O3	Mg # (Fe2+ only)
90-23-px9-z1-r2c	90-23	opx	core	main	53.18	0.22	1.13	21.4	0.82	23.47	1.46	0.02	101.7	68	0.20	0.02	68.70
90-23-px9-z1-r2c	90-23	opx	core	main	53.2	0.23	1.37	21.44	0.76	23.51	1.37	0.02	101.9	68	0.21	0.02	68.58
90-23-px9-z1-r2c	90-23	opx	core	main	53.28	0.18	0.94	21.5	0.83	23.6	1.3	0.01	101.6	69	0.16	0.01	68.71
90-23-px9-z1-r2c	90-23	opx	core	main	53.22	0.17	1.13	21.42	0.78	23.54	1.47	0.02	101.8	69	0.15	0.01	68.87
90-23-px9-z1-r2c	90-23	opx	core	main	53.14	0.19	1.04	21.3	0.77	23.43	1.45	0.01	101.3	69	0.17	0.01	68.54
90-23-px9-z1-r2c	90-23	opx	core	main	53.17	0.23	1.34	21.42	0.73	23.59	1.43	0.02	101.9	69	0.20	0.02	68.91
90-23-px9-z1-r2c	90-23	opx	core	main	53.28	0.2	0.87	21.41	0.84	23.67	1.37	0.02	101.7	69	0.18	0.02	69.07
90-23-px9-z1-r2c	90-23	opx	core	main	53.57	0.18	0.87	21.4	0.82	23.67	1.33	0.01	101.9	69	0.16	0.01	68.55
90-23-px9-z1-r2c	90-23	opx	core	main	53.14	0.19	0.91	21.42	0.8	23.71	1.31	0.03	101.5	69	0.17	0.02	69.31
90-23-px9-z1-r2c	90-23	opx	core	main	53	0.19	1.11	21.28	0.79	23.55	1.46	0.01	101.4	69	0.17	0.02	69.13
90-23-px9-z1-r2c	90-23	opx	core	main	53.17	0.21	1.04	21.35	0.75	23.65	1.43	0.02	101.6	69	0.19	0.02	69.13
90-23-px9-z1-r2c	90-23	opx	core	main	53.2	0.22	1.25	21.22	0.72	23.51	1.39	0.02	101.5	69	0.20	0.01	68.56
90-23-px9-z1-r2c	90-23	opx	core	main	53	0.22	1.06	21.27	0.77	23.61	1.45	0.01	101.4	69	0.19	0.02	69.24
90-23-px9-z1-r2c	90-23	opx	core	main	53.13	0.18	0.9	21.24	0.83	23.62	1.33	0.03	101.3	69	0.16	0.01	69.13
90-23-px9-z1-r2c	90-23	opx	core	main	52.99	0.19	1.15	21.22	0.8	23.64	1.51	0.02	101.5	69	0.17	0.02	69.55
90-23-px9-z1-r2c	90-23	opx	core	main	52.94	0.23	1.13	21.09	0.77	23.54	1.47	0.01	101.2	69	0.21	0.02	69.12
90-23-px9-z1-r2c	90-23	opx	core	main	53.37	0.23	0.97	21.31	0.82	23.8	1.4	0.01	101.9	69	0.20	0.02	69.26
90-23-px9-z1-r2c	90-23	opx	core	main	53.2	0.19	0.92	21.27	0.8	23.75	1.38	0.01	101.5	69	0.17	0.02	69.34
90-23-px9-z1-r2c	90-23	opx	core	main	52.93	0.22	1.1	21.18	0.76	23.76	1.38	0.02	101.4	69	0.19	0.02	69.72
90-23-px9-z1-r2c	90-23	opx	core	main	53.5	0.17	0.84	21.37	0.82	24.04	1.34	0.01	102.1	69	0.15	0.02	69.77
90-23-px9-z1-r2c	90-23	opx	core	main	53.28	0.22	1.15	21.16	0.76	23.85	1.41	0.02	101.9	69	0.19	0.02	69.54
90-23-px9-z1-r2c	90-23	opx	core	main	53.34	0.18	1.03	21.13	0.78	23.83	1.33	0.02	101.6	69	0.16	0.01	69.34
90-23-px9-z1-r2c	90-23	opx	core	main	53.22	0.22	1.23	20.93	0.74	23.74	1.39	0.02	101.5	69	0.20	0.02	69.23
90-23-px9-z1-r2c	90-23	opx	core	main	53.21	0.23	1.15	20.85	0.72	23.84	1.42	0.03	101.5	69	0.21	0.02	69.61
90-23-px9-z1-r2c	90-23	opx	core	main	53.18	0.21	1.16	20.96	0.75	24	1.43	0.02	101.7	69	0.18	0.02	70.15

SAMPLE GRAIN ID	Sample	Min	Texture	stage	SiO2	TiO2	Al2O3	FeO*	MnO	MgO	CaO	Na2O	Total	Mg #	FeO	Fe2O3	Mg # (Fe2+ only)
90-23-px9-z1-r2c	90-23	opx	core	main	53.28	0.18	1.16	20.81	0.71	23.98	1.44	0.01	101.6	70	0.16	0.01	69.88
90-23-px9-z1-r2c	90-23	opx	core	main	53.66	0.16	0.8	20.86	0.76	24.11	1.38	0.01	101.7	70	0.14	0.01	69.73
90-23-px9-z1-r2c	90-23	opx	core	main	53.68	0.14	0.78	20.86	0.76	24.15	1.38	0.02	101.8	70	0.13	0.01	69.89
90-23-px9-z1-r2c	90-23	opx	core	main	53.15	0.21	1.36	20.62	0.67	24.14	1.44	0.01	101.6	70	0.18	0.02	70.46
90-23-px9-z1-r2c	90-23	opx	core	main	53.37	0.21	1.15	20.51	0.69	24.04	1.45	0.01	101.4	70	0.19	0.01	69.88
90-23-px9-z1-r2c	90-23	opx	core	main	53.26	0.19	1.15	20.62	0.67	24.24	1.44	0.02	101.6	70	0.17	0.02	70.67
90-23-px9-z1-r2c	90-23	opx	core	main	53.39	0.21	1.24	20.47	0.69	24.26	1.39	0.01	101.7	70	0.19	0.02	70.41
90-23-px9-z1-r2c	90-23	opx	core	main	53.19	0.21	1.4	20.41	0.67	24.19	1.43	0.01	101.5	70	0.19	0.02	70.52
90-23-px9-z1-r2c	90-23	opx	core	main	53.12	0.22	1.45	20.42	0.65	24.28	1.44	0.01	101.6	70	0.19	0.02	70.87
90-23-px9-z1-r2c	90-23	opx	core	main	53.19	0.22	1.43	20.4	0.64	24.5	1.4	0	101.8	70	0.19	0.02	71.30
90-23-px9-z1-r2c	90-23	opx	core	main	53.35	0.2	1.43	20.23	0.66	24.41	1.4	0	101.7	71	0.18	0.02	70.84
90-23-px9-z1-r2c	90-23	opx	core	main	53.19	0.21	1.46	20.2	0.62	24.39	1.44	0	101.5	71	0.19	0.02	71.01
90-23-px9-z1-r2c	90-23	opx	core	main	53.16	0.23	1.55	19.95	0.63	24.48	1.46	0.02	101.5	71	0.20	0.02	71.44
90-23-px9-z1-r2c	90-23	opx	core	main	53.11	0.21	1.57	20	0.61	24.56	1.46	0	101.5	71	0.18	0.02	71.64
90-23-px9-z1-r2c	90-23	opx	core	main	52.9	0.24	1.78	20	0.6	24.66	1.49	0.02	101.7	71	0.20	0.02	72.35
90-23-px9-z1-r2c	90-23	opx	core	main	53.06	0.21	1.74	19.87	0.61	24.52	1.47	0.02	101.5	71	0.18	0.02	71.72
90-23-px9-z1-r2c	90-23	opx	core	main	53.15	0.21	1.58	19.82	0.65	24.55	1.44	0.01	101.4	71	0.18	0.02	71.62
90-23-px9-z1-r2c	90-23	opx	core	main	53.21	0.23	1.62	19.83	0.61	24.69	1.48	0.03	101.7	71	0.20	0.02	72.05
90-23-px9-z1-r2c	90-23	opx	core	main	52.99	0.21	1.66	19.81	0.61	24.69	1.44	0.02	101.4	71	0.18	0.02	72.27
90-23-px9-z1-r2c	90-23	opx	core	main	52.87	0.2	1.7	19.98	0.62	25.27	1.54	0.02	102.2	71	0.16	0.03	74.35
90-23-px9-z1-r2c	90-23	opx	core	main	52.26	0.22	4.35	19.1	0.61	24.21	1.51	0.04	102.3	72	0.19	0.02	72.09
90-23-px9-z1-r2c	90-23	opx	core	main	51.76	0.18	1.61	19.52	0.65	25.39	1.42	0.02	100.6	72	0.13	0.03	76.24
KELUD1990-2PX2-c-only	PL2	opx	pheno	late	52.93	0.19	0.91	19.47	0.69	23.38	1.37	0.02	99	68	0.19	0.00	68.43
KELUD1990-2PX5-c-only	PL2	opx	glom	late	52.39	0.18	0.99	19.34	0.79	23.05	1.4	0.01	98.1	68	0.18	0.00	68.30
KELUD1990-2PX5-c-only	PL2	opx	glom	late	52.32	0.23	1	19.24	0.72	23.16	1.41	0.01	98.1	68	0.23	0.00	68.61

SAMPLE GRAIN ID	Sample	Min	Texture	stage	SiO2	TiO2	Al2O3	FeO*	MnO	MgO	CaO	Na2O	Total	Mg #	FeO	Fe2O3	Mg # (Fe2+ only)
KELUD1990-2PX6-c-only	PL2	opx	pheno	late	53.09	0.12	1.01	18.87	0.73	23.07	1.57	0.02	98.5	69	0.12	-0.00	67.65
KELUD1990-glom1-c-only	PL2	opx	glom	late	51.82	0.25	1.2	21.52	0.92	20.94	1.44	0.03	98.1	63	0.25	-0.00	62.95
KELUD1990-glom1-c-only	PL2	opx	glom	late	52.41	0.24	0.95	20.5	0.83	21.88	1.5	0.01	98.3	66	0.25	-0.00	64.89
KELUD1990-glom1-c-only	PL2	opx	glom	late	52.02	0.28	1.53	20.07	0.79	22.17	1.5	0.01	98.4	66	0.28	-0.00	66.21
KELUD1990-glom1-c-only	PL2	opx	glom	late	53.32	0.16	0.84	19.55	0.77	22.96	1.27	0.01	98.9	68	0.17	-0.01	66.55
KELUD1990-glom1-c-only	PL2	opx	glom	late	52.43	0.18	1.61	19.32	0.71	22.74	1.56	0.02	98.6	68	0.18	-0.00	67.50
KELUD1990-glom1-c-only	PL2	opx	glom	late	53.12	0.14	1.11	19.66	0.79	23.28	1.18	0.01	99.3	68	0.14	-0.00	67.70
KELUD1990-glom1-c-only	PL2	opx	glom	late	52.64	0.18	1.16	19.2	0.84	22.94	1.3	0.03	98.3	68	0.18	-0.00	67.62
KELUD1990-glom1-c-only	PL2	opx	glom	late	53.29	0.14	0.72	19.25	0.74	23.07	1.35	0.01	98.6	68	0.15	-0.00	67.00
KELUD1990-glom1-c-only	PL2	opx	glom	late	53.2	0.13	0.94	19.07	0.82	23.52	1.25	0.02	99	69	0.13	-0.00	68.49
KELUD1990-glom1-c-only	PL2	opx	glom	late	53.09	0.17	1.04	18.87	0.82	23.49	1.33	0.02	98.8	69	0.17	-0.00	68.62
KELUD1990-glom1-c-only	PL2	opx	glom	late	53.01	0.19	1.33	18.76	0.73	23.7	1.23	0.01	99	69	0.19	-0.00	69.02
KELUD1990-glom1-c-only	PL2	opx	glom	late	53.81	0.1	0.6	17.29	0.68	24.82	1.34	0.02	98.7	72	0.10	-0.00	71.41
KELUD1990-glom10-rerun-c-only	PL2	opx	glom	late	51.83	0.19	0.85	24.94	1.11	20.31	1.26	0.02	100.5	62	0.18	0.01	61.14
KELUD1990-glom10-rerun-c-only	PL2	opx	glom	late	52.09	0.18	0.83	23.92	1.02	20.86	1.43	0.03	100.4	63	0.17	0.01	62.65
KELUD1990-glom10-rerun-c-only	PL2	opx	glom	late	52.25	0.18	0.92	24.29	0.96	21.37	1.39	0.02	101.4	64	0.16	0.02	63.84
KELUD1990-glom10-rerun-c-only	PL2	opx	glom	late	50.43	0.26	2.16	23.81	0.89	21.01	1.36	0.02	99.9	64	0.22	0.03	64.97
KELUD1990-glom10-rerun-c-only	PL2	opx	glom	late	50.51	0.26	2.06	23.44	0.83	21.27	1.37	0.03	99.8	64	0.22	0.03	65.66
KELUD1990-glom10-rerun-c-only	PL2	opx	glom	late	51.76	0.17	0.93	23.47	0.88	21.29	1.36	0.02	99.9	64	0.15	0.01	64.09
KELUD1990-glom10-rerun-c-only	PL2	opx	glom	late	50.9	0.29	2.24	22.63	0.8	21.46	1.44	0.02	99.8	65	0.26	0.03	65.66
KELUD1990-glom10-rerun-c-only	PL2	opx	glom	late	50.94	0.24	2.23	22.62	0.8	21.57	1.48	0.02	99.9	65	0.21	0.02	66.06
KELUD1990-glom10-rerun-c-only	PL2	opx	glom	late	51.71	0.17	1.17	22.78	0.82	21.91	1.26	0.01	99.8	66	0.15	0.01	65.77
KELUD1990-glom10-rerun-c-only	PL2	opx	glom	late	51.91	0.18	1.03	22.4	0.86	22.06	1.4	0.02	99.9	66	0.16	0.01	66.23
KELUD1990-glom10-rerun-c-only	PL2	opx	glom	late	51.37	0.31	2.55	21.95	0.67	22.1	1.83	0.02	100.8	67	0.27	0.03	67.37

SAMPLE GRAIN ID	Sample	Min	Texture	stage	SiO2	TiO2	Al2O3	FeO*	MnO	MgO	CaO	Na2O	Total	Mg #	FeO	Fe2O3	Mg # (Fe2+ only)
KELUD1990-glom10-rerun-c-only	PL2	opx	glom	late	52.73	0.2	0.95	22.35	0.81	22.55	1.35	0.01	101	67	0.18	0.01	66.39
KELUD1990-glom10-rerun-c-only	PL2	opx	glom	late	52.11	0.21	0.99	22.12	0.86	22.4	1.34	0.02	100.1	67	0.19	0.02	66.86
KELUD1990-glom10-rerun-c-only	PL2	opx	glom	late	51.29	0.3	2.51	21.52	0.66	22.28	1.54	0.02	100.1	67	0.27	0.02	67.59
KELUD1990-glom10-rerun-c-only	PL2	opx	glom	late	51.8	0.18	1.69	21.62	0.76	22.4	1.51	0.01	100	67	0.16	0.01	67.39
KELUD1990-glom10-rerun-c-only	PL2	opx	glom	late	52.64	0.2	1.03	21.64	0.82	23.03	1.36	0.03	100.7	68	0.18	0.02	68.07
KELUD1990-glom10-rerun-c-only	PL2	opx	glom	late	52.12	0.26	2.02	21.32	0.68	22.75	1.76	0.02	100.9	68	0.23	0.02	68.25
KELUD1990-glom10-rerun-c-only	PL2	opx	glom	late	51.37	0.22	2	21.26	0.67	22.89	1.29	0.02	99.7	68	0.19	0.02	69.06
KELUD1990-glom12-c-only	PL2	opx	glom	late	52.5	0.17	0.99	21.5	0.83	21.17	1.45	0	98.6	64	0.18	-0.01	62.59
KELUD1990-glom12-c-only	PL2	opx	glom	late	52.39	0.18	0.96	20.93	0.8	22.01	1.41	0.01	98.7	65	0.18	0.00	65.23
KELUD1990-glom12-core-only	PL2	opx	glom	late	52.45	0.19	1.23	19.49	0.73	23.06	1.36	0	98.5	68	0.19	0.00	68.06
KELUD1990-glom12-core-only	PL2	opx	glom	late	53.21	0.19	1.08	19.2	0.7	23.91	1.42	0.02	99.7	69	0.18	0.00	69.70
KELUD1990-glom12-core-only	PL2	opx	glom	late	53.25	0.16	0.74	18.8	0.73	23.69	1.5	0.01	98.9	69	0.16	-0.00	69.10
KELUD1990-glom12-core-only	PL2	opx	glom	late	53.36	0.15	0.81	18.68	0.71	24.1	1.44	0.01	99.3	70	0.15	0.00	70.06
KELUD1990-glom12-core-only	PL2	opx	glom	late	53.63	0.12	0.76	18.48	0.71	24.05	1.48	0.03	99.3	70	0.12	-0.00	69.72
KELUD1990-glom3-c-only	PL2	opx	glom	late	52.82	0.17	1.16	19.32	0.76	23.13	1.48	0.01	98.8	68	0.17	-0.00	68.03
KELUD1990-glom3-c-only	PL2	opx	glom	late	52.12	0.19	1.48	19.04	0.68	23.05	1.47	0.02	98.1	68	0.19	0.00	68.69
KELUD1990-glom3-c-only	PL2	opx	glom	late	53.25	0.17	0.93	19.1	0.76	23.2	1.42	0	98.8	68	0.18	-0.00	67.49
KELUD1990-glom3-c-only	PL2	opx	glom	late	53.16	0.15	0.79	18.96	0.76	23.39	1.44	0.02	98.7	69	0.15	-0.00	68.34
KELUD1990-glom3-c-only	PL2	opx	glom	late	52.62	0.25	1.47	18.71	0.66	23.12	1.68	0.02	98.5	69	0.25	-0.00	68.41
KELUD1990-glom4-c-only	PL2	opx	glom	late	52.72	0.21	1.15	19.04	0.72	23.21	1.44	0.02	98.5	68	0.21	-0.00	68.31
KELUD1990-glom4-c-only	PL2	opx	glom	late	53.27	0.16	0.68	18.98	0.76	23.34	1.44	0.03	98.7	69	0.16	-0.00	68.08
KELUD1990-glom4-c-only	PL2	opx	glom	late	53.28	0.14	0.7	19.01	0.79	23.45	1.45	0.02	98.8	69	0.14	-0.00	68.42
KELUD1990-glom5-c-only	PL2	opx	pseudo	late	51.48	0.26	1.31	21.32	0.84	21.44	1.44	0.01	98.1	64	0.25	0.00	64.75
KELUD1990-glom5-c-only	PL2	opx	pseudo	late	53.26	0.22	1.91	19.17	0.78	22.34	1.12	0.06	98.8	68	0.25	-0.02	64.72

SAMPLE GRAIN ID	Sample	Min	Texture	stage	SiO2	TiO2	Al2O3	FeO*	MnO	MgO	CaO	Na2O	Total	Mg #	FeO	Fe2O3	Mg # (Fe2+ only)
KELUD1990-glom5-r2c	PL2	opx	glom	late	55.08	0.17	1.2	22.46	1.18	18.16	1.61	0.02	99.9	59	0.23	-0.05	51.01
KELUD1990-glom5-r2c	PL2	opx	core	late	52.15	0.21	0.99	21.7	0.8	23.12	1.42	0.01	100.4	68	0.18	0.02	68.98
KELUD1990-glom5-r2c	PL2	opx	rim	late	51.5	0.18	0.48	26.28	1.22	19.62	1.51	0.03	100.8	60	0.16	0.02	60.01
KELUD1990-glom5-r2c	PL2	opx	rim	late	52.15	0.18	0.52	26.22	1.24	19.62	1.45	0.02	101.4	60	0.17	0.01	59.07
KELUD1990-glom5-r2c	PL2	opx	rim	late	51.31	0.16	0.48	26.28	1.25	19.75	1.51	0.01	100.7	60	0.14	0.02	60.61
KELUD1990-glom5-r2c	PL2	opx	rim	late	51.62	0.15	0.41	26.25	1.23	19.82	1.32	0.03	100.8	60	0.13	0.01	60.26
KELUD1990-glom5-r2c	PL2	opx	rim	late	51.82	0.16	0.42	25.84	1.16	19.89	1.3	0.02	100.6	60	0.15	0.01	60.04
KELUD1990-glom5-r2c	PL2	opx	rim	late	51.65	0.14	0.46	25.87	1.2	19.91	1.39	0.02	100.6	60	0.13	0.01	60.50
KELUD1990-glom5-r2c	PL2	opx	rim	late	51.36	0.17	0.58	25.66	1.19	19.89	1.5	0.01	100.4	61	0.15	0.02	60.87
KELUD1990-glom5-r2c	PL2	opx	rim	late	51.6	0.17	0.58	25.51	1.15	20.19	1.51	0.03	100.7	61	0.15	0.02	61.56
KELUD1990-glom5-r2c	PL2	opx	rim	late	51.74	0.16	0.61	25.42	1.1	20.22	1.53	0.02	100.8	61	0.14	0.01	61.40
KELUD1990-glom5-r2c	PL2	opx	rim	late	51.58	0.18	0.64	24.92	1.05	20.38	1.46	0	100.2	62	0.16	0.01	61.80
KELUD1990-glom5-r2c	PL2	opx	rim	late	51.5	0.2	0.67	24.8	1.04	20.63	1.41	0.02	100.3	62	0.18	0.02	62.68
KELUD1990-glom5-r2c	PL2	opx	rim	late	51.04	0.25	1.58	24.44	0.94	20.83	1.44	0.02	100.5	63	0.22	0.03	63.78
KELUD1990-glom5-r2c	PL2	opx	rim	late	51.41	0.19	0.84	24.15	1.03	20.83	1.5	0.03	100	63	0.17	0.02	63.57
KELUD1990-glom5-r2c	PL2	opx	rim	late	51.39	0.19	1	23.71	0.92	21.64	1.38	0.01	100.2	64	0.16	0.02	65.69
KELUD1990-glom5-r2c	PL2	opx	rim	late	51.9	0.18	0.88	23.16	0.91	22.14	1.38	0.02	100.6	65	0.16	0.02	66.55
KELUD1990-glom5-r2c	PL2	opx	rim	late	51.93	0.17	0.91	22.72	0.83	22.36	1.4	0.02	100.3	66	0.15	0.02	67.11
KELUD1990-glom5-r2c	PL2	opx	rim	late	51.63	0.21	1.26	22.5	0.84	22.44	1.37	0.02	100.3	66	0.18	0.02	67.69
KELUD1990-glom5-r2c	PL2	opx	rim	late	51.94	0.24	1.18	22.16	0.82	22.83	1.37	0.02	100.6	67	0.21	0.03	68.38
KELUD1990-glom5-r2c	PL2	opx	rim	late	51.94	0.23	1.19	22	0.85	22.75	1.4	0.03	100.4	67	0.20	0.02	68.28
KELUD1990-glom5-r2c	PL2	opx	rim	late	52	0.18	1.07	21.76	0.8	23.01	1.38	0.01	100.2	68	0.15	0.02	68.83
KELUD1990-glom5-r2c	PL2	opx	rim	late	52.26	0.19	0.98	21.7	0.8	23.1	1.4	0.01	100.4	68	0.16	0.02	68.75
KELUD1990-glom5-r2c	PL2	opx	glom	late	52.23	0.16	1.01	19.71	0.78	22.78	1.36	0.03	98.1	67	0.16	0.00	67.78
KELUD1990-glom5-r2c	PL2	opx	glom	late	52.14	0.23	1.26	19.13	0.76	23	1.47	0.02	98	68	0.23	0.00	68.57

SAMPLE GRAIN ID	Sample	Min	Texture	stage	SiO2	TiO2	Al2O3	FeO*	MnO	MgO	CaO	Na2O	Total	Mg #	FeO	Fe2O3	Mg # (Fe2+ only)
KELUD1990-glom5-r2c	PL2	opx	glom	late	52.25	0.23	1.24	19.12	0.74	23.16	1.43	0.01	98.2	68	0.23	0.00	68.76
KELUD1990-glom5-rerun-c-only	PL2	opx	glom	late	51.26	0.24	1.03	25.39	0.97	20.23	1.34	0	100.5	61	0.22	0.02	61.46
KELUD1990-glom5-rerun-c-only	PL2	opx	glom	late	51.32	0.25	0.97	24.86	0.91	20.45	1.39	0.02	100.2	62	0.22	0.02	62.14
KELUD1990-glom5-rerun-c-only	PL2	opx	glom	late	51.78	0.23	1.1	25.07	0.91	20.71	1.39	0.01	101.2	62	0.21	0.02	62.32
KELUD1990-glom5-rerun-c-only	PL2	opx	glom	late	51.49	0.23	1.12	24.45	0.89	20.71	1.39	0.02	100.3	63	0.21	0.02	62.70
KELUD1990-glom5-rerun-c-only	PL2	opx	glom	late	50.93	0.31	1.54	24.06	0.85	21.08	1.34	0.02	100.1	63	0.27	0.03	64.38
KELUD1990-glom5-rerun-c-only	PL2	opx	glom	late	51.82	0.29	1.07	23.87	0.94	21.22	1.41	0.02	100.6	64	0.26	0.02	63.83
KELUD1990-glom5-rerun-c-only	PL2	opx	glom	late	51.74	0.22	1.08	23.77	0.89	21.37	1.48	0.02	100.6	64	0.20	0.02	64.51
KELUD1990-glom5-rerun-c-only	PL2	opx	glom	late	51.97	0.25	1.31	21.92	0.77	23.06	1.2	0.02	100.5	68	0.22	0.03	68.70
KELUD1990-glom5-rerun-c-only	PL2	opx	pseudo	late	51.24	0.29	1.29	25.95	0.98	20.2	1.43	0.02	101.4	61	0.25	0.03	61.61
KELUD1990-glom5-rerun-c-only	PL2	opx	pseudo	late	50.47	0.23	1	25.72	0.92	20.19	1.44	0.01	100	61	0.19	0.03	62.54
KELUD1990-glom5-rerun-c-only	PL2	opx	pseudo	late	51.22	0.22	0.88	25.43	1	20.41	1.39	0.02	100.6	61	0.19	0.02	62.30
KELUD1990-glom5-rerun-c-only	PL2	opx	pseudo	late	51.47	0.21	1.09	24.77	0.92	20.98	1.41	0.02	100.9	63	0.18	0.02	63.66
KELUD1990-glom5-rerun-c-only	PL2	opx	pseudo	late	51.7	0.26	0.97	24.86	1.01	21.23	1.33	0.01	101.4	63	0.22	0.03	64.01
KELUD1990-glom5-rerun-c-only	PL2	opx	pseudo	late	50.96	0.32	1.57	24.48	0.86	21.24	1.29	0.03	100.8	63	0.27	0.04	64.84
KELUD1990-glom5-rerun-c-only	PL2	opx	pseudo	late	51.44	0.21	1.06	24.14	0.87	21.4	1.47	0.03	100.6	64	0.18	0.03	65.05
KELUD1990-glom5-rerun-c-only	PL2	opx	pseudo	late	52.11	0.3	1.24	22.37	0.77	23.24	1.25	0.02	101.3	67	0.25	0.04	69.08
KELUD1990-glom6-c-only	PL2	opx	glom	late	52.62	0.23	0.99	19.12	0.76	23.41	1.43	0.01	98.6	69	0.23	0.00	69.02
KELUD1990-glom6-c-only	PL2	opx	glom	late	52.71	0.15	0.97	18.9	0.73	23.39	1.32	0.02	98.2	69	0.15	-0.00	68.75
KELUD1990-glom6-c-only	PL2	opx	glom	late	52.61	0.18	0.81	18.81	0.69	23.5	1.45	0.01	98.1	69	0.18	0.00	69.29
KELUD1990-glom6-c-only	PL2	opx	glom	late	52.74	0.16	0.79	18.6	0.69	23.68	1.48	0.02	98.1	69	0.16	0.00	69.76
KELUD1990-glom6-rerun-c-only	PL2	opx	glom	late	48.99	0.24	0.77	25.6	0.98	21.44	1.27	0.01	99.3	62	0.17	0.06	68.35
KELUD1990-glom6-rerun-c-only	PL2	opx	glom	late	52.77	0.16	1.01	21.68	0.77	23.79	1.38	0	101.6	68	0.14	0.02	70.02

SAMPLE GRAIN ID	Sample	Min	Texture	stage	SiO2	TiO2	Al2O3	FeO*	MnO	MgO	CaO	Na2O	Total	Mg #	FeO	Fe2O3	Mg # (Fe2+ only)
KELUD1990-glom6-rerun-c-only	PL2	opx	glom	late	52.71	0.19	1.22	21.2	0.69	23.85	1.49	0.02	101.4	69	0.16	0.02	70.41
KELUD1990-glom6-rerun-c-only	PL2	opx	glom	late	53.12	0.15	0.78	21.27	0.74	23.98	1.42	0.01	101.5	69	0.13	0.02	70.16
KELUD1990-glom8-z1-r2c	PL2	opx	core	late	50.01	0.23	4.16	20.36	0.77	21.31	1.42	0.03	98.3	67	0.22	0.01	66.39
KELUD1990-glom8-z1-r2c	PL2	opx	core	late	51.9	0.2	1.23	21.2	0.75	23.06	1.42	0.02	99.8	68	0.17	0.02	69.14
KELUD1990-glom8-z1-r2c	PL2	opx	core	late	51.85	0.23	1.18	21.18	0.73	23.06	1.45	0	99.7	68	0.20	0.02	69.09
KELUD1990-glom8-z1-r2c	PL2	opx	core	late	51.8	0.23	1.2	21.07	0.73	22.97	1.4	0.01	99.4	68	0.20	0.02	68.86
KELUD1990-glom8-z1-r2c	PL2	opx	core	late	51.88	0.21	1.19	21.12	0.74	23.08	1.41	0.02	99.6	68	0.18	0.02	69.18
KELUD1990-glom8-z1-r2c	PL2	opx	core	late	51.77	0.18	0.98	21	0.73	22.98	1.45	0.01	99.1	68	0.16	0.02	69.06
KELUD1990-glom8-z1-r2c	PL2	opx	core	late	51.88	0.2	1.05	21.11	0.73	23.09	1.43	0.01	99.5	68	0.17	0.02	69.19
KELUD1990-glom8-z1-r2c	PL2	opx	core	late	51.7	0.23	1.12	21.06	0.73	23.05	1.4	0.02	99.3	68	0.20	0.02	69.30
KELUD1990-glom8-z1-r2c	PL2	opx	core	late	51.68	0.19	0.99	21.12	0.75	23.12	1.4	0.01	99.3	68	0.16	0.02	69.56
KELUD1990-glom8-z1-r2c	PL2	opx	core	late	52.12	0.2	1	21.17	0.78	23.18	1.42	0.01	99.9	68	0.18	0.02	69.17
KELUD1990-glom8-z1-r2c	PL2	opx	core	late	51.89	0.2	1.1	21	0.75	23.05	1.43	0.02	99.4	69	0.18	0.02	69.13
KELUD1990-glom8-z1-r2c	PL2	opx	core	late	51.84	0.21	1.44	21.19	0.76	23.28	1.4	0.04	100.2	69	0.18	0.02	69.97
KELUD1990-glom8-z1-r2c	PL2	opx	core	late	51.66	0.21	1.26	20.92	0.72	23	1.41	0.03	99.2	69	0.18	0.02	69.28
KELUD1990-glom8-z1-r2c	PL2	opx	core	late	52.08	0.22	1.04	20.97	0.75	23.08	1.43	0.01	99.6	69	0.20	0.02	68.87
KELUD1990-glom8-z1-r2c	PL2	opx	core	late	51.77	0.2	0.97	20.97	0.72	23.11	1.43	0.01	99.2	69	0.17	0.02	69.39
KELUD1990-glom8-z1-r2c	PL2	opx	core	late	51.8	0.21	1.21	20.77	0.74	23.01	1.49	0.01	99.2	69	0.19	0.02	69.14
KELUD1990-glom8-z1-r2c	PL2	opx	core	late	52.06	0.19	0.99	20.39	0.72	23.43	1.42	0.01	99.2	69	0.17	0.02	69.92
KELUD1990-glom8-z1-r2c	PL2	opx	core	late	52.15	0.18	1.24	20.06	0.69	23.83	1.53	0.03	99.7	70	0.15	0.02	71.25
KELUD1990-glom8-z1-r2c	PL2	opx	core	late	51.62	0.24	1.72	19.39	0.64	24	1.69	0.02	99.3	71	0.20	0.03	72.60
KELUD1990-glom8-z1-r2c	PL2	opx	core	late	51.49	0.22	1.99	18.73	0.61	24.2	1.77	0.01	99	72	0.18	0.02	73.44
KELUD1990-glom8-z1-r2c	PL2	opx	rim	late	50.9	0.17	0.54	25.2	1.1	19.82	1.48	0.04	99.3	61	0.15	0.02	61.25
KELUD1990-glom8-z1-r2c	PL2	opx	rim	late	50.88	0.19	0.76	25.06	1.06	19.97	1.47	0.03	99.4	61	0.17	0.02	61.62
KELUD1990-glom8-z1-r2c	PL2	opx	rim	late	50.92	0.2	0.79	24.52	1	20.24	1.34	0.02	99	62	0.18	0.02	62.08

SAMPLE GRAIN ID	Sample	Min	Texture	stage	SiO2	TiO2	Al2O3	FeO*	MnO	MgO	CaO	Na2O	Total	Mg #	FeO	Fe2O3	Mg # (Fe2+ only)
KELUD1990-glom8-z1-r2c	PL2	opx	rim	late	50.94	0.18	0.9	24.27	0.96	20.66	1.32	0.01	99.2	63	0.16	0.02	63.25
KELUD1990-glom8-z1-r2c	PL2	opx	rim	late	50.07	0.17	0.84	25.18	1.16	22.12	1.46	0.11	101.1	64	0.12	0.05	70.06
KELUD1990-glom8-z1-r2c	PL2	opx	rim	late	51.41	0.16	1.03	23.53	0.92	21.18	1.38	0.03	99.6	64	0.14	0.01	64.37
KELUD1990-glom8-z1-r2c	PL2	opx	rim	late	51.41	0.22	1.12	21.86	0.79	22.25	1.42	0.02	99.1	67	0.19	0.02	67.40
KELUD1990-glom8-z1-r2c	PL2	opx	rim	late	51.54	0.23	1.23	20.3	0.75	23.01	1.58	0.01	98.6	69	0.20	0.02	69.62
KELUD1990-glom8-z1-r2c	PL2	opx	rim	late	51.53	0.2	1.41	19.87	0.7	23.48	1.56	0.02	98.8	70	0.17	0.02	71.07
KELUD1990-glom8-z1-r2c	PL2	opx	rim	late	51.87	0.2	1.52	19.12	0.67	23.96	1.51	0	98.8	71	0.18	0.02	71.78
KELUD1990-glom8-z1-r2c	PL2	opx	rim	late	51.85	0.2	1.57	19.06	0.64	24.53	1.41	0.02	99.3	72	0.17	0.02	73.45
KELUD1990-glom8-z1-r2c	PL2	opx	rim	late	51.95	0.19	1.62	18.83	0.61	24.58	1.32	0.02	99.1	72	0.16	0.02	73.28
KELUD1990-glom8-z1-r2c	PL2	opx	rim	late	51.42	0.2	1.8	18.49	0.61	24.49	1.72	0.01	98.8	72	0.16	0.02	74.38
KELUD1990-glom9-rerun-c-only	PL2	opx	glom	late	52.42	0.18	1.4	23.13	0.86	22.21	1.49	0.01	101.7	66	0.16	0.02	66.10
KELUD1990-glom9-rerun-c-only	PL2	opx	glom	late	51.1	0.26	2	22.57	0.81	22.03	1.52	0.01	100.3	66	0.22	0.03	67.26
KELUD1990-glom9-rerun-c-only	PL2	opx	glom	late	52.59	0.24	1.28	22.69	0.84	22.64	1.39	0.03	101.7	66	0.21	0.02	67.03
KELUD1990-glom9-rerun-c-only	PL2	opx	glom	late	52.16	0.24	1.24	22.36	0.83	22.38	1.37	0.02	100.6	66	0.21	0.02	66.72
KELUD1990-glom9-rerun-c-only	PL2	opx	glom	late	51.69	0.22	1.73	22.13	0.74	22.76	1.47	0.01	100.7	67	0.19	0.03	68.54
KELUD1990-glom9-rerun-c-only	PL2	opx	glom	late	52.58	0.25	1.35	22.28	0.87	22.97	1.35	0.03	101.7	67	0.22	0.02	67.99
KELUD1990-glom9-rerun-c-only	PL2	opx	glom	late	52.41	0.21	1.04	22.17	0.8	22.92	1.36	0.01	100.9	67	0.18	0.02	67.93
KELUD1990-glom9-rerun-c-only	PL2	opx	glom	late	52.73	0.22	1.08	21.85	0.77	23.18	1.34	0.02	101.2	68	0.19	0.02	68.24
KELUD1990-PL2-2PX5-r2c	PL2	opx	core	late	52.62	0.21	0.91	21.98	0.89	23.01	1.41	0.01	101	67	0.18	0.02	68.09
KELUD1990-PL2-2PX5-r2c	PL2	opx	core	late	53	0.21	0.83	21.86	0.85	23.26	1.39	0.02	101.4	68	0.19	0.02	68.28
KELUD1990-PL2-2PX5-r2c	PL2	opx	core	late	52.85	0.19	0.85	21.74	0.85	23.15	1.41	0.01	101	68	0.17	0.02	68.15
KELUD1990-PL2-2PX5-r2c	PL2	opx	core	late	52.79	0.2	0.84	21.53	0.85	23.21	1.38	0.02	100.8	68	0.18	0.02	68.41
KELUD1990-PL2-2PX5-r2c	PL2	opx	rim	late	52.09	0.19	0.47	25.98	1.21	19.82	1.41	0.01	101.2	60	0.18	0.01	59.61
KELUD1990-PL2-2PX5-r2c	PL2	opx	rim	late	52.03	0.21	0.51	25.81	1.14	20.03	1.43	0	101.2	61	0.19	0.02	60.21

SAMPLE GRAIN ID	Sample	Min	Texture	stage	SiO2	TiO2	Al2O3	FeO*	MnO	MgO	CaO	Na2O	Total	Mg #	FeO	Fe2O3	Mg # (Fe2+ only)
KELUD1990-PL2-2PX5-r2c	PL2	opx	rim	late	51.82	0.25	0.86	24.85	1.05	20.59	1.37	0.01	100.8	62	0.23	0.02	61.99
KELUD1990-PL2-2PX5-r2c	PL2	opx	rim	late	52.28	0.23	0.87	23.22	0.88	21.87	1.45	0.01	100.8	65	0.21	0.02	65.17
KELUD1990-PL2-2PX5-r2c	PL2	opx	rim	late	52.61	0.18	0.88	22.24	0.85	22.63	1.43	0.01	100.8	67	0.16	0.01	66.98
KELUD1990-PL2-2PX5-r2c	PL2	opx	rim	late	52.48	0.25	1.13	21.63	0.76	22.86	1.51	0.02	100.6	68	0.22	0.02	67.82
KELUD1990-PL2-2PX5-r2c	PL2	opx	rim	late	52.55	0.21	1.15	21.38	0.74	23.34	1.46	0.02	100.8	68	0.18	0.02	69.11
KELUD1990-PL2-2px7	PL2	opx	overgrowth	late	53.08	0.14	0.79	18.54	0.72	23.58	1.51	0.01	98.4	69	0.14	-0.00	69.02
KELUD1990-PL2-2px7	PL2	opx	overgrowth	late	52.88	0.18	0.84	18.49	0.71	23.56	1.55	0.02	98.2	69	0.18	-0.00	69.30
KELUD1990-PL2-glom1	PL2	opx	glom	late	52.28	0.2	0.96	19.51	0.78	22.87	1.49	0.01	98.1	68	0.20	0.00	68.02
KELUD1990-PL2-glom1	PL2	opx	glom	late	52.64	0.14	0.94	19.05	0.81	23.39	1.25	0.02	98.2	69	0.14	0.00	68.86
KELUD1990-PL2-PX10-r2c	PL2	opx	core	late	52.58	0.25	1.17	21.71	0.78	22.93	1.52	0.01	100.9	68	0.22	0.02	67.88
KELUD1990-PL2-PX10-r2c	PL2	opx	core	late	52.74	0.24	1.09	21.73	0.81	23.1	1.5	0	101.2	68	0.21	0.02	68.13
KELUD1990-PL2-PX10-r2c	PL2	opx	core	late	52.51	0.23	1.17	21.57	0.81	22.95	1.63	0.01	100.9	68	0.20	0.02	68.26
KELUD1990-PL2-PX10-r2c	PL2	opx	core	late	52.61	0.23	1.07	21.56	0.84	22.98	1.46	0.02	100.8	68	0.21	0.02	68.04
KELUD1990-PL2-PX10-r2c	PL2	opx	core	late	52.62	0.21	1.07	21.5	0.84	22.93	1.47	0.02	100.7	68	0.19	0.02	67.91
KELUD1990-PL2-PX10-r2c	PL2	opx	core	late	52.5	0.22	1.1	21.5	0.87	22.96	1.43	0.01	100.6	68	0.20	0.02	68.08
KELUD1990-PL2-PX10-r2c	PL2	opx	core	late	52.77	0.19	1.07	21.66	0.84	23.13	1.4	0	101.1	68	0.17	0.01	68.12
KELUD1990-PL2-PX10-r2c	PL2	opx	core	late	52.76	0.22	1.11	21.52	0.84	23	1.42	0	100.9	68	0.20	0.01	67.73
KELUD1990-PL2-PX10-r2c	PL2	opx	core	late	52.87	0.2	1.02	21.64	0.84	23.24	1.45	0	101.3	68	0.18	0.02	68.37
KELUD1990-PL2-PX10-r2c	PL2	opx	core	late	52.92	0.19	1.14	21.56	0.79	23.2	1.37	0.03	101.2	68	0.17	0.01	68.18
KELUD1990-PL2-PX10-r2c	PL2	opx	core	late	52.76	0.19	1.05	21.42	0.82	23.17	1.37	0.02	100.8	68	0.17	0.01	68.28
KELUD1990-PL2-PX10-r2c	PL2	opx	core	late	52.87	0.2	1.18	21.54	0.77	23.32	1.5	0.01	101.4	68	0.18	0.02	68.66
KELUD1990-PL2-PX10-r2c	PL2	opx	core	late	52.59	0.21	1.11	21.39	0.79	23.16	1.43	0.01	100.7	68	0.19	0.02	68.47
KELUD1990-PL2-PX10-r2c	PL2	opx	core	late	52.77	0.19	1.03	21.29	0.84	23.18	1.44	0.01	100.8	68	0.17	0.01	68.37
KELUD1990-PL2-PX10-r2c	PL2	opx	core	late	52.94	0.19	1.16	21.49	0.78	23.47	1.49	0.01	101.5	68	0.17	0.02	69.01
KELUD1990-PL2-PX10-r2c	PL2	opx	core	late	53.04	0.19	1.15	21.36	0.74	23.46	1.48	0.01	101.4	69	0.17	0.01	68.78

SAMPLE GRAIN ID	Sample	Min	Texture	stage	SiO2	TiO2	Al2O3	FeO*	MnO	MgO	CaO	Na2O	Total	Mg #	FeO	Fe2O3	Mg # (Fe2+ only)
KELUD1990-PL2-PX10-r2c	PL2	opx	core	late	52.8	0.22	1.19	21.19	0.75	23.5	1.53	0.02	101.2	69	0.19	0.02	69.34
KELUD1990-PL2-PX10-r2c	PL2	opx	rim	late	52.18	0.16	0.42	26.25	1.2	19.56	1.31	0.01	101.1	60	0.15	0.01	58.59
KELUD1990-PL2-PX10-r2c	PL2	opx	rim	late	52.41	0.16	0.48	26.03	1.23	19.5	1.42	0.01	101.2	60	0.15	0.01	58.29
KELUD1990-PL2-PX10-r2c	PL2	opx	rim	late	51.89	0.17	0.5	25.87	1.19	19.49	1.38	0.01	100.5	60	0.16	0.01	58.79
KELUD1990-PL2-PX10-r2c	PL2	opx	rim	late	52.28	0.14	0.43	26.07	1.18	19.73	1.36	0.02	101.2	60	0.13	0.01	59.10
KELUD1990-PL2-PX10-r2c	PL2	opx	rim	late	52.4	0.12	0.43	25.7	1.19	19.85	1.37	0.01	101.1	60	0.11	0.01	59.29
KELUD1990-PL2-PX10-r2c	PL2	opx	rim	late	52.19	0.19	0.55	25.63	1.14	19.99	1.44	0.02	101.1	61	0.18	0.01	60.01
KELUD1990-PL2-PX10-r2c	PL2	opx	rim	late	52.39	0.16	0.49	25.63	1.16	20.09	1.41	0.02	101.4	61	0.15	0.01	60.07
KELUD1990-PL2-PX10-r2c	PL2	opx	rim	late	52.17	0.21	0.59	25.51	1.15	20.12	1.47	0.01	101.2	61	0.19	0.01	60.41
KELUD1990-PL2-PX10-r2c	PL2	opx	rim	late	52.24	0.18	0.66	25.45	1.12	20.15	1.58	0.02	101.4	61	0.17	0.01	60.61
KELUD1990-PL2-PX10-r2c	PL2	opx	rim	late	52.24	0.18	0.65	25.15	1.09	20.01	1.51	0.02	100.9	61	0.17	0.01	60.03
KELUD1990-PL2-PX10-r2c	PL2	opx	rim	late	52.65	0.18	0.55	24.86	1.07	20.61	1.47	0.02	101.4	62	0.17	0.01	61.26
KELUD1990-PL2-PX10-r2c	PL2	opx	rim	late	52.45	0.19	0.56	24.65	1.07	20.65	1.48	0.03	101.1	62	0.18	0.01	61.68
KELUD1990-PL2-PX10-r2c	PL2	opx	rim	late	52.36	0.2	0.6	24.43	1.04	20.91	1.45	0	101	63	0.19	0.01	62.35
KELUD1990-PL2-PX10-r2c	PL2	opx	rim	late	52.31	0.22	0.7	24.34	1.01	20.99	1.52	0.02	101.1	63	0.20	0.02	62.80
KELUD1990-PL2-PX10-r2c	PL2	opx	rim	late	52.54	0.19	0.66	24.37	1.07	21.1	1.51	0	101.4	63	0.17	0.01	62.82
KELUD1990-PL2-PX10-r2c	PL2	opx	rim	late	52.56	0.2	0.58	24.19	1.06	20.99	1.48	0.01	101.1	63	0.19	0.01	62.44
KELUD1990-PL2-PX10-r2c	PL2	opx	rim	late	52.98	0.22	0.77	23.99	1.05	21.1	1.47	0.01	101.6	64	0.21	0.01	62.17
KELUD1990-PL2-PX10-r2c	PL2	opx	rim	late	52.62	0.18	0.86	23.08	0.96	22.01	1.32	0.01	101	65	0.16	0.01	65.09
KELUD1990-PL2-PX10-r2c	PL2	opx	rim	late	52.68	0.18	1	22.13	0.89	22.48	1.4	0.01	100.8	67	0.17	0.01	66.42
KELUD1990-PL2-PX10-r2c	PL2	opx	rim	late	52.65	0.2	1.02	21.61	0.85	22.88	1.41	0.02	100.6	68	0.18	0.01	67.65
KELUD1990-PL2-px7	PL2	opx	overgrowth	late	52.69	0.18	1.2	19.04	0.72	22.96	1.5	0.01	98.3	68	0.18	-0.00	67.65
KELUD1990-PL2-z1-r2c	PL2	opx	core	late	52.8	0.2	0.96	22.32	0.79	23.41	1.3	0.02	101.8	68	0.17	0.02	68.83
KELUD1990-PL2-z1-r2c	PL2	opx	rim	late	53.46	0.19	0.86	26.3	1.23	19.01	1.19	0.02	102.3	59	0.20	-0.01	55.27
KELUD1990-PL2-z1-r2c	PL2	opx	rim	late	52.41	0.21	0.53	26.34	1.15	20.01	1.45	0.02	102.1	60	0.19	0.02	59.83

SAMPLE GRAIN ID	Sample	Min	Texture	stage	SiO2	TiO2	Al2O3	FeO*	MnO	MgO	CaO	Na2O	Total	Mg #	FeO	Fe2O3	Mg # (Fe2+ only)
KELUD1990-PL2-z1-r2c	PL2	opx	rim	late	52.18	0.21	0.55	25.56	1.13	20.45	1.52	0.01	101.6	61	0.19	0.02	61.46
KELUD1990-PL2-z1-r2c	PL2	opx	rim	late	52.43	0.16	0.58	24.95	1.1	20.98	1.36	0.01	101.6	62	0.14	0.01	62.53
KELUD1990-PL2-z1-r2c	PL2	opx	rim	late	52.2	0.15	0.52	24.89	1.14	21.01	1.38	0.02	101.3	63	0.13	0.01	63.05
KELUD1990-PL2-z1-r2c	PL2	opx	rim	late	52.28	0.19	0.6	24.59	1.06	21.17	1.42	0.01	101.3	63	0.17	0.02	63.30
KELUD1990-PL2-z1-r2c	PL2	opx	rim	late	52.39	0.2	0.62	24.52	1.07	21.28	1.45	0.03	101.5	63	0.18	0.02	63.63
KELUD1990-PL2-z1-r2c	PL2	opx	rim	late	52.58	0.19	0.63	24.3	1	21.51	1.49	0.01	101.7	64	0.17	0.02	63.96
KELUD1990-PL2-z1-r2c	PL2	opx	rim	late	52.46	0.19	0.63	23.8	0.98	21.88	1.43	0.01	101.4	65	0.17	0.02	65.11
KELUD1990-PL2-z1-r2c	PL2	opx	rim	late	52.67	0.19	0.62	23.6	0.95	22.05	1.38	0	101.5	65	0.17	0.02	65.18
KELUD1990-PL2-z1-r2c	PL2	opx	rim	late	52.53	0.16	0.74	23.35	0.94	22.2	1.33	0.03	101.3	65	0.14	0.02	65.92
KELUD1990-PL2-z1-r2c	PL2	opx	rim	late	52.47	0.18	0.91	23.25	0.92	22.47	1.32	0.01	101.5	66	0.16	0.02	66.65
KELUD1990-PL2-z1-r2c	PL2	opx	rim	late	52.43	0.18	0.98	22.71	0.85	22.68	1.31	0.01	101.1	66	0.16	0.02	67.22
KELUD1990-PL2-z1-r2c	PL2	opx	rim	late	52.7	0.2	0.95	22.76	0.82	22.99	1.27	-0.01	101.7	67	0.17	0.02	67.56
KELUD1990-PL2-z1-r2c	PL2	opx	rim	late	52.85	0.17	0.96	22.49	0.84	23.08	1.26	0.01	101.6	67	0.15	0.02	67.76
KELUD1990-PL2-z10-r2c	PL2	opx	core	late	52.38	0.18	0.93	21.52	0.85	22.89	1.43	0.01	100.2	68	0.16	0.01	68.05
KELUD1990-PL2-z10-r2c	PL2	opx	core	late	52.27	0.2	0.89	21.62	0.85	23.02	1.36	0.01	100.2	68	0.18	0.02	68.48
KELUD1990-PL2-z10-r2c	PL2	opx	core	late	52.15	0.24	1.1	21.49	0.84	22.93	1.53	0.01	100.3	68	0.21	0.02	68.57
KELUD1990-PL2-z10-r2c	PL2	opx	core	late	52.23	0.21	1	21.43	0.81	22.9	1.41	0.01	100	68	0.19	0.02	68.18
KELUD1990-PL2-z10-r2c	PL2	opx	core	late	52.32	0.2	1	21.41	0.76	22.99	1.34	0	100	68	0.18	0.01	68.12
KELUD1990-PL2-z10-r2c	PL2	opx	core	late	52.18	0.22	1.09	21.24	0.82	22.87	1.55	0.01	100	68	0.20	0.02	68.37
KELUD1990-PL2-z10-r2c	PL2	opx	core	late	52.14	0.22	1.03	21.37	0.83	23.03	1.47	0	100.1	68	0.19	0.02	68.75
KELUD1990-PL2-z10-r2c	PL2	opx	core	late	51.97	0.21	1.1	21.22	0.79	22.93	1.51	0.01	99.7	68	0.18	0.02	68.76
KELUD1990-PL2-z10-r2c	PL2	opx	core	late	52.25	0.22	1.04	21.35	0.76	23.13	1.36	0.02	100.1	68	0.19	0.02	68.76
KELUD1990-PL2-z10-r2c	PL2	opx	core	late	52.39	0.21	1	21.33	0.77	23.18	1.39	0.01	100.3	68	0.19	0.02	68.72
KELUD1990-PL2-z10-r2c	PL2	opx	core	late	52	0.23	1.13	21.19	0.78	23.04	1.47	0.01	99.9	68	0.20	0.02	68.96
KELUD1990-PL2-z10-r2c	PL2	opx	core	late	52.03	0.21	1.13	21.29	0.77	23.16	1.39	0.03	100	68	0.18	0.02	69.28

SAMPLE GRAIN ID	Sample	Min	Texture	stage	SiO2	TiO2	Al2O3	FeO*	MnO	MgO	CaO	Na2O	Total	Mg #	FeO	Fe2O3	Mg # (Fe2+ only)
KELUD1990-PL2-z10-r2c	PL2	opx	core	late	52.26	0.18	1.07	21.26	0.77	23.13	1.35	0.02	100	68	0.16	0.02	68.78
KELUD1990-PL2-z10-r2c	PL2	opx	core	late	52.39	0.24	1.01	21.23	0.77	23.11	1.41	0.02	100.2	68	0.21	0.02	68.56
KELUD1990-PL2-z10-r2c	PL2	opx	core	late	52.4	0.18	0.99	21.31	0.77	23.2	1.34	0.01	100.2	68	0.16	0.01	68.73
KELUD1990-PL2-z10-r2c	PL2	opx	core	late	51.98	0.21	1.09	21.14	0.84	23.04	1.49	0.03	99.8	68	0.18	0.02	69.22
KELUD1990-PL2-z10-r2c	PL2	opx	core	late	52.29	0.17	1.03	21.23	0.79	23.21	1.41	0.03	100.1	68	0.15	0.02	69.16
KELUD1990-PL2-z10-r2c	PL2	opx	core	late	52.24	0.17	1.03	21.15	0.82	23.11	1.32	0.02	99.9	68	0.15	0.01	68.77
KELUD1990-PL2-z10-r2c	PL2	opx	core	late	52.08	0.19	1.02	21.11	0.76	23.07	1.4	0.03	99.7	68	0.17	0.02	68.95
KELUD1990-PL2-z10-r2c	PL2	opx	core	late	52.11	0.21	1.03	21.09	0.78	23.14	1.41	0.02	99.8	68	0.18	0.02	69.09
KELUD1990-PL2-z10-r2c	PL2	opx	core	late	52.04	0.18	1.15	21.12	0.78	23.19	1.35	0.03	99.8	69	0.16	0.02	69.34
KELUD1990-PL2-z10-r2c	PL2	opx	core	late	52.13	0.17	0.99	21.14	0.78	23.27	1.39	0.02	99.9	69	0.15	0.02	69.47
KELUD1990-PL2-z10-r2c	PL2	opx	rim	late	51.6	0.16	0.32	26.3	1.22	19.73	1.21	0.02	100.6	60	0.14	0.01	59.79
KELUD1990-PL2-z10-r2c	PL2	opx	rim	late	51.74	0.15	0.34	26.2	1.22	19.71	1.25	0.01	100.6	60	0.14	0.01	59.56
KELUD1990-PL2-z10-r2c	PL2	opx	rim	late	51.69	0.14	0.44	26.06	1.2	19.74	1.38	0.01	100.7	60	0.13	0.01	59.87
KELUD1990-PL2-z10-r2c	PL2	opx	rim	late	51.72	0.18	0.37	26.22	1.19	19.88	1.28	0.02	100.9	60	0.16	0.02	60.14
KELUD1990-PL2-z10-r2c	PL2	opx	rim	late	51.44	0.19	0.48	25.74	1.16	19.84	1.55	0.01	100.4	60	0.17	0.02	60.63
KELUD1990-PL2-z10-r2c	PL2	opx	rim	late	51.81	0.16	0.41	26.1	1.23	20.31	1.19	0.01	101.2	61	0.14	0.02	61.24
KELUD1990-PL2-z10-r2c	PL2	opx	rim	late	55.26	0.16	2.22	23.27	1.12	18.38	1.12	0.07	101.6	61	0.21	-0.04	51.15
KELUD1990-PL2-z10-r2c	PL2	opx	rim	late	50.98	0.2	0.46	24.93	1.16	19.73	2.29	0.02	99.8	61	0.17	0.02	61.94
KELUD1990-PL2-z10-r2c	PL2	opx	rim	late	51.44	0.17	0.51	25.45	1.13	20.17	1.6	0.02	100.5	61	0.15	0.02	61.75
KELUD1990-PL2-z10-r2c	PL2	opx	rim	late	51.47	0.22	0.54	25.01	1.1	20.41	1.53	0.01	100.3	62	0.20	0.02	62.21
KELUD1990-PL2-z10-r2c	PL2	opx	rim	late	51.68	0.2	0.62	24.5	1.08	20.57	1.49	0.02	100.1	62	0.18	0.02	62.40
KELUD1990-PL2-z10-r2c	PL2	opx	rim	late	51.68	0.23	0.77	24.65	1.06	20.88	1.49	0.03	100.8	63	0.20	0.02	63.37
KELUD1990-PL2-z10-r2c	PL2	opx	rim	late	51.7	0.23	0.85	23.62	0.98	21.05	1.56	0.02	100	64	0.21	0.02	63.78
KELUD1990-PL2-z10-r2c	PL2	opx	rim	late	51.76	0.18	0.85	23.03	0.91	21.87	1.32	0	99.9	65	0.16	0.02	65.72
KELUD1990-PL2-z10-r2c	PL2	opx	rim	late	52	0.21	0.83	22.4	0.87	22.51	1.35	0.02	100.2	67	0.18	0.02	67.39

SAMPLE GRAIN ID	Sample	Min	Texture	stage	SiO2	TiO2	Al2O3	FeO*	MnO	MgO	CaO	Na2O	Total	Mg #	FeO	Fe2O3	Mg # (Fe2+ only)
KELUD1990-PL2-z10-r2c	PL2	opx	rim	late	52.24	0.2	0.84	21.76	0.81	22.86	1.35	0	100.1	68	0.18	0.02	67.93
KELUD1990-PL2-z11-r2c	PL2	opx	core	late	52.8	0.22	1.1	21.81	0.83	22.88	1.34	0.03	101	68	0.20	0.01	67.36
KELUD1990-PL2-z11-r2c	PL2	opx	core	late	53.78	0.21	1.07	21.82	0.82	23.32	1.38	0.01	102.4	68	0.20	0.01	67.29
KELUD1990-PL2-z11-r2c	PL2	opx	rim	late	52.28	0.18	0.52	26.19	1.21	19.94	1.42	0.03	101.8	60	0.16	0.01	59.87
KELUD1990-PL2-z11-r2c	PL2	opx	rim	late	51.68	0.27	1.11	25.99	1.09	20.07	1.39	0.02	101.6	60	0.24	0.03	60.72
KELUD1990-PL2-z11-r2c	PL2	opx	rim	late	52.48	0.18	0.63	26.06	1.16	20.18	1.41	0.02	102.1	61	0.16	0.01	60.24
KELUD1990-PL2-z11-r2c	PL2	opx	rim	late	52.62	0.17	0.9	24.18	0.97	21.57	1.38	0.03	101.8	64	0.15	0.01	64.02
KELUD1990-PL2-z11-r2c	PL2	opx	rim	late	52.28	0.21	1.13	23.43	0.9	22.01	1.36	0	101.3	65	0.19	0.02	65.47
KELUD1990-PL2-z11-r2c	PL2	opx	rim	late	50.54	0.2	2.42	22.71	0.85	22.03	1.39	0.02	100.1	66	0.16	0.03	68.03
KELUD1990-PL2-z3a-r2c	PL2	opx	core	late	52.19	0.23	1.3	21.96	0.83	22.93	1.39	0.01	100.8	67	0.20	0.02	68.32
KELUD1990-PL2-z3a-r2c	PL2	opx	core	late	52.55	0.24	1.09	22.16	0.89	23.22	1.34	0.01	101.5	67	0.21	0.03	68.69
KELUD1990-PL2-z3a-r2c	PL2	opx	core	late	52.44	0.21	1.08	22.21	0.84	23.32	1.35	0.02	101.5	68	0.18	0.03	69.19
KELUD1990-PL2-z3a-r2c	PL2	opx	core	late	52.56	0.22	1.23	22.14	0.83	23.26	1.42	0.01	101.7	68	0.19	0.02	68.86
KELUD1990-PL2-z3a-r2c	PL2	opx	core	late	52.25	0.21	1.29	21.94	0.84	23.08	1.39	0.01	101	68	0.18	0.02	68.72
KELUD1990-PL2-z3a-r2c	PL2	opx	core	late	52.68	0.19	0.95	22.03	0.84	23.31	1.31	0.01	101.3	68	0.16	0.02	68.72
KELUD1990-PL2-z3a-r2c	PL2	opx	core	late	52.64	0.21	1.01	22.04	0.83	23.4	1.35	0.01	101.5	68	0.18	0.02	69.07
KELUD1990-PL2-z3a-r2c	PL2	opx	core	late	52.78	0.19	0.87	21.87	0.86	23.37	1.37	0	101.3	68	0.17	0.02	68.81
KELUD1990-PL2-z3a-r2c	PL2	opx	core	late	52.92	0.18	0.89	21.72	0.84	23.43	1.37	0.01	101.4	68	0.16	0.02	68.83
KELUD1990-PL2-z3a-r2c	PL2	opx	core	late	52.95	0.19	0.89	21.56	0.85	23.36	1.31	0.02	101.1	68	0.17	0.02	68.54
KELUD1990-PL2-z3a-r2c	PL2	opx	core	late	52.85	0.19	0.91	21.75	0.87	23.62	1.38	0.01	101.6	68	0.16	0.02	69.54
KELUD1990-PL2-z3a-r2c	PL2	opx	rim	late	51.95	0.15	0.41	26.36	1.27	19.55	1.26	0.01	101	60	0.14	0.01	58.87
KELUD1990-PL2-z3a-r2c	PL2	opx	rim	late	52.03	0.15	0.4	26.56	1.23	19.82	1.28	0.01	101.5	60	0.14	0.01	59.60
KELUD1990-PL2-z3a-r2c	PL2	opx	rim	late	52.1	0.17	0.48	26.25	1.23	19.76	1.31	0.02	101.3	60	0.16	0.01	59.38
KELUD1990-PL2-z3a-r2c	PL2	opx	rim	late	52.2	0.17	0.43	26.5	1.23	19.96	1.34	0.03	101.9	60	0.15	0.02	59.97
KELUD1990-PL2-z3a-r2c	PL2	opx	rim	late	52.1	0.16	0.42	26.39	1.28	19.9	1.34	0.03	101.6	60	0.14	0.01	59.97

SAMPLE GRAIN ID	Sample	Min	Texture	stage	SiO2	TiO2	Al2O3	FeO*	MnO	MgO	CaO	Na2O	Total	Mg #	FeO	Fe2O3	Mg # (Fe2+ only)
KELUD1990-PL2-z3a-r2c	PL2	opx	rim	late	51.94	0.16	0.44	26.29	1.24	19.87	1.52	0.02	101.5	60	0.14	0.02	60.23
KELUD1990-PL2-z3a-r2c	PL2	opx	rim	late	52.1	0.16	0.44	26.47	1.26	20.01	1.4	0.02	101.9	60	0.14	0.02	60.33
KELUD1990-PL2-z3a-r2c	PL2	opx	rim	late	52.14	0.18	0.43	26.2	1.26	19.87	1.31	0.03	101.4	60	0.16	0.01	59.74
KELUD1990-PL2-z3a-r2c	PL2	opx	rim	late	51.23	0.19	0.57	25.88	1.22	19.79	1.93	0.01	100.8	60	0.16	0.02	61.35
KELUD1990-PL2-z3a-r2c	PL2	opx	rim	late	50.62	0.17	0.47	25.1	1.17	19.38	3.53	0.02	100.5	60	0.14	0.03	63.17
KELUD1990-PL2-z3a-r2c	PL2	opx	rim	late	50.99	0.23	0.7	25.7	1.1	19.92	2.32	0.03	101	61	0.19	0.03	62.56
KELUD1990-PL2-z3a-r2c	PL2	opx	rim	late	49.91	0.19	0.57	24.96	1.14	19.47	3.13	0.02	99.4	61	0.15	0.03	63.81
KELUD1990-PL2-z3a-r2c	PL2	opx	rim	late	52	0.18	0.57	25.82	1.19	20.15	1.53	0.01	101.4	61	0.16	0.02	60.89
KELUD1990-PL2-z3a-r2c	PL2	opx	rim	late	50.69	0.23	1.04	25.14	1.09	20.14	2.22	0.03	100.6	61	0.19	0.03	63.49
KELUD1990-PL2-z3a-r2c	PL2	opx	rim	late	51.81	0.21	1.04	25.45	1.12	20.84	1.36	0.01	101.8	62	0.18	0.02	62.91
KELUD1990-PL2-z3a-r2c	PL2	opx	rim	late	52.09	0.21	1.13	24.32	1	21.37	1.36	0.01	101.5	64	0.19	0.02	63.98
KELUD1990-PL2-z3a-r2c	PL2	opx	rim	late	52	0.22	1.2	23.56	0.92	22.17	1.42	0.02	101.5	65	0.19	0.03	66.55
KELUD1990-PL2-z3a-r2c	PL2	opx	rim	late	52.41	0.19	1.26	22.87	0.83	22.62	1.41	0.02	101.6	66	0.16	0.02	67.24
KELUD1990-PL2-z3a-r2c	PL2	opx	rim	late	52.24	0.2	1.25	22.12	0.86	22.86	1.39	0	100.9	67	0.17	0.02	68.06
KELUD1990-PL2-z3b-r2c	PL2	opx	core	late	52.89	0.19	0.9	22.71	0.82	23.06	1.34	0.02	101.9	67	0.16	0.02	67.78
KELUD1990-PL2-z3b-r2c	PL2	opx	core	late	52.63	0.16	0.93	22.42	0.85	22.94	1.34	0.02	101.3	67	0.14	0.02	67.83
KELUD1990-PL2-z3b-r2c	PL2	opx	core	late	52.52	0.18	0.93	22.51	0.84	23.07	1.36	0.02	101.4	67	0.15	0.02	68.38
KELUD1990-PL2-z3b-r2c	PL2	opx	core	late	52.83	0.15	0.93	22.52	0.8	23.1	1.34	0.01	101.7	67	0.13	0.02	67.94
KELUD1990-PL2-z3b-r2c	PL2	opx	core	late	52.75	0.19	0.93	22.6	0.79	23.18	1.34	0.01	101.8	67	0.16	0.02	68.24
KELUD1990-PL2-z3b-r2c	PL2	opx	core	late	52.82	0.17	0.93	22.55	0.81	23.15	1.34	0.03	101.8	67	0.15	0.02	68.20
KELUD1990-PL2-z3b-r2c	PL2	opx	core	late	52.92	0.17	0.95	22.55	0.85	23.14	1.35	0.01	101.9	67	0.15	0.02	67.99
KELUD1990-PL2-z3b-r2c	PL2	opx	core	late	52.75	0.2	0.93	22.44	0.82	23.1	1.32	0.02	101.6	67	0.17	0.02	68.04
KELUD1990-PL2-z3b-r2c	PL2	opx	core	late	52.52	0.17	0.92	22.29	0.78	23.19	1.35	0.02	101.3	67	0.14	0.02	68.66
KELUD1990-PL2-z3b-r2c	PL2	opx	rim	late	51.95	0.16	0.79	25.87	1.11	20.33	1.33	0.01	101.6	61	0.14	0.02	61.17
KELUD1990-PL2-z3b-r2c	PL2	opx	rim	late	52.25	0.17	0.87	25.07	1.01	20.98	1.32	0.01	101.7	62	0.15	0.02	62.60

SAMPLE GRAIN ID	Sample	Min	Texture	stage	SiO2	TiO2	Al2O3	FeO*	MnO	MgO	CaO	Na2O	Total	Mg #	FeO	Fe2O3	Mg # (Fe2+ only)
KELUD1990-PL2-z3b-r2c	PL2	opx	rim	late	52.28	0.19	0.9	24.35	0.95	21.56	1.33	0.01	101.6	64	0.17	0.02	64.23
KELUD1990-PL2-z3b-r2c	PL2	opx	rim	late	52.6	0.19	0.89	23.76	0.93	22.14	1.32	0.02	101.8	65	0.17	0.02	65.55
KELUD1990-PL2-z3b-r2c	PL2	opx	rim	late	52.44	0.2	0.93	22.93	0.85	22.57	1.34	0	101.3	66	0.18	0.02	66.85
KELUD1990-PL2-z3b-r2c	PL2	opx	rim	late	52.69	0.18	0.96	22.85	0.82	22.66	1.32	0.01	101.5	66	0.16	0.02	66.79
KELUD1990-PL2-z4a-r2c	PL2	opx	core	late	52.46	0.22	1.13	22.44	0.82	22.78	1.36	0.02	101.2	67	0.19	0.02	67.52
KELUD1990-PL2-z4a-r2c	PL2	opx	core	late	52.48	0.22	1.08	22.29	0.82	23.06	1.34	0.02	101.3	67	0.19	0.02	68.30
KELUD1990-PL2-z4a-r2c	PL2	opx	core	late	52.5	0.2	1.11	22.26	0.83	23.08	1.35	0	101.3	67	0.17	0.02	68.27
KELUD1990-PL2-z4a-r2c	PL2	opx	core	late	52.48	0.26	1.21	22.24	0.83	23.12	1.34	0.01	101.5	67	0.22	0.03	68.40
KELUD1990-PL2-z4a-r2c	PL2	opx	core	late	52.67	0.22	1.2	22.13	0.83	23.21	1.34	0.01	101.6	68	0.19	0.02	68.44
KELUD1990-PL2-z4a-r2c	PL2	opx	core	late	52.51	0.18	1.12	22.13	0.79	23.4	1.39	0.02	101.5	68	0.15	0.02	69.36
KELUD1990-PL2-z4a-r2c	PL2	opx	core	late	52.41	0.22	1.25	21.88	0.8	23.19	1.38	0.02	101.2	68	0.19	0.02	68.81
KELUD1990-PL2-z4a-r2c	PL2	opx	rim	late	51.98	0.16	0.55	26.98	1.29	19.97	1.33	0.05	102.3	59	0.14	0.02	60.46
KELUD1990-PL2-z4a-r2c	PL2	opx	rim	late	51.77	0.19	0.54	26.52	1.19	20.21	1.38	0.01	101.8	60	0.17	0.02	61.19
KELUD1990-PL2-z4a-r2c	PL2	opx	rim	late	51.91	0.16	0.5	26.01	1.17	20.64	1.32	0.01	101.7	61	0.14	0.02	62.23
KELUD1990-PL2-z4a-r2c	PL2	opx	rim	late	51.86	0.18	0.47	25.8	1.18	21.02	1.3	0.01	101.8	62	0.15	0.02	63.42
KELUD1990-PL2-z4a-r2c	PL2	opx	rim	late	47.9	0.18	0.5	26.06	1.23	22.53	1.36	0.01	99.8	63	0.10	0.07	73.94
KELUD1990-PL2-z4a-r2c	PL2	opx	rim	late	52.66	0.21	1.04	22.29	0.82	21.99	1.34	0.03	100.4	66	0.20	0.01	64.88
KELUD1990-PL2-z4b-r2c	PL2	opx	core	late	51.73	0.3	1.74	23.03	0.85	22.23	1.56	0.03	101.5	66	0.25	0.04	67.18
KELUD1990-PL2-z4b-r2c	PL2	opx	core	late	52.49	0.19	0.98	23.19	0.85	22.67	1.37	0.02	101.8	66	0.16	0.02	67.26
KELUD1990-PL2-z4b-r2c	PL2	opx	core	late	52.39	0.18	0.98	23	0.79	22.66	1.31	0.01	101.3	66	0.16	0.02	67.16
KELUD1990-PL2-z4b-r2c	PL2	opx	core	late	52.26	0.2	0.96	22.85	0.82	22.53	1.34	0.03	101	66	0.17	0.02	67.10
KELUD1990-PL2-z4b-r2c	PL2	opx	core	late	52.44	0.23	1.08	22.87	0.81	22.69	1.41	0.02	101.5	66	0.20	0.02	67.34
KELUD1990-PL2-z4b-r2c	PL2	opx	core	late	52.33	0.22	1.29	22.75	0.82	22.61	1.51	0.04	101.6	66	0.19	0.02	67.53
KELUD1990-PL2-z4b-r2c	PL2	opx	core	late	52.1	0.24	1.42	22.55	0.8	22.47	1.44	0.02	101	66	0.21	0.02	67.16
KELUD1990-PL2-z4b-r2c	PL2	opx	core	late	52.48	0.21	1.08	22.63	0.79	22.57	1.41	0.01	101.2	66	0.19	0.02	66.86

SAMPLE GRAIN ID	Sample	Min	Texture	stage	SiO2	TiO2	Al2O3	FeO*	MnO	MgO	CaO	Na2O	Total	Mg #	FeO	Fe2O3	Mg # (Fe2+ only)
KELUD1990-PL2-z4b-r2c	PL2	opx	core	late	52.72	0.18	1.07	22.49	0.8	22.86	1.41	0.02	101.5	67	0.16	0.02	67.50
KELUD1990-PL2-z4b-r2c	PL2	opx	core	late	52.62	0.18	1.09	22.44	0.8	23.13	1.43	0.02	101.7	67	0.15	0.02	68.47
KELUD1990-PL2-z4b-r2c	PL2	opx	rim	late	51.92	0.21	0.58	26.24	1.22	19.77	1.38	0.01	101.3	60	0.19	0.02	59.64
KELUD1990-PL2-z4b-r2c	PL2	opx	rim	late	50.86	0.14	0.5	25.62	1.2	19.62	1.4	0	99.3	60	0.13	0.01	60.52
KELUD1990-PL2-z4b-r2c	PL2	opx	rim	late	51.82	0.18	0.59	25.83	1.21	20.22	1.39	0.04	101.3	61	0.16	0.02	61.32
KELUD1990-PL2-z4b-r2c	PL2	opx	rim	late	51.92	0.18	0.81	25.59	1.15	20.22	1.4	0.08	101.4	61	0.16	0.02	61.33
KELUD1990-PL2-z4b-r2c	PL2	opx	rim	late	51.86	0.21	0.74	25.53	1.16	20.35	1.44	0.05	101.3	61	0.19	0.02	61.69
KELUD1990-PL2-z4b-r2c	PL2	opx	rim	late	51.55	0.23	0.79	25.55	1.16	20.4	1.47	0.03	101.2	61	0.20	0.03	62.17
KELUD1990-PL2-z4b-r2c	PL2	opx	rim	late	50.53	0.21	0.87	24.97	1.11	20.02	2.75	0.07	100.5	61	0.17	0.04	64.37
KELUD1990-PL2-z4b-r2c	PL2	opx	rim	late	51.83	0.17	0.56	25.27	1.19	20.33	1.5	0.03	100.9	61	0.15	0.02	61.71
KELUD1990-PL2-z4b-r2c	PL2	opx	rim	late	52.36	0.13	0.51	25.46	1.17	20.59	1.34	0.02	101.6	62	0.12	0.01	61.58
KELUD1990-PL2-z4b-r2c	PL2	opx	rim	late	51.62	0.25	2.45	23.69	1.05	19.28	1.95	0.26	100.5	62	0.24	0.01	60.15
KELUD1990-PL2-z4b-r2c	PL2	opx	rim	late	51.9	0.24	1.2	24.91	1.09	20.74	1.37	0.05	101.5	62	0.21	0.02	62.61
KELUD1990-PL2-z4b-r2c	PL2	opx	rim	late	51.85	0.19	1.05	24.27	0.97	21.38	1.27	0.01	101	64	0.17	0.02	64.19
KELUD1990-PL2-z4b-r2c	PL2	opx	rim	late	51.84	0.18	1.3	23.71	0.87	22.06	1.31	0.01	101.3	65	0.15	0.02	66.21
KELUD1990-PL2-z4b-r2c	PL2	opx	rim	late	52.15	0.22	1.01	22.98	0.85	22.51	1.35	0.01	101.1	66	0.19	0.02	67.12
KELUD1990-PL2-z5-r2c	PL2	opx	core	late	52.08	0.22	1.04	21.96	0.81	23.13	1.32	0.03	100.6	68	0.19	0.03	69.07
KELUD1990-PL2-z5-r2c	PL2	opx	core	late	52.03	0.21	1.07	21.91	0.82	23.1	1.35	0.01	100.5	68	0.18	0.02	69.01
KELUD1990-PL2-z5-r2c	PL2	opx	core	late	52.17	0.2	1.09	21.79	0.82	23.03	1.3	0.02	100.4	68	0.17	0.02	68.59
KELUD1990-PL2-z5-r2c	PL2	opx	core	late	52.01	0.22	0.99	21.83	0.81	23.11	1.28	0.03	100.3	68	0.19	0.02	69.05
KELUD1990-PL2-z5-r2c	PL2	opx	core	late	52.13	0.2	1.04	21.82	0.75	23.14	1.42	0.01	100.5	68	0.17	0.02	69.02
KELUD1990-PL2-z5-r2c	PL2	opx	core	late	52.21	0.21	0.98	21.78	0.8	23.24	1.33	0.02	100.6	68	0.18	0.02	69.18
KELUD1990-PL2-z5-r2c	PL2	opx	core	late	52.35	0.19	0.99	21.32	0.79	23.42	1.36	0.01	100.4	69	0.16	0.02	69.50
KELUD1990-PL2-z5-r2c	PL2	opx	core	late	52.14	0.19	1.12	20.84	0.81	23.7	1.25	0.01	100.1	69	0.16	0.02	70.49
KELUD1990-PL2-z5-r2c	PL2	opx	core	late	52.26	0.15	1.35	20.49	0.76	23.73	1.29	0.02	100.1	70	0.13	0.01	70.49

SAMPLE GRAIN ID	Sample	Min	Texture	stage	SiO2	TiO2	Al2O3	FeO*	MnO	MgO	CaO	Na2O	Total	Mg #	FeO	Fe2O3	Mg # (Fe2+ only)
KELUD1990-PL2-z5-r2c	PL2	opx	core	late	52.29	0.18	1.33	20.2	0.76	24.14	1.34	0.01	100.2	70	0.15	0.02	71.67
KELUD1990-PL2-z5-r2c	PL2	opx	core	late	52.08	0.21	1.38	20.01	0.77	24.06	1.38	0.01	99.9	70	0.18	0.02	71.77
KELUD1990-PL2-z5-r2c	PL2	opx	rim	late	51.29	0.17	0.62	25.29	1.12	20.26	1.3	0.02	100.1	61	0.15	0.02	61.79
KELUD1990-PL2-z5-r2c	PL2	opx	rim	late	51.52	0.21	0.9	25.42	1.14	20.48	1.41	0.03	101.1	61	0.18	0.02	62.37
KELUD1990-PL2-z5-r2c	PL2	opx	rim	late	51.42	0.16	0.59	25.21	1.13	20.45	1.29	0.01	100.3	62	0.14	0.02	62.17
KELUD1990-PL2-z5-r2c	PL2	opx	rim	late	51.46	0.19	1.24	22.83	0.94	21.9	1.6	0.02	100.2	66	0.16	0.02	66.76
KELUD1990-PL2-z5-r2c	PL2	opx	rim	late	51.8	0.21	1.36	21.32	0.84	22.8	1.75	0.01	100.1	68	0.18	0.02	69.04
KELUD1990-PL2-z5-r2c	PL2	opx	rim	late	51.77	0.23	1.45	20.81	0.82	23.08	1.76	0.02	99.9	69	0.20	0.02	69.95
KELUD1990-PL2-z5-r2c	PL2	opx	rim	late	52.09	0.21	1.44	20.55	0.77	23.74	1.47	0.02	100.3	70	0.18	0.02	71.00
KELUD1990-PL2-z5b-r2c	PL2	opx	core	late	52.06	0.26	1.33	21.28	0.74	23.26	1.57	0.01	100.5	68	0.22	0.03	69.62
KELUD1990-PL2-z5b-r2c	PL2	opx	core	late	52.01	0.24	1.48	20.09	0.68	24.27	1.5	0.01	100.3	71	0.20	0.03	72.55
KELUD1990-PL2-z5b-r2c	PL2	opx	core	late	51.83	0.24	1.71	19.46	0.67	24.07	1.77	0.02	99.8	71	0.20	0.03	72.67
KELUD1990-PL2-z5b-r2c	PL2	opx	core	late	51.72	0.2	1.71	19.11	0.65	24.36	1.58	0.01	99.3	72	0.17	0.02	73.36
KELUD1990-PL2-z5b-r2c	PL2	opx	core	late	51.8	0.24	1.79	18.83	0.59	24.44	1.76	0.01	99.5	72	0.20	0.03	73.65
KELUD1990-PL2-z5b-r2c	PL2	opx	core	late	51.84	0.26	1.87	18.85	0.62	24.47	1.83	0.02	99.8	72	0.21	0.03	73.87
KELUD1990-PL2-z5b-r2c	PL2	opx	rim	late	52.58	0.16	0.8	25.81	1.27	18.96	1.1	0.02	100.7	59	0.16	-0.00	56.07
KELUD1990-PL2-z5b-r2c	PL2	opx	rim	late	51.29	0.15	0.42	26.34	1.21	19.75	1.25	0	100.4	60	0.13	0.02	60.20
KELUD1990-PL2-z5b-r2c	PL2	opx	rim	late	51.27	0.18	0.51	25.73	1.16	20.02	1.39	0.02	100.3	61	0.16	0.02	61.25
KELUD1990-PL2-z5b-r2c	PL2	opx	rim	late	51.44	0.21	0.56	25.38	1.13	20.43	1.47	0.01	100.6	61	0.18	0.02	62.29
KELUD1990-PL2-z5b-r2c	PL2	opx	rim	late	51.35	0.17	0.58	24.67	1.06	20.92	1.64	0.02	100.4	63	0.14	0.02	64.16
KELUD1990-PL2-z5b-r2c	PL2	opx	rim	late	51.77	0.22	0.92	23.63	0.98	22.02	1.4	0.03	101	65	0.19	0.03	66.50
KELUD1990-PL2-z6-r2c	PL2	opx	core	late	52.33	0.14	0.46	24.36	1.06	21.34	1.42	0.01	101.1	63	0.12	0.01	63.79
KELUD1990-PL2-z6-r2c	PL2	opx	core	late	52.34	0.17	0.44	24.25	1.1	21.44	1.48	0.01	101.2	64	0.15	0.02	64.18
KELUD1990-PL2-z6-r2c	PL2	opx	core	late	52.38	0.17	0.46	24.11	1.06	21.33	1.49	0.01	101	64	0.15	0.01	63.75
KELUD1990-PL2-z6-r2c	PL2	opx	core	late	52.54	0.17	0.5	24.18	1.04	21.43	1.47	0.02	101.4	64	0.15	0.01	63.85

SAMPLE GRAIN ID	Sample	Min	Texture	stage	SiO2	TiO2	Al2O3	FeO*	MnO	MgO	CaO	Na2O	Total	Mg #	FeO	Fe2O3	Mg # (Fe2+ only)
KELUD1990-PL2-z6-r2c	PL2	opx	core	late	52.29	0.18	0.47	24.16	1	21.5	1.42	0.02	101	64	0.16	0.02	64.27
KELUD1990-PL2-z6-r2c	PL2	opx	core	late	52.54	0.15	0.46	23.9	0.98	21.39	1.45	0.02	100.9	64	0.14	0.01	63.64
KELUD1990-PL2-z6-r2c	PL2	opx	core	late	52.53	0.15	0.53	23.9	0.96	21.58	1.42	0.02	101.1	64	0.14	0.01	64.17
KELUD1990-PL2-z6-r2c	PL2	opx	core	late	52.51	0.16	0.51	23.92	1.03	21.61	1.41	0.01	101.2	64	0.14	0.01	64.29
KELUD1990-PL2-z6-r2c	PL2	opx	core	late	52.55	0.15	0.5	23.89	0.99	21.7	1.43	0.03	101.2	64	0.13	0.01	64.61
KELUD1990-PL2-z6-r2c	PL2	opx	core	late	52.25	0.18	0.91	23.79	0.94	21.68	1.37	0.01	101.1	64	0.16	0.02	64.67
KELUD1990-PL2-z6-r2c	PL2	opx	core	late	52.47	0.18	0.76	23.87	0.98	21.79	1.33	0.02	101.4	64	0.16	0.02	64.75
KELUD1990-PL2-z6-r2c	PL2	opx	core	late	52.53	0.15	0.57	23.82	0.94	21.77	1.37	0.01	101.2	64	0.13	0.01	64.60
KELUD1990-PL2-z6-r2c	PL2	opx	core	late	52.05	0.18	0.91	23.76	0.95	21.84	1.35	0.02	101.1	65	0.16	0.02	65.46
KELUD1990-PL2-z6-r2c	PL2	opx	core	late	52.19	0.21	1.01	23.39	0.93	21.93	1.39	0.01	101.1	65	0.19	0.02	65.48
KELUD1990-PL2-z6-r2c	PL2	opx	core	late	52	0.23	1.16	23.19	0.91	22.16	1.37	0.03	101.1	65	0.20	0.02	66.46
KELUD1990-PL2-z6-r2c	PL2	opx	core	late	52.2	0.2	1.05	23.04	0.94	22.07	1.52	0.02	101	65	0.18	0.02	66.14
KELUD1990-PL2-z6-r2c	PL2	opx	core	late	52.27	0.22	1.21	22.98	0.88	22.43	1.38	0.01	101.4	66	0.19	0.02	66.79
KELUD1990-PL2-z6-r2c	PL2	opx	core	late	52.53	0.22	1.22	22.82	0.79	22.63	1.38	0	101.6	66	0.19	0.02	66.87
KELUD1990-PL2-z6-r2c	PL2	opx	core	late	52.53	0.21	1.16	22.63	0.78	23.14	1.42	0.01	101.9	67	0.18	0.03	68.51
KELUD1990-PL2-z6-r2c	PL2	opx	rim	late	51.72	0.17	0.41	26.35	1.29	19.73	1.31	0.03	101	60	0.15	0.02	59.89
KELUD1990-PL2-z6-r2c	PL2	opx	rim	late	51.83	0.19	0.44	26.1	1.27	19.62	1.34	0.02	100.8	60	0.18	0.01	59.34
KELUD1990-PL2-z6-r2c	PL2	opx	rim	late	51.23	0.24	0.91	26.38	1.15	19.87	1.49	0.02	101.3	60	0.21	0.03	60.93
KELUD1990-PL2-z6-r2c	PL2	opx	rim	late	51.53	0.16	0.57	26.12	1.17	19.96	1.39	0.03	100.9	60	0.14	0.02	60.82
KELUD1990-PL2-z6-r2c	PL2	opx	rim	late	51.74	0.15	0.47	26.37	1.17	20.16	1.42	0.03	101.5	60	0.13	0.02	61.24
KELUD1990-PL2-z6-r2c	PL2	opx	rim	late	50.44	0.18	0.47	25.9	1.24	19.82	1.38	0.02	99.5	60	0.15	0.02	61.80
KELUD1990-PL2-z6-r2c	PL2	opx	rim	late	51.45	0.21	0.6	25.9	1.21	19.86	1.39	0.01	100.6	60	0.19	0.02	60.50
KELUD1990-PL2-z6-r2c	PL2	opx	rim	late	51.73	0.16	0.54	26.05	1.21	20	1.4	0.03	101.1	60	0.14	0.02	60.75
KELUD1990-PL2-z6-r2c	PL2	opx	rim	late	50.96	0.3	1.47	25.84	1.1	19.83	1.46	0.02	101	60	0.26	0.03	60.98
KELUD1990-PL2-z6-r2c	PL2	opx	rim	late	51.75	0.18	0.56	25.98	1.15	19.97	1.42	0.01	101	60	0.16	0.02	60.47

SAMPLE GRAIN ID	Sample	Min	Texture	stage	SiO2	TiO2	Al2O3	FeO*	MnO	MgO	CaO	Na2O	Total	Mg #	FeO	Fe2O3	Mg # (Fe2+ only)
KELUD1990-PL2-z6-r2c	PL2	opx	rim	late	51.73	0.16	0.53	25.84	1.2	19.89	1.42	0.02	100.8	60	0.15	0.01	60.36
KELUD1990-PL2-z6-r2c	PL2	opx	rim	late	51.61	0.16	0.38	26.25	1.27	20.25	1.2	0.02	101.1	60	0.14	0.02	61.42
KELUD1990-PL2-z6-r2c	PL2	opx	rim	late	51.65	0.17	0.49	26.09	1.19	20.19	1.4	0.03	101.2	61	0.15	0.02	61.41
KELUD1990-PL2-z6-r2c	PL2	opx	rim	late	51.54	0.1	0.46	25.77	1.18	20.16	1.41	0.01	100.6	61	0.09	0.01	61.42
KELUD1990-PL2-z6-r2c	PL2	opx	rim	late	51.24	0.2	1.2	25.85	1.09	20.36	1.43	0.02	101.4	61	0.17	0.03	62.31
KELUD1990-PL2-z6-r2c	PL2	opx	rim	late	51.73	0.19	0.91	25.05	1.01	20.89	1.38	0.01	101.2	62	0.17	0.02	63.07
KELUD1990-PL2-z6-r2c	PL2	opx	rim	late	51.64	0.22	1.19	24.75	0.95	20.92	1.33	0.03	101	63	0.19	0.02	63.21
KELUD1990-PL2-z6-r2c	PL2	opx	rim	late	51.67	0.23	1.33	24.45	0.95	21.04	1.39	0.02	101.1	63	0.20	0.02	63.55
KELUD1990-PL2-z6-r2c	PL2	opx	rim	late	51.92	0.22	1.28	23.96	0.94	21.49	1.4	0.02	101.2	64	0.19	0.02	64.59
KELUD1990-PL2-z7-r2c	PL2	opx	core	late	51.31	0.18	0.68	22.48	1.09	20.67	1.6	0.02	98	62	0.17	0.01	63.30
KELUD1990-PL2-z7-r2c	PL2	opx	core	late	52.83	0.2	1.11	21.74	0.77	23.31	1.38	0.02	101.4	68	0.18	0.02	68.56
KELUD1990-PL2-z7-r2c	PL2	opx	core	late	52.63	0.17	1.08	21.71	0.76	23.28	1.32	0.01	101	68	0.15	0.02	68.63
KELUD1990-PL2-z7-r2c	PL2	opx	rim	late	54.29	0.16	1.42	22.77	1.24	17.85	1.11	0.02	98.8	58	0.21	-0.04	50.44
KELUD1990-PL2-z7-r2c	PL2	opx	rim	late	52.17	0.15	0.46	23.27	1.19	19.96	1.45	0.02	98.7	60	0.15	-0.00	59.90
KELUD1990-PL2-z7-r2c	PL2	opx	rim	late	51.85	0.16	0.52	25.94	1.18	20.29	1.37	0.01	101.3	61	0.14	0.02	61.31
KELUD1990-PL2-z7-r2c	PL2	opx	rim	late	51	0.17	0.5	25.4	1.19	20.11	1.44	0.02	99.8	61	0.15	0.02	61.99
KELUD1990-PL2-z7-r2c	PL2	opx	rim	late	53.07	0.16	0.53	23.09	1.18	20.61	1.43	0.03	100.1	61	0.16	-0.00	60.75
KELUD1990-PL2-z7-r2c	PL2	opx	rim	late	52.03	0.15	0.57	25.26	1.16	20.67	1.41	0.02	101.3	62	0.13	0.01	62.31
KELUD1990-PL2-z7-r2c	PL2	opx	rim	late	51.98	0.19	0.62	24.66	1.09	20.81	1.49	0.01	100.9	63	0.17	0.02	62.73
KELUD1990-PL2-z7-r2c	PL2	opx	rim	late	52.18	0.18	0.64	24.46	1.03	21.25	1.49	0.01	101.2	63	0.16	0.02	63.75
KELUD1990-PL2-z7-r2c	PL2	opx	rim	late	51.96	0.22	0.7	24.42	1.02	21.48	1.46	0.03	101.3	64	0.19	0.03	64.75
KELUD1990-PL2-z7-r2c	PL2	opx	rim	late	52.22	0.19	0.62	23.91	1.02	21.67	1.43	0.02	101.1	64	0.17	0.02	64.90
KELUD1990-PL2-z7-r2c	PL2	opx	rim	late	52.04	0.23	0.92	23.85	0.97	21.81	1.31	0	101.1	64	0.20	0.02	65.19
KELUD1990-PL2-z7-r2c	PL2	opx	rim	late	52.34	0.16	0.89	23.38	0.93	22.28	1.32	0.02	101.3	65	0.14	0.02	66.34
KELUD1990-PL2-z7-r2c	PL2	opx	rim	late	52.65	0.19	0.96	22.37	0.84	22.76	1.28	0.02	101.1	67	0.17	0.02	67.13

SAMPLE GRAIN ID	Sample	Min	Texture	stage	SiO2	TiO2	Al2O3	FeO*	MnO	MgO	CaO	Na2O	Total	Mg #	FeO	Fe2O3	Mg # (Fe2+ only)
KELUD1990-PL2-z7-r2c	PL2	opx	rim	late	52.49	0.18	1.03	21.91	0.83	23.11	1.32	0.02	100.9	68	0.16	0.02	68.45
KELUD1990-PL2-z7-r2c	PL2	opx	rim	late	52.63	0.18	1.12	21.91	0.81	23.29	1.3	0.02	101.3	68	0.16	0.02	68.74
KELUD1990-PL2-z9-r2c	PL2	opx	core	late	52.22	0.17	0.99	21.53	0.81	23.15	1.33	0	100.2	68	0.15	0.02	68.83
KELUD1990-PL2-z9-r2c	PL2	opx	core	late	52.12	0.2	1.14	21.24	0.8	23.11	1.39	0.02	100	68	0.18	0.02	68.99
KELUD1990-PL2-z9-r2c	PL2	opx	core	late	51.91	0.2	1.15	21.16	0.79	23.04	1.38	0.01	99.6	68	0.18	0.02	68.99
KELUD1990-PL2-z9-r2c	PL2	opx	rim	late	53.95	0.18	1.37	25.21	1.17	17.91	1.17	0.02	101	58	0.21	-0.03	51.22
KELUD1990-PL2-z9-r2c	PL2	opx	rim	late	51.46	0.17	0.44	25.82	1.19	19.56	1.31	0.01	100	60	0.16	0.01	59.46
KELUD1990-PL2-z9-r2c	PL2	opx	rim	late	51.25	0.19	0.48	25.66	1.11	19.68	1.47	0.01	99.9	60	0.17	0.02	60.20
KELUD1990-PL2-z9-r2c	PL2	opx	rim	late	51.57	0.16	0.52	24.99	1.14	19.99	1.49	0.03	99.9	61	0.15	0.01	60.92
KELUD1990-PL2-z9-r2c	PL2	opx	rim	late	51.53	0.19	0.58	24.89	1.15	20.36	1.5	0.02	100.2	62	0.17	0.02	62.07
KELUD1990-PL2-z9-r2c	PL2	opx	rim	late	51.69	0.16	0.56	24.52	1.06	20.74	1.4	0.03	100.2	63	0.14	0.01	62.86
KELUD1990-PL2-z9-r2c	PL2	opx	rim	late	51.7	0.16	0.56	23.77	1.03	21.15	1.44	0.03	99.8	64	0.14	0.01	64.10
KELUD1990-PL2-z9-r2c	PL2	opx	rim	late	52.06	0.17	0.62	23.86	1.04	21.62	1.45	0.01	100.8	64	0.15	0.02	64.98
KELUD1990-PL2-z9-r2c	PL2	opx	rim	late	51.68	0.21	0.65	23.49	1.02	21.44	1.47	0	100	64	0.19	0.02	64.84
KELUD1990-PL2-z9-r2c	PL2	opx	rim	late	51.84	0.19	0.71	23.32	0.99	21.56	1.42	0.02	100	65	0.17	0.02	65.00
KELUD1990-PL2-z9-r2c	PL2	opx	rim	late	51.7	0.23	0.78	23.18	0.99	21.54	1.5	0.02	99.9	65	0.20	0.02	65.20
KELUD1990-PL2-z9-r2c	PL2	opx	rim	late	51.68	0.25	0.84	23.15	0.99	21.83	1.5	0.01	100.2	65	0.22	0.03	66.05
KELUD1990-PL2-z9-r2c	PL2	opx	rim	late	51.45	0.27	1.44	22.95	0.93	21.68	1.59	0.01	100.3	65	0.24	0.03	65.94
KELUD1990-PL2-z9-r2c	PL2	opx	rim	late	51.54	0.27	1.08	22.82	0.92	21.7	1.47	0.01	99.8	65	0.24	0.02	65.68
KELUD1990-PL2-z9-r2c	PL2	opx	rim	late	51.68	0.21	1.1	22.35	0.91	21.99	1.46	0.03	99.7	66	0.19	0.02	66.50
KELUD1990-PL2-z9-r2c	PL2	opx	rim	late	52	0.22	0.95	21.78	0.86	22.73	1.33	0.01	99.9	67	0.19	0.02	67.93
KELUD1990-PX10-core-only	PL2	opx	pheno	late	52.82	0.19	1.05	19.14	0.73	23.43	1.48	0.02	98.9	69	0.19	0.00	68.93
KELUD1990-PX10-core-only	PL2	opx	pheno	late	53.14	0.17	0.89	18.56	0.67	23.81	1.37	0.02	98.6	70	0.17	-0.00	69.38
KELUD1990-PX10-core-only	PL2	opx	glom	late	53.65	0.15	0.71	17.44	0.64	24.56	1.51	0.01	98.7	72	0.15	-0.00	70.98
KELUD1990-PX3-c-only	PL2	opx	pheno	late	52.16	0.23	1.55	18.99	0.74	22.96	1.45	0.01	98.1	68	0.23	-0.00	68.30

SAMPLE GRAIN ID	Sample	Min	Texture	stage	SiO2	TiO2	Al2O3	FeO*	MnO	MgO	CaO	Na2O	Total	Mg #	FeO	Fe2O3	Mg # (Fe2+ only)
KELUD1990-PX3-c-only	PL2	opx	pheno	late	52.33	0.23	1.54	18.87	0.72	23.06	1.51	0.01	98.3	69	0.23	-0.00	68.42
KELUD1990-PX3-c-only	PL2	opx	pheno	late	52.59	0.21	1.03	18.95	0.73	23.2	1.41	0.01	98.1	69	0.21	-0.00	68.37
KELUD1990-PX6-core-only	PL2	opx	glom	late	52.71	0.2	1.31	19.03	0.75	23.37	1.51	0.02	98.9	69	0.20	0.00	68.96
KELUD1990-PX6-core-only	PL2	opx	glom	late	52.94	0.15	0.97	18.84	0.75	23.67	1.49	0.01	98.8	69	0.15	0.00	69.50
KELUD1990-z14-r2c	PL2	opx	core	late	52.02	0.15	2.3	23.65	1.06	16.21	2.84	0.19	98.4	58	0.18	-0.02	50.60
KELUD1990-z14-r2c	PL2	opx	core	late	54.17	0.13	6.03	22.36	1.01	15.48	2.31	0.7	102.2	58	0.17	-0.03	47.24
KELUD1990-z14-r2c	PL2	opx	core	late	52.88	0.13	3.32	24.4	1.08	17.42	1.76	0.48	101.5	59	0.14	-0.01	53.58
KELUD1990-z14-r2c	PL2	opx	core	late	52.27	0.15	1.01	25.94	1.2	19.26	1.27	0.11	101.2	60	0.14	0.01	57.97
KELUD1990-z14-r2c	PL2	opx	core	late	52.73	0.21	1.28	20.44	0.74	23.77	1.41	0.01	100.6	70	0.19	0.02	69.98
KELUD1990-z14-r2c	PL2	opx	core	late	52.59	0.2	1.32	20.32	0.73	24.1	1.46	0.03	100.7	70	0.17	0.02	71.35
KELUD1990-z14-r2c	PL2	opx	core	late	52.83	0.2	1.4	20.08	0.7	24.18	1.51	0.01	100.9	70	0.17	0.02	71.17
KELUD1990-z14-r2c	PL2	opx	core	late	52.49	0.27	1.56	19.36	0.65	24.51	1.62	0.01	100.5	72	0.23	0.03	72.66
KELUD1990-z14-r2c	PL2	opx	core	late	52.65	0.22	1.84	19.01	0.63	24.8	1.89	0.02	101.1	72	0.18	0.02	73.80
KELUD1990-z14-r2c	PL2	opx	core	late	52.77	0.2	1.99	18.91	0.6	25.16	1.32	0.02	101	72	0.17	0.02	73.77
KELUD1990-z14-r2c	PL2	opx	core	late	52.28	0.26	2.2	18.65	0.6	24.87	1.99	0.03	100.9	73	0.21	0.03	74.70
KELUD1990-z14-r2c	PL2	opx	core	late	52.96	0.19	1.9	18.8	0.58	25.32	1.27	0.01	101	73	0.16	0.02	73.81
KELUD1990-z14-r2c	PL2	opx	core	late	52.9	0.19	1.99	18.87	0.55	25.46	1.39	0.01	101.4	73	0.16	0.02	74.47
KELUD1990-z14-r2c	PL2	opx	core	late	52.48	0.26	2.16	18.5	0.56	25.04	1.7	0.01	100.7	73	0.22	0.03	74.27
KELUD1990-z14-r2c	PL2	opx	core	late	52.33	0.25	2.25	18.34	0.54	24.83	1.88	0.01	100.4	73	0.21	0.02	74.13
KELUD1990-z14-r2c	PL2	opx	core	late	52.62	0.22	2.15	18.51	0.61	25.22	1.36	0.02	100.7	73	0.19	0.02	74.22
KELUD1990-z14-r2c	PL2	opx	core	late	52.94	0.2	1.89	18.64	0.58	25.4	1.37	0.02	101	73	0.17	0.02	74.28
KELUD1990-z14-r2c	PL2	opx	core	late	52.53	0.25	2.22	18.45	0.57	25.17	1.8	0.01	101	73	0.21	0.03	74.77
KELUD1990-z14-r2c	PL2	opx	core	late	52.76	0.21	2.02	18.67	0.55	25.5	1.26	0.02	101	73	0.18	0.02	74.62
KELUD1990-z14-r2c	PL2	opx	core	late	52.7	0.23	2.12	18.53	0.55	25.38	1.45	0.01	101	73	0.19	0.02	74.57
KELUD1990-z14-r2c	PL2	opx	core	late	52.95	0.21	1.89	18.57	0.57	25.46	1.36	0.01	101	73	0.18	0.02	74.34

SAMPLE GRAIN ID	Sample	Min	Texture	stage	SiO2	TiO2	Al2O3	FeO*	MnO	MgO	CaO	Na2O	Total	Mg #	FeO	Fe2O3	Mg # (Fe2+ only)
KELUD1990-z14-r2c	PL2	opx	core	late	53.01	0.22	1.83	18.7	0.56	25.75	1.37	0.01	101.4	73	0.18	0.02	75.11
KELUD1990-z14-r2c	PL2	opx	core	late	53.05	0.2	1.97	18.53	0.57	25.53	1.32	0.02	101.2	73	0.17	0.02	74.41
KELUD1990-z14-r2c	PL2	opx	rim	late	52.72	0.19	0.51	26.32	1.17	19.82	1.38	0.02	102.1	60	0.18	0.01	58.81
KELUD1990-z14-r2c	PL2	opx	rim	late	51.97	0.19	0.61	25.8	1.1	20.13	1.44	0.02	101.3	61	0.17	0.02	60.68
KELUD1990-z14-r2c	PL2	opx	rim	late	52.3	0.21	1.14	24.59	0.98	20.87	1.38	0.03	101.5	63	0.19	0.01	62.29
KELUD1990-z14-r2c	PL2	opx	rim	late	52.16	0.24	1.39	22.93	0.8	22.21	1.5	0.02	101.2	66	0.21	0.02	66.38
KELUD1990-z14-r2c	PL2	opx	rim	late	52.48	0.2	1.34	20.94	0.74	23.7	1.32	0.02	100.7	69	0.17	0.02	70.07
KELUD1990-z14-r2c	PL2	opx	rim	late	52.68	0.23	1.57	19.64	0.63	24.75	1.45	0.02	101	71	0.19	0.02	72.92
KELUD1990-z14-r2c	PL2	opx	rim	late	52.57	0.26	2.24	18.6	0.59	24.82	1.93	0	101	73	0.22	0.02	73.82
KELUD1990-z15-r2c	PL2	opx	core	late	52.54	0.21	1.01	21.91	0.87	22.98	1.45	0.02	101	68	0.18	0.02	68.19
KELUD1990-z15-r2c	PL2	opx	core	late	52.62	0.21	1.09	21.89	0.79	23.13	1.4	0.02	101.2	68	0.18	0.02	68.37
KELUD1990-z15-r2c	PL2	opx	core	late	52.37	0.22	1.01	21.66	0.86	23.19	1.41	0.01	100.7	68	0.19	0.02	68.92
KELUD1990-z15-r2c	PL2	opx	core	late	52.43	0.2	1.09	21.64	0.74	23.2	1.38	0.02	100.7	68	0.17	0.02	68.75
KELUD1990-z15-r2c	PL2	opx	core	late	52.08	0.23	1.12	21.46	0.78	23	1.48	0.01	100.2	68	0.20	0.02	68.75
KELUD1990-z15-r2c	PL2	opx	core	late	52.44	0.21	1.11	21.61	0.78	23.16	1.46	0.02	100.8	68	0.18	0.02	68.78
KELUD1990-z15-r2c	PL2	opx	core	late	52.34	0.21	1.06	21.49	0.79	23.08	1.49	0.02	100.5	68	0.18	0.02	68.73
KELUD1990-z15-r2c	PL2	opx	core	late	52.45	0.2	1.01	21.56	0.82	23.19	1.49	0.02	100.7	68	0.17	0.02	68.95
KELUD1990-z15-r2c	PL2	opx	core	late	52.62	0.24	1.13	21.46	0.79	23.11	1.51	0.01	100.9	68	0.21	0.02	68.37
KELUD1990-z15-r2c	PL2	opx	core	late	52.52	0.21	1.01	21.5	0.8	23.16	1.35	0.01	100.6	68	0.19	0.02	68.46
KELUD1990-z15-r2c	PL2	opx	core	late	52.61	0.2	1.03	21.63	0.79	23.31	1.4	0.03	101	68	0.17	0.02	68.98
KELUD1990-z15-r2c	PL2	opx	core	late	52.72	0.17	0.96	21.6	0.82	23.37	1.4	0.01	101	68	0.15	0.02	68.96
KELUD1990-z15-r2c	PL2	opx	core	late	52.62	0.17	0.99	21.51	0.78	23.3	1.38	0.02	100.8	68	0.15	0.02	68.86
KELUD1990-z15-r2c	PL2	opx	core	late	52.43	0.19	0.95	21.46	0.8	23.31	1.44	0.02	100.6	68	0.16	0.02	69.25
KELUD1990-z15-r2c	PL2	opx	rim	late	51.9	0.17	0.48	25.67	1.19	20.03	1.5	0.02	101	61	0.15	0.01	60.66
KELUD1990-z15-r2c	PL2	opx	rim	late	52.15	0.17	0.49	25.79	1.19	20.27	1.55	0.02	101.6	61	0.15	0.02	61.15

SAMPLE GRAIN ID	Sample	Min	Texture	stage	SiO2	TiO2	Al2O3	FeO*	MnO	MgO	CaO	Na2O	Total	Mg #	FeO	Fe2O3	Mg # (Fe2+ only)
KELUD1990-z15-r2c	PL2	opx	rim	late	52.03	0.17	0.51	25.44	1.2	20.23	1.52	0.02	101.1	61	0.15	0.01	61.14
KELUD1990-z15-r2c	PL2	opx	rim	late	51.97	0.17	0.51	25.41	1.13	20.31	1.47	0.03	101	61	0.15	0.01	61.37
KELUD1990-z15-r2c	PL2	opx	rim	late	51.82	0.2	0.57	25.42	1.15	20.4	1.49	0.03	101.1	61	0.18	0.02	61.86
KELUD1990-z15-r2c	PL2	opx	rim	late	51.94	0.17	0.5	25.44	1.2	20.46	1.5	0.02	101.2	61	0.15	0.02	61.94
KELUD1990-z15-r2c	PL2	opx	rim	late	52.22	0.15	0.54	25.3	1.14	20.38	1.47	0.02	101.2	61	0.14	0.01	61.23
KELUD1990-z15-r2c	PL2	opx	rim	late	51.84	0.17	0.59	25.39	1.15	20.59	1.48	0.02	101.2	62	0.15	0.02	62.39
KELUD1990-z15-r2c	PL2	opx	rim	late	51.82	0.2	0.62	25.04	1.11	20.6	1.46	0.02	100.9	62	0.18	0.02	62.33
KELUD1990-z15-r2c	PL2	opx	rim	late	52.04	0.19	0.87	24.44	1.05	21.02	1.4	0.02	101	63	0.17	0.02	63.16
KELUD1990-z15-r2c	PL2	opx	rim	late	51.94	0.21	1.01	23.04	0.93	22.1	1.35	0	100.6	66	0.18	0.02	66.21
KELUD1990-z15-r2c	PL2	opx	rim	late	52.34	0.2	0.9	22.33	0.86	22.87	1.39	0.02	100.9	67	0.17	0.02	68.07
KELUD1990-z15-r2c	PL2	opx	rim	late	52.27	0.22	1	21.83	0.87	23	1.44	0.01	100.6	68	0.19	0.02	68.55
KELUD1990-z15-r2c	PL2	opx	rim	late	52.27	0.24	1.07	21.72	0.88	22.95	1.52	0	100.7	68	0.21	0.02	68.45
KELUD1990-z16-r2c	PL2	opx	core	late	53.09	0.18	1.35	21.72	0.77	22.56	1.44	0.02	101.1	67	0.17	0.01	66.06
KELUD1990-z16-r2c	PL2	opx	core	late	53.1	0.22	1.26	21.77	0.77	22.86	1.44	0.01	101.4	68	0.20	0.01	66.86
KELUD1990-z16-r2c	PL2	opx	core	late	52.78	0.2	1.18	21.99	0.77	23.22	1.42	0.04	101.6	68	0.17	0.02	68.54
KELUD1990-z16-r2c	PL2	opx	core	late	52.41	0.21	1.07	21.65	0.78	23.18	1.37	0.04	100.7	68	0.18	0.02	68.85
KELUD1990-z16-r2c	PL2	opx	core	late	52.42	0.2	1.04	21.44	0.78	23.36	1.41	0.01	100.7	68	0.17	0.02	69.28
KELUD1990-z16-r2c	PL2	opx	core	late	52.67	0.2	1.06	20.75	0.75	23.85	1.46	0.02	100.8	69	0.17	0.02	70.47
KELUD1990-z16-r2c	PL2	opx	core	late	52.52	0.19	1.4	19.74	0.67	24.47	1.53	0.01	100.5	71	0.16	0.02	72.48
KELUD1990-z16-r2c	PL2	opx	core	late	52.38	0.22	1.92	19.08	0.58	24.61	1.66	0.04	100.5	72	0.19	0.02	73.32
KELUD1990-z16-r2c	PL2	opx	rim	late	52.16	0.12	7.07	21.5	1	14.6	3.19	1.01	100.6	57	0.15	-0.02	48.99
KELUD1990-z16-r2c	PL2	opx	rim	late	52.16	0.16	0.63	24.86	1.12	20.53	1.52	0.05	101	62	0.15	0.01	61.94
KELUD1990-z16-r2c	PL2	opx	rim	late	52.31	0.14	0.67	23.51	0.99	21.73	1.46	0.02	100.8	65	0.12	0.01	65.00
KELUD1990-z16-r2c	PL2	opx	rim	late	52.08	0.22	1.68	21.09	0.71	23.31	1.54	0.02	100.6	69	0.19	0.02	69.75
KELUD1990-z16-r2c	PL2	opx	rim	late	52.38	0.21	1.85	20	0.64	23.95	1.62	0.02	100.7	70	0.18	0.02	71.27

SAMPLE GRAIN ID	Sample	Min	Texture	stage	SiO2	TiO2	Al2O3	FeO*	MnO	MgO	CaO	Na2O	Total	Mg #	FeO	Fe2O3	Mg # (Fe2+ only)
KELUD1990-z16-r2c	PL2	opx	rim	late	52.23	0.21	1.94	19.14	0.62	24.61	1.62	0.02	100.4	72	0.18	0.02	73.43
KELUD1990-z17-r2c	PL2	opx	core	late	52.61	0.23	1.26	21.7	0.83	22.9	1.66	0.03	101.2	68	0.20	0.02	68.15
KELUD1990-z17-r2c	PL2	opx	core	late	52.43	0.23	1.06	21.79	0.81	23.32	1.37	0.01	101	68	0.20	0.02	69.10
KELUD1990-z17-r2c	PL2	opx	core	late	52.44	0.22	1.18	21.52	0.81	23.06	1.58	0.02	100.8	68	0.19	0.02	68.68
KELUD1990-z17-r2c	PL2	opx	core	late	53.25	0.22	1.09	21.84	0.77	23.61	1.38	0.02	102.2	68	0.19	0.02	68.86
KELUD1990-z17-r2c	PL2	opx	core	late	52.45	0.19	1.03	21.45	0.81	23.26	1.4	0.03	100.6	68	0.17	0.02	69.08
KELUD1990-z17-r2c	PL2	opx	core	late	52.74	0.21	1.07	21.63	0.78	23.57	1.4	0.02	101.4	68	0.18	0.02	69.50
KELUD1990-z17-r2c	PL2	opx	core	late	52.53	0.21	1.2	21.43	0.8	23.36	1.57	0.01	101.1	68	0.18	0.02	69.38
KELUD1990-z17-r2c	PL2	opx	core	late	52.63	0.23	1.4	20.18	0.75	23.51	1.62	0.02	100.3	70	0.21	0.01	69.69
KELUD1990-z17-r2c	PL2	opx	core	late	52.34	0.23	1.8	19.81	0.65	24.04	1.75	0.01	100.6	71	0.20	0.02	71.73
KELUD1990-z17-r2c	PL2	opx	rim	late	52.35	0.12	0.59	26.11	1.27	19.24	1.18	0.02	100.9	59	0.12	0.00	57.37
KELUD1990-z17-r2c	PL2	opx	rim	late	51.84	0.19	0.49	25.97	1.22	19.79	1.37	0.02	100.9	60	0.17	0.01	59.84
KELUD1990-z17-r2c	PL2	opx	rim	late	51.98	0.19	0.53	24.94	1.13	20.58	1.5	0.03	100.9	62	0.17	0.02	62.19
KELUD1990-z17-r2c	PL2	opx	rim	late	52.05	0.23	0.81	24.39	1.06	21.11	1.61	0.03	101.3	63	0.20	0.02	63.74
KELUD1990-z17-r2c	PL2	opx	rim	late	52.07	0.2	0.97	23.86	0.93	21.91	1.52	0.02	101.5	65	0.17	0.02	65.85
KELUD1990-z17-r2c	PL2	opx	rim	late	52.1	0.21	1.3	21.99	0.81	22.81	1.63	0.01	100.9	67	0.18	0.02	68.44
KELUD1990-z17-r2c	PL2	opx	rim	late	52.78	0.21	1.16	20.73	0.71	23.79	1.57	0	100.9	69	0.18	0.02	70.13
KELUD1990-z17-r2c	PL2	opx	rim	late	53.27	0.21	1.22	19.61	0.66	24.44	1.53	0.01	101	71	0.19	0.01	71.26
KELUD1990-z17-r2c	PL2	opx	rim	late	52.55	0.26	1.81	19.37	0.64	24.26	1.74	0.01	100.6	71	0.23	0.02	72.01
KELUD1990-z17-r2c	PL2	opx	rim	late	52.86	0.25	1.64	19.46	0.65	24.45	1.65	0.02	101	71	0.22	0.02	72.07
KELUD1990-z19-r2c	PL2	opx	core	late	52.52	0.19	1.04	22.22	0.83	22.91	1.35	0.04	101.1	67	0.17	0.02	67.96
KELUD1990-z19-r2c	PL2	opx	core	late	52.72	0.2	0.93	22.01	0.82	22.94	1.32	0.04	101	67	0.18	0.02	67.69
KELUD1990-z19-r2c	PL2	opx	core	late	52.5	0.19	1.08	21.98	0.79	22.99	1.41	0.01	101	67	0.17	0.02	68.10
KELUD1990-z19-r2c	PL2	opx	core	late	52.62	0.25	1.1	21.92	0.77	23.03	1.4	0.03	101.1	68	0.22	0.02	68.05
KELUD1990-z19-r2c	PL2	opx	core	late	51.92	0.21	1.65	19.33	0.72	22.9	1.38	0.02	98.1	68	0.20	0.00	68.42

SAMPLE GRAIN ID	Sample	Min	Texture	stage	SiO2	TiO2	Al2O3	FeO*	MnO	MgO	CaO	Na2O	Total	Mg #	FeO	Fe2O3	Mg # (Fe2+ only)
KELUD1990-z19-r2c	PL2	opx	core	late	52.15	0.21	1.36	19.36	0.78	22.97	1.39	0.01	98.2	68	0.21	0.00	68.34
KELUD1990-z19-r2c	PL2	opx	core	late	52.65	0.19	1.08	19.56	0.78	23.4	1.46	0.02	99.1	68	0.18	0.01	69.14
KELUD1990-z19-r2c	PL2	opx	core	late	52.06	0.23	1.6	19.13	0.76	22.97	1.44	0.02	98.2	68	0.23	0.00	68.55
KELUD1990-z19-r2c	PL2	opx	core	late	52.35	0.21	1.09	19.18	0.8	23.1	1.46	0.01	98.2	68	0.21	0.00	68.58
KELUD1990-z19-r2c	PL2	opx	core	late	52.65	0.16	0.91	18.97	0.78	23.22	1.4	0.01	98.1	69	0.16	-0.00	68.44
KELUD1990-z19-r2c	PL2	opx	core	late	53.84	0.21	1.17	19.24	0.79	24.76	1.37	0.02	101.4	70	0.19	0.01	71.35
KELUD1990-z19-r2c	PL2	opx	rim	late	52.89	0.18	0.86	22.78	1.18	19.09	1.31	0.03	98.3	60	0.21	-0.02	56.08
KELUD1990-z19-r2c	PL2	opx	rim	late	51.24	0.16	0.55	25.37	1.14	19.82	1.97	0.03	100.3	61	0.14	0.02	61.51
KELUD1990-z19-r2c	PL2	opx	rim	late	52.01	0.18	0.55	25.58	1.12	20.28	1.44	0.03	101.2	61	0.16	0.02	61.17
KELUD1990-z19-r2c	PL2	opx	rim	late	51.7	0.21	0.63	25.18	1.08	20.59	1.54	0.01	100.9	62	0.19	0.02	62.48
KELUD1990-z19-r2c	PL2	opx	rim	late	51.73	0.25	0.99	24.58	1	21.15	1.46	0.03	101.2	63	0.22	0.03	64.00
KELUD1990-z19-r2c	PL2	opx	rim	late	52.4	0.2	0.94	22.45	0.85	22.65	1.33	0.02	100.8	67	0.18	0.02	67.22
KELUD1990-z19-r2c	PL2	opx	rim	late	52.19	0.25	0.95	19.77	0.88	22.76	1.39	0.03	98.2	67	0.24	0.00	67.85
KELUD1990-z19-r2c	PL2	opx	rim	late	52.43	0.19	0.94	19.17	0.83	23.01	1.44	0.01	98	68	0.19	0.00	68.21
KELUD1990-z19-rerun-r2c-only	PL2	opx	core	late	52.2	0.21	1.52	21.71	0.76	22.83	1.27	0.02	100.5	68	0.19	0.02	67.81
KELUD1990-z19-rerun-r2c-only	PL2	opx	core	late	52.2	0.22	1.2	21.55	0.82	22.78	1.4	0.02	100.2	68	0.20	0.02	67.90
KELUD1990-z19-rerun-r2c-only	PL2	opx	core	late	52.4	0.21	1.01	21.52	0.79	22.96	1.36	0.03	100.3	68	0.19	0.02	68.14
KELUD1990-z19-rerun-r2c-only	PL2	opx	core	late	52.09	0.19	1.57	21.44	0.79	22.92	1.33	0.01	100.3	68	0.17	0.02	68.32
KELUD1990-z19-rerun-r2c-only	PL2	opx	core	late	52.32	0.2	1.15	21.57	0.78	23.08	1.35	0.01	100.5	68	0.18	0.02	68.49
KELUD1990-z19-rerun-r2c-only	PL2	opx	core	late	52.25	0.21	1.23	21.61	0.79	23.15	1.34	0.03	100.6	68	0.18	0.02	68.90
KELUD1990-z19-rerun-r2c-only	PL2	opx	core	late	52.58	0.16	0.91	21.48	0.79	23.1	1.36	0.01	100.4	68	0.14	0.01	68.25
KELUD1990-z19-rerun-r2c-only	PL2	opx	core	late	52.49	0.19	0.94	21.49	0.8	23.11	1.31	0.01	100.3	68	0.17	0.01	68.32
KELUD1990-z19-rerun-r2c-only	PL2	opx	core	late	52.14	0.23	1.47	21.43	0.76	23.05	1.36	0.03	100.5	68	0.20	0.02	68.72
KELUD1990-z19-rerun-r2c-only	PL2	opx	rim	late	51.95	0.15	0.6	26.05	1.19	19.44	1.23	0.02	100.6	60	0.14	0.01	58.44

SAMPLE GRAIN ID	Sample	Min	Texture	stage	SiO2	TiO2	Al2O3	FeO*	MnO	MgO	CaO	Na2O	Total	Mg #	FeO	Fe2O3	Mg # (Fe2+ only)
KELUD1990-z19-rerun-r2c-only	PL2	opx	rim	late	51.63	0.21	0.47	25.67	1.21	19.77	1.26	0.04	100.3	60	0.19	0.01	59.95
KELUD1990-z19-rerun-r2c-only	PL2	opx	rim	late	51.25	0.2	0.52	25.44	1.16	19.78	1.79	0.01	100.1	61	0.18	0.02	61.00
KELUD1990-z19-rerun-r2c-only	PL2	opx	rim	late	51.74	0.2	0.49	25.61	1.16	19.94	1.38	0.01	100.5	61	0.18	0.01	60.30
KELUD1990-z19-rerun-r2c-only	PL2	opx	rim	late	51.67	0.18	0.48	25.49	1.18	19.95	1.33	0.03	100.3	61	0.16	0.01	60.49
KELUD1990-z19-rerun-r2c-only	PL2	opx	rim	late	50.68	0.2	0.68	24.41	1.04	19.91	2.51	0.02	99.5	62	0.17	0.02	63.09
KELUD1990-z19-rerun-r2c-only	PL2	opx	rim	late	51.87	0.22	1.09	23.32	0.91	21.42	1.52	0.02	100.4	65	0.20	0.02	64.55
KELUD1990-z19-rerun-r2c-only	PL2	opx	rim	late	52.11	0.23	1.14	22.14	0.83	22.38	1.43	0.01	100.3	67	0.21	0.02	66.83
KELUD1990-z19-rerun-r2c-only	PL2	opx	rim	late	52.35	0.22	1.06	22.22	0.91	22.69	1.32	0.01	100.8	67	0.19	0.02	67.38
KELUD1990-z19-rerun-r2c-only	PL2	opx	rim	late	52.5	0.2	1.01	22.14	0.86	22.79	1.33	0.02	100.9	67	0.18	0.02	67.51
KELUD1990-z20-r2c	PL2	opx	core	late	52.03	0.16	1.59	19.61	0.79	22.54	1.46	0.02	98.2	67	0.16	0.00	67.43
KELUD1990-z20-r2c	PL2	opx	core	late	52.2	0.22	1.56	19.66	0.74	22.7	1.56	0.03	98.7	67	0.22	0.00	67.77
KELUD1990-z20-r2c	PL2	opx	core	late	52.1	0.18	1.49	19.46	0.73	22.66	1.55	0.02	98.2	67	0.18	0.00	67.74
KELUD1990-z20-r2c	PL2	opx	core	late	52.07	0.21	1.46	19.52	0.77	22.77	1.51	0.02	98.3	68	0.21	0.00	68.08
KELUD1990-z20-r2c	PL2	opx	core	late	52.07	0.22	1.5	19.56	0.72	22.91	1.51	0.01	98.5	68	0.21	0.00	68.38
KELUD1990-z20-r2c	PL2	opx	core	late	53.5	0.21	1.49	19.42	0.76	22.8	1.45	0.01	99.6	68	0.23	-0.01	66.01
KELUD1990-z20-r2c	PL2	opx	core	late	52.59	0.17	0.95	19.21	0.81	22.81	1.42	0.02	98	68	0.17	-0.00	67.40
KELUD1990-z20-r2c	PL2	opx	core	late	52.4	0.22	1.04	21.46	0.78	23.1	1.3	0.01	100.3	68	0.20	0.02	68.34
KELUD1990-z20-r2c	PL2	opx	core	late	52.32	0.19	1.12	19.2	0.74	22.98	1.47	0.02	98	68	0.19	0.00	68.27
KELUD1990-z20-r2c	PL2	opx	core	late	52.35	0.18	1.07	21.4	0.82	23.06	1.35	0	100.2	68	0.16	0.01	68.40
KELUD1990-z20-r2c	PL2	opx	core	late	52.25	0.19	0.96	21.55	0.78	23.24	1.32	0.02	100.3	68	0.16	0.02	69.09
KELUD1990-z20-r2c	PL2	opx	core	late	52.55	0.18	0.94	19.14	0.76	23.1	1.42	0.02	98.1	68	0.18	0.00	68.27
KELUD1990-z20-r2c	PL2	opx	rim	late	52.8	0.18	0.96	25.64	1.21	19.23	1.17	0.03	101.2	60	0.18	-0.00	56.69
KELUD1990-z20-r2c	PL2	opx	rim	late	51.61	0.21	0.46	26.08	1.23	19.78	1.33	0.02	100.7	60	0.19	0.02	60.04
KELUD1990-z20-r2c	PL2	opx	rim	late	51.65	0.22	0.47	26.06	1.2	19.82	1.33	0.02	100.8	60	0.20	0.02	60.07

SAMPLE GRAIN ID	Sample	Min	Texture	stage	SiO2	TiO2	Al2O3	FeO*	MnO	MgO	CaO	Na2O	Total	Mg #	FeO	Fe2O3	Mg # (Fe2+ only)
KELUD1990-z20-r2c	PL2	opx	rim	late	52.11	0.16	0.5	23.11	1.14	19.62	1.53	0.01	98.2	60	0.17	-0.01	58.90
KELUD1990-z20-r2c	PL2	opx	rim	late	51.74	0.18	0.54	25.51	1.16	20.05	1.45	0.02	100.7	61	0.16	0.01	60.81
KELUD1990-z20-r2c	PL2	opx	rim	late	51.64	0.2	0.5	25.39	1.18	19.98	1.36	0.03	100.3	61	0.18	0.02	60.64
KELUD1990-z20-r2c	PL2	opx	rim	late	51.84	0.21	0.86	22.66	1.12	19.96	1.46	0	98.1	61	0.22	-0.01	60.07
KELUD1990-z20-r2c	PL2	opx	rim	late	51.79	0.22	0.74	25.21	1.12	20.19	1.48	0.04	100.8	61	0.20	0.02	61.22
KELUD1990-z20-r2c	PL2	opx	rim	late	51.73	0.24	1.06	23.8	0.95	21.16	1.45	0.01	100.4	64	0.22	0.02	63.83
KELUD1990-z20-r2c	PL2	opx	rim	late	52.07	0.2	1.18	22.65	0.83	22.12	1.43	0.02	100.5	66	0.18	0.02	66.20
KELUD1990-z20-r2c	PL2	opx	rim	late	52.48	0.19	1.05	20.24	0.81	22.24	1.46	0.01	98.5	66	0.19	-0.00	65.85
KELUD1990-z20-r2c	PL2	opx	rim	late	52.12	0.2	1.13	22.08	0.87	22.47	1.35	0.02	100.2	67	0.18	0.02	67.10
KELUD1990-z20-r2c	PL2	opx	rim	late	52.33	0.2	1.29	19.79	0.79	22.45	1.45	0.02	98.3	67	0.20	-0.00	66.68
KELUD1990-z20-r2c	PL2	opx	rim	late	52.17	0.21	1.14	21.72	0.84	22.71	1.39	0.02	100.2	67	0.19	0.02	67.76
KELUD1990-z20-r2c	PL2	opx	rim	late	52.65	0.17	1.06	19.33	0.74	22.78	1.42	0.02	98.2	68	0.17	-0.00	67.15
KELUD1990-z20-r2c	PL2	opx	rim	late	52.51	0.16	1.02	19.28	0.78	22.91	1.42	0.03	98.1	68	0.16	-0.00	67.85
KELUD1990-z20-r2c	PL2	opx	rim	late	52.15	0.21	1.23	21.52	0.83	23	1.44	0.01	100.4	68	0.18	0.02	68.67
KELUD1990-z20-rerun-r2c-only	PL2	opx	core	late	52.57	0.19	1.13	22.03	0.8	22.97	1.38	0.02	101.1	67	0.17	0.02	67.96
KELUD1990-z20-rerun-r2c-only	PL2	opx	core	late	52.82	0.19	1.1	21.94	0.78	23	1.38	0.01	101.2	68	0.17	0.01	67.62
KELUD1990-z20-rerun-r2c-only	PL2	opx	core	late	52.8	0.16	1.07	21.85	0.8	23	1.38	0.02	101.1	68	0.14	0.01	67.76
KELUD1990-z20-rerun-r2c-only	PL2	opx	core	late	52.66	0.17	0.96	21.74	0.77	23.1	1.36	0.02	100.8	68	0.15	0.01	68.17
KELUD1990-z20-rerun-r2c-only	PL2	opx	core	late	52.89	0.16	0.92	21.85	0.79	23.27	1.35	0.01	101.2	68	0.14	0.01	68.33
KELUD1990-z20-rerun-r2c-only	PL2	opx	core	late	52.72	0.18	1	21.7	0.78	23.19	1.36	0.02	100.9	68	0.16	0.02	68.36
KELUD1990-z20-rerun-r2c-only	PL2	opx	core	late	53.48	0.15	0.92	21.86	0.77	23.35	1.45	0.04	102	68	0.13	0.01	68.05
KELUD1990-z20-rerun-r2c-only	PL2	opx	rim	late	52.39	0.18	0.61	25.76	1.15	19.54	1.37	0.02	101	60	0.17	0.01	58.30
KELUD1990-z20-rerun-r2c-only	PL2	opx	rim	late	51.89	0.17	0.53	25.61	1.13	20.14	1.43	0.02	100.9	61	0.15	0.01	60.85
KELUD1990-z20-rerun-r2c-only	PL2	opx	rim	late	52.23	0.2	0.57	25.35	1.09	20.28	1.46	0.03	101.2	61	0.18	0.01	60.85

SAMPLE GRAIN ID	Sample	Min	Texture	stage	SiO2	TiO2	Al2O3	FeO*	MnO	MgO	CaO	Na2O	Total	Mg #	FeO	Fe2O3	Mg # (Fe2+ only)
KELUD1990-z20-rerun-r2c-only	PL2	opx	rim	late	52.19	0.21	0.67	24.77	1.04	20.8	1.43	0.01	101.1	62	0.19	0.02	62.26
KELUD1990-z20-rerun-r2c-only	PL2	opx	rim	late	52.13	0.24	0.99	24.2	0.96	21.44	1.41	0.02	101.4	64	0.21	0.02	64.18
KELUD1990-z20-rerun-r2c-only	PL2	opx	rim	late	52.61	0.23	0.95	22.52	0.83	22.44	1.34	0.02	100.9	66	0.21	0.02	66.26
KELUD1990-z20-rerun-r2c-only	PL2	opx	rim	late	52.76	0.22	0.92	22.04	0.84	22.89	1.32	0.02	101	67	0.20	0.02	67.38
KELUD1990-z20-rerun-r2c-only	PL2	opx	rim	late	52.56	0.17	0.93	21.92	0.76	23.04	1.35	0.02	100.7	68	0.15	0.02	68.11
KELUT90B-cpx-z1-r2c	90B	opx	rim	main	52.6	0.14	0.79	18.35	0.88	23.96	1.44	0.02	98.2	70	0.13	0.00	71.00
KELUT90B-cpx-z1-r2c	90B	opx	rim	main	52.51	0.14	0.63	18.46	0.89	24.38	1.41	0.03	98.5	70	0.13	0.01	72.44
KELUT90B-cpx-z1-r2c	90B	opx	core	main	52.34	0.18	0.86	20.19	0.93	23.26	1.41	0.01	99.2	67	0.16	0.01	69.24
KELUT90B-cpx-z1-r2c	90B	opx	core	main	52.28	0.18	0.96	20.17	0.92	23.35	1.44	0.02	99.3	67	0.16	0.01	69.69
KELUT90B-cpx-z1-r2c	90B	opx	core	main	52.24	0.18	0.95	20.01	0.93	23.28	1.35	0.02	99	67	0.17	0.01	69.40
KELUT90B-cpx-z1-r2c	90B	opx	core	main	52.38	0.17	0.78	19.9	0.95	23.19	1.41	0.02	98.8	67	0.16	0.01	69.05
KELUT90B-cpx-z1-r2c	90B	opx	core	main	52.12	0.19	0.94	19.88	0.94	23.19	1.41	0.02	98.7	68	0.17	0.01	69.39
KELUT90B-cpx-z1-r2c	90B	opx	core	main	52.48	0.16	0.67	19.95	0.95	23.38	1.44	0.02	99.1	68	0.15	0.01	69.55
KELUT90B-cpx-z1-r2c	90B	opx	core	main	52.07	0.19	0.96	19.79	0.91	23.27	1.4	0.02	98.6	68	0.17	0.01	69.65
KELUT90B-cpx-z1-r2c	90B	opx	core	main	52.61	0.17	0.67	19.88	0.94	23.5	1.45	0.02	99.2	68	0.16	0.01	69.71
KELUT90B-cpx-z1-r2c	90B	opx	core	main	52.86	0.14	0.62	19.8	0.97	23.48	1.41	0.03	99.3	68	0.13	0.01	69.35
KELUT90B-cpx-z1-r2c	90B	opx	core	main	52.35	0.19	0.97	19.86	0.94	23.6	1.41	0.02	99.3	68	0.17	0.01	70.31
KELUT90B-cpx-z1-r2c	90B	opx	core	main	52.66	0.15	0.59	19.75	0.92	23.49	1.41	0.02	99	68	0.14	0.01	69.54
KELUT90B-cpx-z1-r2c	90B	opx	core	main	52.52	0.16	0.67	19.72	0.93	23.48	1.57	0.02	99.1	68	0.15	0.01	69.96
KELUT90B-cpx-z1-r2c	90B	opx	core	main	52.48	0.17	0.74	19.61	0.93	23.42	1.42	0.02	98.8	68	0.16	0.01	69.59
KELUT90B-cpx-z1-r2c	90B	opx	core	main	52.32	0.15	0.63	19.62	0.97	23.47	1.54	0.02	98.7	68	0.14	0.01	70.23
KELUT90B-cpx-z1-r2c	90B	opx	core	main	52.29	0.18	0.9	19.76	0.91	23.65	1.35	0.02	99.1	68	0.16	0.01	70.42
KELUT90B-cpx-z1-r2c	90B	opx	core	main	52.75	0.15	0.58	19.55	0.94	23.45	1.38	0.03	98.8	68	0.14	0.01	69.31
KELUT90B-cpx-z1-r2c	90B	opx	core	main	52.37	0.15	0.69	19.64	0.91	23.5	1.41	0.02	98.7	68	0.14	0.01	69.97
KELUT90B-cpx-z1-r2c	90B	opx	core	main	52.64	0.15	0.62	19.61	0.93	23.5	1.48	0.03	99	68	0.14	0.01	69.77

SAMPLE GRAIN ID	Sample	Min	Texture	stage	SiO2	TiO2	Al2O3	FeO*	MnO	MgO	CaO	Na2O	Total	Mg #	FeO	Fe2O3	Mg # (Fe2+ only)
KELUT90B-cpx-z1-r2c	90B	opx	core	main	52.53	0.19	0.97	19.53	0.94	23.45	1.42	0.01	99	68	0.18	0.01	69.54
KELUT90B-cpx-z1-r2c	90B	opx	core	main	52.55	0.15	0.75	19.73	0.96	23.71	1.39	0.03	99.3	68	0.14	0.01	70.44
KELUT90B-cpx-z1-r2c	90B	opx	core	main	52.65	0.14	0.7	19.62	0.93	23.67	1.37	0.01	99.1	68	0.13	0.01	70.00
KELUT90B-cpx-z1-r2c	90B	opx	core	main	52.64	0.16	0.77	19.43	0.94	23.45	1.36	0.01	98.8	68	0.15	0.00	69.31
KELUT90B-cpx-z1-r2c	90B	opx	core	main	52.6	0.13	0.68	19.42	0.94	23.44	1.38	0.01	98.6	68	0.12	0.00	69.40
KELUT90B-cpx-z1-r2c	90B	opx	core	main	52.37	0.19	0.87	19.54	0.93	23.64	1.44	0.02	99	68	0.17	0.01	70.42
KELUT90B-cpx-z1-r2c	90B	opx	core	main	52.75	0.14	0.59	19.59	0.91	23.79	1.43	0.02	99.2	68	0.13	0.01	70.34
KELUT90B-cpx-z1-r2c	90B	opx	core	main	52.18	0.19	0.95	19.37	0.89	23.68	1.41	0.01	98.7	69	0.17	0.01	70.66
KELUT90B-cpx-z1-r2c	90B	opx	core	main	52.65	0.14	0.6	19.36	0.91	23.7	1.42	0	98.8	69	0.13	0.01	70.08
KELUT90B-cpx-z1-r2c	90B	opx	core	main	52.57	0.14	0.63	19.2	0.91	23.61	1.35	0.03	98.4	69	0.13	0.01	69.97
KELUT90B-cpx-z1-r2c	90B	opx	core	main	52.64	0.17	0.63	19.28	0.92	23.65	1.43	0.01	98.7	69	0.16	0.01	69.99
KELUT90B-cpx-z1-r2c	90B	opx	core	main	52.26	0.19	0.97	19.28	0.9	23.71	1.4	0.03	98.7	69	0.17	0.01	70.74
KELUT90B-cpx-z1-r2c	90B	opx	core	main	52.65	0.17	0.85	18.92	0.86	24.13	1.42	0.02	99	69	0.16	0.01	71.38
KELUT90B-cpx-z1-r2c	90B	opx	core	main	53.02	0.14	0.68	18.49	0.83	24.55	1.54	0.01	99.3	70	0.13	0.01	72.21
KELUT90B-cpx-z1-r2c	90B	opx	core	main	52.66	0.14	0.63	18.31	0.86	24.43	1.44	0.01	98.5	70	0.13	0.01	72.25
KELUT90B-cpx-z1-r2c	90B	opx	core	main	52.98	0.15	0.63	18.35	0.83	24.56	1.45	0.02	99	70	0.14	0.01	72.20
KELUT90B-cpx-z1-r2c	90B	opx	core	main	53.12	0.13	0.66	18.2	0.78	24.5	1.5	0.02	98.9	71	0.12	0.00	71.84
KELUT90B-cpx-z1-r2c	90B	opx	core	main	53.01	0.13	0.65	18.1	0.86	24.8	1.45	0.01	99	71	0.12	0.01	72.87
KELUT90B-cpx-z1-r2c	90B	opx	core	main	53.19	0.15	0.7	18.11	0.8	24.85	1.46	0.01	99.3	71	0.14	0.01	72.67
KELUT90B-cpx-z1-r2c	90B	opx	core	main	53.03	0.13	0.67	18.11	0.79	24.94	1.46	0.02	99.2	71	0.12	0.01	73.24
KELUT90B-cpx-z1-r2c	90B	opx	core	main	53.33	0.13	0.65	17.92	0.78	24.85	1.49	0.01	99.2	71	0.12	0.00	72.50
KELUT90B-cpx-z1-r2c	90B	opx	core	main	53.42	0.11	0.68	17.77	0.77	25.03	1.58	0.02	99.4	72	0.10	0.00	73.11
KELUT90B-cpx-z1-r2c	90B	opx	core	main	53.11	0.13	0.69	17.77	0.78	25.04	1.43	0.02	99	72	0.12	0.01	73.35
KELUT90B-cpx-z1-r2c	90B	opx	core	main	53.21	0.13	0.69	17.68	0.78	25.06	1.51	0.01	99.1	72	0.12	0.01	73.33
KELUT90B-cpx-z1-r2c	90B	opx	core	main	52.88	0.13	0.69	17.72	0.8	25.15	1.57	0.02	99	72	0.11	0.01	74.27

SAMPLE GRAIN ID	Sample	Min	Texture	stage	SiO2	TiO2	Al2O3	FeO*	MnO	MgO	CaO	Na2O	Total	Mg #	FeO	Fe2O3	Mg # (Fe2+ only)
KELUT90B-cpx-z1-r2c	90B	opx	core	main	53.26	0.13	0.67	17.69	0.79	25.17	1.49	0.01	99.2	72	0.12	0.01	73.56
KELUT90B-cpx-z1-r2c	90B	opx	core	main	53.13	0.11	0.69	17.67	0.78	25.12	1.52	0.01	99	72	0.10	0.01	73.66
KELUT90B-cpx-z1-r2c	90B	opx	core	main	53.14	0.12	0.68	17.56	0.79	25.16	1.52	0.01	99	72	0.11	0.01	73.77
KELUT90B-cpx-z1-r2c	90B	opx	core	main	53.43	0.13	0.7	17.52	0.78	25.14	1.58	0	99.3	72	0.12	0.01	73.29
KELUT90B-cpx-z1-r2c	90B	opx	core	main	53.25	0.14	0.69	17.46	0.78	25.21	1.51	0.02	99.1	72	0.13	0.01	73.75
KELUT90B-cpx-z10-r2c	90B	opx	rim	main	58.42	0.39	7.26	14.43	0.67	16.62	3.86	0.28	101.9	67	0.88	-0.25	44.94
KELUT90B-cpx-z10-r2c	90B	opx	rim	main	52.77	0.2	1.06	19.03	0.89	23.86	1.44	0.02	99.3	69	0.19	0.01	70.43
KELUT90B-cpx-z10-r2c	90B	opx	rim	main	53.08	0.21	1.12	18.96	0.89	23.93	1.38	0.02	99.6	69	0.20	0.01	70.08
KELUT90B-cpx-z10-r2c	90B	opx	core	main	52.37	0.24	1.29	20.04	0.87	22.95	1.71	0.04	99.5	67	0.22	0.01	68.73
KELUT90B-cpx-z10-r2c	90B	opx	core	main	52.46	0.22	1.07	20.02	0.94	23.16	1.64	0.02	99.5	67	0.20	0.01	69.14
KELUT90B-cpx-z10-r2c	90B	opx	core	main	52.48	0.24	1.17	19.88	0.91	23.14	1.56	0.04	99.4	67	0.22	0.01	68.97
KELUT90B-cpx-z10-r2c	90B	opx	core	main	52.31	0.24	1.22	19.73	0.91	23.01	1.66	0.04	99.1	68	0.23	0.01	68.96
KELUT90B-cpx-z10-r2c	90B	opx	core	main	52.64	0.2	1.13	19.95	0.91	23.25	1.51	0.05	99.6	68	0.19	0.01	69.10
KELUT90B-cpx-z10-r2c	90B	opx	core	main	52.57	0.21	1.06	19.82	0.93	23.13	1.61	0.03	99.4	68	0.20	0.01	68.89
KELUT90B-cpx-z10-r2c	90B	opx	core	main	52.79	0.22	0.97	19.91	0.97	23.3	1.44	0.03	99.6	68	0.21	0.01	68.87
KELUT90B-cpx-z10-r2c	90B	opx	core	main	52.81	0.22	0.99	19.85	0.96	23.2	1.46	0.03	99.5	68	0.21	0.01	68.56
KELUT90B-cpx-z10-r2c	90B	opx	core	main	52.54	0.21	1.02	19.95	0.92	23.38	1.47	0.03	99.5	68	0.19	0.01	69.47
KELUT90B-cpx-z10-r2c	90B	opx	core	main	52.99	0.22	1.24	18.77	0.89	23.83	1.61	0.02	99.6	69	0.21	0.01	70.25
KELUT90B-cpx-z10-r2c	90B	opx	core	main	52.95	0.23	1.41	18.41	0.82	24.19	1.68	0.01	99.7	70	0.22	0.01	71.33
KELUT90B-cpx-z10-r2c	90B	opx	core	main	52.53	0.25	1.64	17.97	0.79	24.28	1.8	0.02	99.3	71	0.23	0.01	72.40
KELUT90B-cpx-z10-r2c	90B	opx	core	main	52.78	0.18	1.61	18.1	0.76	24.79	1.56	0.03	99.8	71	0.16	0.01	73.29
KELUT90B-cpx-z10-r2c	90B	opx	core	main	52.44	0.26	1.77	17.41	0.74	24.39	1.93	0.02	99	71	0.24	0.01	72.98
KELUT90B-cpx-z10-r2c	90B	opx	core	main	52.82	0.22	1.79	17.39	0.71	24.75	1.81	0.02	99.5	72	0.20	0.01	73.31
KELUT90B-cpx-z11a-r2c	90B	opx	rim	main	52.93	0.21	1.38	18.76	0.88	23.62	1.66	0.02	99.5	69	0.20	0.00	69.77
KELUT90B-cpx-z11a-r2c	90B	opx	core	main	52.57	0.23	1.02	20.14	0.93	22.89	1.34	0.03	99.2	67	0.22	0.01	67.74

SAMPLE GRAIN ID	Sample	Min	Texture	stage	SiO2	TiO2	Al2O3	FeO*	MnO	MgO	CaO	Na2O	Total	Mg #	FeO	Fe2O3	Mg # (Fe2+ only)
KELUT90B-cpx-z11a-r2c	90B	opx	core	main	52.53	0.19	0.93	20.12	0.91	23.06	1.33	0.04	99.1	67	0.18	0.01	68.37
KELUT90B-cpx-z11a-r2c	90B	opx	core	main	52.54	0.21	1.11	20.02	0.96	23.04	1.38	0.03	99.3	67	0.20	0.01	68.35
KELUT90B-cpx-z11a-r2c	90B	opx	core	main	52.7	0.23	1.11	19.94	0.91	23.06	1.37	0.03	99.4	67	0.22	0.01	68.08
KELUT90B-cpx-z11a-r2c	90B	opx	core	main	52.69	0.19	0.97	20.01	0.94	23.25	1.39	0.03	99.5	67	0.18	0.01	68.79
KELUT90B-cpx-z11a-r2c	90B	opx	core	main	52.73	0.2	1.11	19.95	0.9	23.3	1.38	0.02	99.6	68	0.19	0.01	68.75
KELUT90B-cpx-z11a-r2c	90B	opx	core	main	52.62	0.19	0.98	19.86	0.93	23.25	1.38	0.03	99.2	68	0.18	0.01	68.85
KELUT90B-cpx-z11a-r2c	90B	opx	core	main	52.65	0.2	1.16	19.8	0.9	23.28	1.37	0.03	99.4	68	0.19	0.01	68.84
KELUT90B-cpx-z11a-r2c	90B	opx	core	main	52.34	0.2	1.14	19.71	0.88	23.26	1.37	0.03	98.9	68	0.19	0.01	69.19
KELUT90B-cpx-z11a-r2c	90B	opx	core	main	52.64	0.22	1.16	19.79	0.91	23.26	1.37	0.02	99.4	68	0.21	0.01	68.72
KELUT90B-cpx-z11a-r2c	90B	opx	core	main	52.71	0.21	1.17	19.69	0.9	23.39	1.41	0.02	99.5	68	0.20	0.01	69.07
KELUT90B-cpx-z11a-r2c	90B	opx	core	main	52.51	0.2	1.04	19.73	0.91	23.35	1.36	0.03	99.1	68	0.19	0.01	69.24
KELUT90B-cpx-z11a-r2c	90B	opx	core	main	52.6	0.2	1.09	19.62	0.88	23.37	1.41	0.02	99.2	68	0.19	0.01	69.15
KELUT90B-cpx-z11a-r2c	90B	opx	core	main	53.03	0.2	1.02	19.8	0.89	23.51	1.38	0.02	99.9	68	0.19	0.01	68.94
KELUT90B-cpx-z11a-r2c	90B	opx	core	main	52.32	0.18	1	19.61	0.88	23.37	1.42	0.03	98.8	68	0.17	0.01	69.65
KELUT90B-cpx-z11a-r2c	90B	opx	core	main	52.8	0.17	0.99	19.79	0.9	23.6	1.4	0.03	99.7	68	0.16	0.01	69.67
KELUT90B-cpx-z11a-r2c	90B	opx	core	main	52.71	0.21	1.08	19.59	0.91	23.33	1.4	0.02	99.3	68	0.20	0.01	68.88
KELUT90B-cpx-z11a-r2c	90B	opx	core	main	52.54	0.2	1.08	19.63	0.9	23.48	1.37	0.02	99.2	68	0.19	0.01	69.54
KELUT90B-cpx-z11a-r2c	90B	opx	core	main	52.64	0.2	1.08	19.7	0.9	23.54	1.38	0.03	99.5	68	0.19	0.01	69.65
KELUT90B-cpx-z11a-r2c	90B	opx	core	main	52.68	0.2	1.07	19.57	0.87	23.49	1.4	0.03	99.3	68	0.19	0.01	69.43
KELUT90B-cpx-z11a-r2c	90B	opx	core	main	52.35	0.19	1.03	19.42	0.87	23.29	1.39	0.04	98.6	68	0.18	0.01	69.34
KELUT90B-cpx-z11a-r2c	90B	opx	core	main	52.83	0.19	1.01	19.79	0.87	23.67	1.46	0.02	99.8	68	0.18	0.01	69.82
KELUT90B-cpx-z11a-r2c	90B	opx	core	main	52.89	0.17	1.4	18.42	0.79	24.2	1.52	0.01	99.4	70	0.16	0.01	71.23
KELUT90B-cpx-z11a-r2c	90B	opx	core	main	52.43	0.23	1.62	18.08	0.78	24.28	1.71	0.03	99.2	71	0.21	0.01	72.47
KELUT90B-cpx-z11a-r2c	90B	opx	core	main	52.4	0.23	1.8	17.72	0.74	24.44	1.74	0.02	99.1	71	0.21	0.01	72.93
KELUT90B-cpx-z11a-r2c	90B	opx	core	main	52.29	0.26	2.08	17.35	0.72	24.57	1.95	0.03	99.3	72	0.23	0.02	73.82

SAMPLE GRAIN ID	Sample	Min	Texture	stage	SiO2	TiO2	Al2O3	FeO*	MnO	MgO	CaO	Na2O	Total	Mg #	FeO	Fe2O3	Mg # (Fe2+ only)
KELUT90B-cpx-z11a-r2c	90B	opx	core	main	52.77	0.19	1.72	17.54	0.69	24.96	1.51	0.02	99.4	72	0.17	0.01	73.55
KELUT90B-cpx-z11a-r2c	90B	opx	core	main	52.71	0.21	1.93	17.29	0.68	24.91	1.75	0.04	99.5	72	0.19	0.01	73.95
KELUT90B-cpx-z11a-r2c	90B	opx	core	main	52.51	0.21	2.07	17.15	0.68	24.9	1.92	0.02	99.5	72	0.19	0.01	74.38
KELUT90B-cpx-z11b-r2c	90B	opx	rim	main	52.52	0.22	1.21	19.36	0.91	23.14	1.58	0.02	99	68	0.21	0.00	68.83
KELUT90B-cpx-z11b-r2c	90B	opx	rim	main	52.8	0.22	1.3	19.03	0.85	23.53	1.68	0.03	99.4	69	0.21	0.01	69.74
KELUT90B-cpx-z11b-r2c	90B	opx	core	main	52.58	0.23	1.02	20.18	0.94	22.66	1.65	0.03	99.3	67	0.22	0.01	67.50
KELUT90B-cpx-z11b-r2c	90B	opx	core	main	52.42	0.21	1.11	20.02	0.94	22.69	1.56	0.02	99	67	0.20	0.00	67.64
KELUT90B-cpx-z11b-r2c	90B	opx	core	main	52.78	0.21	1.13	20.01	0.96	22.86	1.53	0.02	99.5	67	0.20	0.00	67.63
KELUT90B-cpx-z11b-r2c	90B	opx	core	main	52.71	0.21	1.09	19.89	0.92	22.95	1.39	0.03	99.2	67	0.21	0.00	67.79
KELUT90B-cpx-z11b-r2c	90B	opx	core	main	52.56	0.2	1.09	19.11	0.87	23.57	1.57	0.02	99	69	0.19	0.01	70.03
KELUT90B-cpx-z11b-r2c	90B	opx	core	main	52.5	0.23	1.51	18.01	0.8	24.04	1.82	0.02	98.9	70	0.22	0.01	71.78
KELUT90B-cpx-z11b-r2c	90B	opx	core	main	52.34	0.25	1.77	17.6	0.74	23.93	1.97	0.02	98.6	71	0.24	0.01	71.80
KELUT90B-cpx-z11b-r2c	90B	opx	core	main	52.54	0.24	1.6	17.83	0.76	24.26	1.9	0.03	99.2	71	0.22	0.01	72.50
KELUT90B-cpx-z11b-r2c	90B	opx	core	main	52.51	0.25	1.94	17.21	0.71	24.45	2.15	0.02	99.2	72	0.23	0.01	73.38
KELUT90B-cpx-z11b-r2c	90B	opx	core	main	52.57	0.22	1.79	17.33	0.68	24.71	1.88	0.02	99.2	72	0.20	0.01	73.64
KELUT90B-cpx-z11c-r2c	90B	opx	rim	main	52.56	0.24	1.35	19.43	0.89	23.26	1.62	0.04	99.4	68	0.23	0.01	69.27
KELUT90B-cpx-z11c-r2c	90B	opx	core	main	52.24	0.22	1.1	20.19	0.94	22.94	1.41	0.02	99.1	67	0.21	0.01	68.43
KELUT90B-cpx-z11c-r2c	90B	opx	core	main	52.46	0.22	1.11	20.24	0.91	23.15	1.4	0.03	99.5	67	0.20	0.01	68.77
KELUT90B-cpx-z11c-r2c	90B	opx	core	main	52.28	0.23	1.1	20.17	0.93	23.13	1.48	0.02	99.3	67	0.21	0.01	69.04
KELUT90B-cpx-z11c-r2c	90B	opx	core	main	52.22	0.23	1.06	20	0.98	23.17	1.47	0.02	99.2	67	0.21	0.01	69.29
KELUT90B-cpx-z11c-r2c	90B	opx	core	main	51.87	0.22	1.87	19.82	0.81	23.02	1.51	0.02	99.1	67	0.20	0.01	69.19
KELUT90B-cpx-z11c-r2c	90B	opx	core	main	52.63	0.23	1.15	19.8	0.9	23.09	1.36	0.02	99.2	68	0.22	0.00	68.18
KELUT90B-cpx-z11c-r2c	90B	opx	core	main	52.64	0.23	1.21	19.96	0.89	23.29	1.36	0	99.6	68	0.22	0.01	68.66
KELUT90B-cpx-z11c-r2c	90B	opx	core	main	52.14	0.23	1.63	19.82	0.81	23.13	1.6	0.02	99.4	68	0.21	0.01	69.26
KELUT90B-cpx-z11c-r2c	90B	opx	core	main	52.63	0.23	1.03	19.84	0.96	23.21	1.45	0.03	99.4	68	0.22	0.01	68.82

SAMPLE GRAIN ID	Sample	Min	Texture	stage	SiO2	TiO2	Al2O3	FeO*	MnO	MgO	CaO	Na2O	Total	Mg #	FeO	Fe2O3	Mg # (Fe2+ only)
KELUT90B-cpx-z11c-r2c	90B	opx	core	main	52.23	0.24	1.43	19.69	0.85	23.31	1.55	0.01	99.3	68	0.22	0.01	69.58
KELUT90B-cpx-z11c-r2c	90B	opx	core	main	52.28	0.24	1.49	19.61	0.82	23.27	1.55	0.02	99.3	68	0.22	0.01	69.41
KELUT90B-cpx-z11c-r2c	90B	opx	core	main	52.67	0.23	1.22	19.78	0.89	23.52	1.41	0.02	99.7	68	0.21	0.01	69.50
KELUT90B-cpx-z11c-r2c	90B	opx	core	main	52.59	0.23	1.2	19.74	0.85	23.45	1.49	0.02	99.6	68	0.21	0.01	69.47
KELUT90B-cpx-z11c-r2c	90B	opx	core	main	52.69	0.23	1.22	19.81	0.86	23.67	1.35	0.02	99.9	68	0.21	0.01	69.79
KELUT90B-cpx-z11c-r2c	90B	opx	core	main	52.7	0.22	0.94	19.73	0.93	23.54	1.44	0.03	99.5	68	0.20	0.01	69.67
KELUT90B-cpx-z11c-r2c	90B	opx	core	main	52.53	0.24	1.27	19.52	0.84	23.39	1.52	0.03	99.3	68	0.23	0.01	69.44
KELUT90B-cpx-z11c-r2c	90B	opx	core	main	52.43	0.2	1.16	19.52	0.87	23.46	1.43	0.03	99.1	68	0.19	0.01	69.74
KELUT90B-cpx-z11c-r2c	90B	opx	core	main	52.47	0.25	1.29	18.62	0.81	23.94	1.61	0.02	99	70	0.23	0.01	71.20
KELUT90B-cpx-z11c-r2c	90B	opx	core	main	52.77	0.22	1.14	18.73	0.84	24.33	1.54	0.02	99.6	70	0.20	0.01	71.91
KELUT90B-cpx-z11c-r2c	90B	opx	core	main	52.74	0.24	1.48	18.17	0.74	24.34	1.74	0.02	99.5	70	0.22	0.01	72.13
KELUT90B-cpx-z11c-r2c	90B	opx	core	main	52.41	0.23	1.5	18.02	0.75	24.45	1.73	0.02	99.1	71	0.21	0.01	72.95
KELUT90B-cpx-z11c-r2c	90B	opx	core	main	52.63	0.23	1.63	17.95	0.76	24.66	1.85	0.02	99.7	71	0.20	0.02	73.46
KELUT90B-cpx-z11c-r2c	90B	opx	core	main	52.57	0.27	1.86	17.34	0.71	24.72	1.95	0.02	99.4	72	0.24	0.01	73.77
KELUT90B-cpx-z11c-r2c	90B	opx	core	main	52.74	0.22	1.66	17.34	0.69	25.11	1.62	0.02	99.4	72	0.20	0.01	74.19
KELUT90B-cpx-z12-r2c	90B	opx	rim	main	52.74	0.2	2.87	18.67	0.87	21.14	1.93	0.25	98.7	67	0.23	-0.02	64.00
KELUT90B-cpx-z12-r2c	90B	opx	core	main	52.78	0.2	1.03	19.79	0.9	23.16	1.43	0.02	99.3	68	0.19	0.00	68.32
KELUT90B-cpx-z12-r2c	90B	opx	core	main	52.93	0.18	0.98	19.65	0.91	23.23	1.41	0.02	99.3	68	0.18	0.00	68.32
KELUT90B-cpx-z12-r2c	90B	opx	core	main	52.83	0.19	0.97	19.67	0.95	23.21	1.4	0.02	99.2	68	0.18	0.00	68.42
KELUT90B-cpx-z12-r2c	90B	opx	core	main	52.79	0.19	0.95	19.7	0.93	23.4	1.46	0.02	99.4	68	0.18	0.01	69.12
KELUT90B-cpx-z12-r2c	90B	opx	core	main	52.13	0.19	1.13	19.41	0.88	23.04	1.39	0.04	98.2	68	0.18	0.01	68.90
KELUT90B-cpx-z12-r2c	90B	opx	core	main	52.97	0.18	0.91	19.46	0.95	23.2	1.46	0.01	99.1	68	0.18	0.00	68.23
KELUT90B-cpx-z12-r2c	90B	opx	core	main	52.92	0.21	0.98	19.58	0.93	23.39	1.38	0.02	99.4	68	0.20	0.00	68.76
KELUT90B-cpx-z12-r2c	90B	opx	core	main	52.75	0.18	1.09	19.3	0.86	23.27	1.43	0.02	98.9	68	0.18	0.00	68.65
KELUT90B-cpx-z12-r2c	90B	opx	core	main	52.79	0.2	0.99	19.48	0.88	23.58	1.51	0.02	99.5	68	0.19	0.01	69.67

SAMPLE GRAIN ID	Sample	Min	Texture	stage	SiO2	TiO2	Al2O3	FeO*	MnO	MgO	CaO	Na2O	Total	Mg #	FeO	Fe2O3	Mg # (Fe2+ only)
KELUT90B-cpx-z12-r2c	90B	opx	core	main	52.87	0.2	0.99	19.3	0.87	23.93	1.51	0.02	99.7	69	0.18	0.01	70.59
KELUT90B-cpx-z12-r2c	90B	opx	core	main	52.86	0.22	1.38	18.68	0.82	23.74	1.58	0.03	99.3	69	0.21	0.00	70.08
KELUT90B-cpx-z12-r2c	90B	opx	core	main	52.63	0.25	1.49	18.43	0.81	23.68	1.72	0.01	99	70	0.24	0.00	70.28
KELUT90B-cpx-z12-r2c	90B	opx	core	main	52.93	0.18	1.13	18.45	0.8	24.07	1.64	0.01	99.2	70	0.17	0.01	70.97
KELUT90B-cpx-z12-r2c	90B	opx	core	main	52.41	0.22	1.59	18.22	0.77	23.98	1.76	0.02	99	70	0.21	0.01	71.61
KELUT90B-cpx-z12-r2c	90B	opx	core	main	52.47	0.21	1.65	18.2	0.75	24.03	1.78	0.01	99.1	70	0.20	0.01	71.64
KELUT90B-cpx-z12-r2c	90B	opx	core	main	52.46	0.22	1.85	18.15	0.74	24.19	1.82	0.02	99.5	70	0.20	0.01	72.24
KELUT90B-cpx-z12-r2c	90B	opx	core	main	52.49	0.22	1.96	17.9	0.69	24.38	1.73	0.02	99.4	71	0.20	0.01	72.55
KELUT90B-cpx-z12-r2c	90B	opx	core	main	52.81	0.21	1.63	17.8	0.74	24.37	1.74	0.02	99.3	71	0.20	0.01	72.13
KELUT90B-cpx-z12-r2c	90B	opx	core	main	52.62	0.23	1.75	17.66	0.73	24.55	1.76	0.03	99.3	71	0.21	0.01	73.01
KELUT90B-cpx-z12-r2c	90B	opx	core	main	52.88	0.22	1.74	17.41	0.69	24.58	1.72	0.01	99.3	72	0.21	0.01	72.48
KELUT90B-cpx-z12-r2c	90B	opx	core	main	52.82	0.24	1.82	17.29	0.7	24.75	1.68	0.02	99.3	72	0.23	0.01	73.06
KELUT90B-cpx-z12-r2c	90B	opx	core	main	52.85	0.26	1.96	17.3	0.68	24.77	1.71	0.02	99.6	72	0.25	0.01	73.08
KELUT90B-cpx-z12-r2c	90B	opx	core	main	52.52	0.25	2.09	17.17	0.66	24.73	1.84	0.02	99.3	72	0.23	0.01	73.65
KELUT90B-cpx-z12-r2c	90B	opx	core	main	52.69	0.26	2	17.17	0.68	24.85	2.01	0.02	99.7	72	0.24	0.01	74.04
KELUT90B-cpx-z12-r2c	90B	opx	core	main	52.82	0.22	1.71	17.19	0.68	24.88	1.66	0.03	99.2	72	0.21	0.01	73.48
KELUT90B-cpx-z12-r2c	90B	opx	core	main	52.68	0.25	1.83	17.24	0.66	24.89	1.72	0.02	99.3	72	0.23	0.01	73.70
KELUT90B-cpx-z12-r2c	90B	opx	core	main	52.84	0.25	1.91	17.09	0.65	24.78	1.89	0.01	99.4	72	0.24	0.01	73.32
KELUT90B-cpx-z12-r2c	90B	opx	core	main	52.87	0.24	1.93	17.09	0.64	24.83	1.98	0.02	99.6	72	0.22	0.01	73.63
KELUT90B-cpx-z12-r2c	90B	opx	core	main	52.71	0.24	1.82	17.15	0.64	25.02	1.85	0.01	99.4	72	0.22	0.01	74.18
KELUT90B-cpx-z12-r2c	90B	opx	core	main	53.13	0.21	1.63	17	0.63	25.46	1.73	0.03	99.8	73	0.19	0.01	74.81
KELUT90B-cpx-z12-r2c	90B	opx	core	main	52.66	0.24	1.88	17.16	0.67	25.86	1.86	0.03	100.4	73	0.19	0.03	76.96
KELUT90B-cpx-z13-r2c	90B	opx	rim	main	56.44	0.23	2.94	18.21	0.9	21.01	1.94	0.03	101.7	67	0.34	-0.07	57.68
KELUT90B-cpx-z13-r2c	90B	opx	rim	main	52.46	0.16	0.96	19.23	0.93	23.45	1.38	0.01	98.6	69	0.15	0.01	69.58
KELUT90B-cpx-z13-r2c	90B	opx	rim	main	52.15	0.17	0.91	19.21	0.93	23.57	1.34	0.01	98.3	69	0.16	0.01	70.32

SAMPLE GRAIN ID	Sample	Min	Texture	stage	SiO2	TiO2	Al2O3	FeO*	MnO	MgO	CaO	Na2O	Total	Mg #	FeO	Fe2O3	Mg # (Fe2+ only)
KELUT90B-cpx-z13-r2c	90B	opx	rim	main	52.33	0.17	0.88	19.27	0.91	23.71	1.31	0.02	98.6	69	0.16	0.01	70.48
KELUT90B-cpx-z13-r2c	90B	opx	rim	main	52.27	0.18	0.89	19.02	0.93	23.52	1.35	0.02	98.2	69	0.17	0.01	70.05
KELUT90B-cpx-z13-r2c	90B	opx	rim	main	52.19	0.2	1.05	18.79	0.87	23.82	1.36	0.02	98.3	69	0.19	0.01	70.99
KELUT90B-cpx-z13-r2c	90B	opx	core	main	51.88	0.2	1.07	19.67	0.9	23.23	1.47	0.01	98.4	68	0.18	0.01	69.83
KELUT90B-cpx-z13-r2c	90B	opx	core	main	52.15	0.18	1	19.72	0.92	23.26	1.4	0.01	98.6	68	0.17	0.01	69.47
KELUT90B-cpx-z13-r2c	90B	opx	core	main	51.96	0.19	1.11	19.82	0.9	23.43	1.37	0.01	98.8	68	0.17	0.01	70.19
KELUT90B-cpx-z13-r2c	90B	opx	core	main	52.19	0.2	1.1	19.68	0.89	23.37	1.33	0.02	98.8	68	0.19	0.01	69.63
KELUT90B-cpx-z13-r2c	90B	opx	core	main	51.85	0.22	1.08	19.65	0.91	23.28	1.4	0.01	98.4	68	0.20	0.01	69.91
KELUT90B-cpx-z13-r2c	90B	opx	core	main	51.76	0.21	1.08	19.72	0.91	23.4	1.35	0.02	98.5	68	0.19	0.02	70.40
KELUT90B-cpx-z13-r2c	90B	opx	core	main	52.11	0.22	1.09	19.69	0.89	23.39	1.31	0.02	98.7	68	0.20	0.01	69.76
KELUT90B-cpx-z13-r2c	90B	opx	core	main	52.22	0.2	1.07	19.72	0.86	23.43	1.44	0.01	99	68	0.18	0.01	69.85
KELUT90B-cpx-z13-r2c	90B	opx	core	main	52.35	0.19	1.07	19.73	0.87	23.48	1.42	0.02	99.1	68	0.17	0.01	69.87
KELUT90B-cpx-z13-r2c	90B	opx	core	main	52.01	0.23	1.05	19.55	0.91	23.29	1.38	0.02	98.4	68	0.21	0.01	69.71
KELUT90B-cpx-z13-r2c	90B	opx	core	main	52.23	0.21	1.04	19.65	0.91	23.52	1.43	0.01	99	68	0.19	0.01	70.15
KELUT90B-cpx-z13-r2c	90B	opx	core	main	52.02	0.2	0.99	19.21	0.9	23.42	1.39	0.01	98.1	68	0.19	0.01	70.06
KELUT90B-cpx-z13-r2c	90B	opx	core	main	51.96	0.2	1.12	19.08	0.88	23.8	1.39	0.02	98.5	69	0.18	0.01	71.34
KELUT90B-cpx-z13-r2c	90B	opx	core	main	52.17	0.22	1.14	18.47	0.84	24.01	1.48	0.01	98.3	70	0.20	0.01	71.66
KELUT90B-cpx-z13-r2c	90B	opx	core	main	52.37	0.19	1.23	18.38	0.83	24.36	1.37	0	98.7	70	0.17	0.01	72.21
KELUT90B-cpx-z13-r2c	90B	opx	core	main	52.07	0.21	1.45	18.21	0.74	24.26	1.62	0	98.6	70	0.19	0.01	72.61
KELUT90B-cpx-z13-r2c	90B	opx	core	main	52.23	0.21	1.6	18.03	0.73	24.26	1.64	0.02	98.7	71	0.19	0.01	72.50
KELUT90B-cpx-z13-r2c	90B	opx	core	main	51.86	0.22	1.85	17.78	0.65	24.52	1.66	0.02	98.6	71	0.19	0.02	73.76
KELUT90B-cpx-z13-r2c	90B	opx	core	main	51.82	0.22	1.83	17.59	0.68	24.61	1.78	0.02	98.6	71	0.19	0.02	74.33
KELUT90B-cpx-z13-r2c	90B	opx	core	main	52.18	0.2	1.79	17.43	0.66	24.84	1.67	0.02	98.8	72	0.18	0.01	74.29
KELUT90B-cpx-z13-r2c	90B	opx	core	main	52.03	0.26	1.94	17.25	0.65	24.81	1.82	0.01	98.8	72	0.23	0.02	74.53
KELUT90B-cpx-z13-r2c	90B	opx	core	main	52.27	0.21	1.78	17.15	0.65	25.06	1.56	0.01	98.7	72	0.19	0.01	74.55

SAMPLE GRAIN ID	Sample	Min	Texture	stage	SiO2	TiO2	Al2O3	FeO*	MnO	MgO	CaO	Na2O	Total	Mg #	FeO	Fe2O3	Mg # (Fe2+ only)
KELUT90B-cpx-z2-r2c	90B	opx	rim	main	53.23	0.25	2.95	17.73	0.83	21.03	2.14	0.37	98.5	68	0.30	-0.03	63.76
KELUT90B-cpx-z2-r2c	90B	opx	rim	main	51.92	0.21	1.08	19.56	0.93	23.61	1.38	0.01	98.7	68	0.19	0.02	70.82
KELUT90B-cpx-z2-r2c	90B	opx	core	main	52.25	0.2	1.05	19.76	0.9	23.25	1.42	0.01	98.8	68	0.19	0.01	69.28
KELUT90B-cpx-z2-r2c	90B	opx	core	main	52.09	0.19	1.09	19.81	0.92	23.42	1.41	0.01	98.9	68	0.17	0.01	70.05
KELUT90B-cpx-z2-r2c	90B	opx	core	main	52.29	0.19	1	19.73	0.92	23.34	1.37	0.02	98.9	68	0.18	0.01	69.51
KELUT90B-cpx-z2-r2c	90B	opx	core	main	52.05	0.21	1	19.67	0.93	23.3	1.35	0.02	98.5	68	0.19	0.01	69.69
KELUT90B-cpx-z2-r2c	90B	opx	core	main	52.15	0.18	1.01	19.63	0.94	23.32	1.37	0.02	98.6	68	0.17	0.01	69.68
KELUT90B-cpx-z2-r2c	90B	opx	core	main	52.19	0.2	1.03	19.78	0.9	23.44	1.37	0	98.9	68	0.18	0.01	69.81
KELUT90B-cpx-z2-r2c	90B	opx	core	main	51.84	0.19	1	19.68	0.91	23.3	1.36	0.01	98.3	68	0.17	0.01	69.95
KELUT90B-cpx-z2-r2c	90B	opx	core	main	52.12	0.18	0.98	19.77	0.91	23.47	1.34	0.02	98.8	68	0.16	0.01	70.11
KELUT90B-cpx-z2-r2c	90B	opx	core	main	52.32	0.18	0.99	19.63	0.9	23.33	1.36	0.02	98.7	68	0.17	0.01	69.40
KELUT90B-cpx-z2-r2c	90B	opx	core	main	52.07	0.2	1.12	19.58	0.88	23.34	1.37	0.02	98.6	68	0.18	0.01	69.76
KELUT90B-cpx-z2-r2c	90B	opx	core	main	52.28	0.2	1.08	19.62	0.91	23.36	1.31	0.03	98.8	68	0.19	0.01	69.52
KELUT90B-cpx-z2-r2c	90B	opx	core	main	51.92	0.18	0.92	19.63	0.92	23.36	1.43	0.01	98.4	68	0.16	0.01	70.15
KELUT90B-cpx-z2-r2c	90B	opx	core	main	52.25	0.17	0.87	19.55	0.93	23.34	1.32	0.02	98.5	68	0.16	0.01	69.52
KELUT90B-cpx-z2-r2c	90B	opx	core	main	52.44	0.19	0.95	19.6	0.92	23.37	1.35	0.01	98.8	68	0.18	0.01	69.29
KELUT90B-cpx-z2-r2c	90B	opx	core	main	52.19	0.19	0.99	19.47	0.93	23.27	1.36	0.01	98.4	68	0.18	0.01	69.37
KELUT90B-cpx-z2-r2c	90B	opx	core	main	52.18	0.18	0.94	19.44	0.89	23.35	1.35	0.01	98.3	68	0.17	0.01	69.57
KELUT90B-cpx-z2-r2c	90B	opx	core	main	52.27	0.17	0.96	19.53	0.93	23.46	1.33	0.01	98.7	68	0.16	0.01	69.81
KELUT90B-cpx-z2-r2c	90B	opx	core	main	52.2	0.19	0.92	19.48	0.91	23.37	1.33	0.01	98.4	68	0.18	0.01	69.59
KELUT90B-cpx-z2-r2c	90B	opx	core	main	52.27	0.2	0.95	19.55	0.92	23.51	1.34	0.01	98.8	68	0.18	0.01	69.94
KELUT90B-cpx-z2-r2c	90B	opx	core	main	52.28	0.19	0.98	19.54	0.96	23.51	1.35	0.01	98.8	68	0.18	0.01	70.00
KELUT90B-cpx-z2-r2c	90B	opx	core	main	52.38	0.2	1	19.42	0.9	23.44	1.35	0.01	98.7	68	0.19	0.01	69.55
KELUT90B-cpx-z2-r2c	90B	opx	core	main	52.21	0.18	0.94	19.18	0.93	23.66	1.39	0.02	98.5	69	0.17	0.01	70.63
KELUT90B-cpx-z2-r2c	90B	opx	core	main	52.1	0.19	0.94	19.2	0.96	23.59	1.32	0.02	98.3	69	0.17	0.01	70.50

SAMPLE GRAIN ID	Sample	Min	Texture	stage	SiO2	TiO2	Al2O3	FeO*	MnO	MgO	CaO	Na2O	Total	Mg #	FeO	Fe2O3	Mg # (Fe2+ only)
KELUT90B-cpx-z2-r2c	90B	opx	core	main	51.65	0.2	1.13	19.14	0.89	23.57	1.5	0.02	98.1	69	0.18	0.01	71.28
KELUT90B-cpx-z2-r2c	90B	opx	core	main	51.81	0.21	1.05	19.09	0.91	23.77	1.37	0.02	98.2	69	0.19	0.02	71.46
KELUT90B-cpx-z2-r2c	90B	opx	core	main	51.82	0.18	1.06	19.01	0.91	23.74	1.37	0.02	98.1	69	0.16	0.01	71.39
KELUT90B-cpx-z2-r2c	90B	opx	core	main	52.06	0.18	1.03	18.91	0.84	23.89	1.39	0.02	98.3	69	0.16	0.01	71.43
KELUT90B-cpx-z2-r2c	90B	opx	core	main	52.03	0.21	1.01	18.82	0.86	24.13	1.35	0.02	98.4	70	0.19	0.02	72.13
KELUT90B-cpx-z2-r2c	90B	opx	core	main	52	0.18	1.01	18.72	0.87	23.93	1.36	0	98.1	70	0.16	0.01	71.51
KELUT90B-cpx-z2-r2c	90B	opx	core	main	52.22	0.21	1.05	18.79	0.86	24.1	1.38	0.02	98.6	70	0.19	0.01	71.81
KELUT90B-cpx-z2-r2c	90B	opx	core	main	52.34	0.18	1.01	18.62	0.85	24.14	1.34	0.02	98.5	70	0.16	0.01	71.70
KELUT90B-cpx-z2-r2c	90B	opx	core	main	52.15	0.18	0.99	18.57	0.82	24.09	1.38	0.01	98.2	70	0.16	0.01	71.80
KELUT90B-cpx-z2-r2c	90B	opx	core	main	51.99	0.22	1.46	18.39	0.81	24.19	1.53	0.02	98.6	70	0.20	0.02	72.57
KELUT90B-cpx-z2-r2c	90B	opx	core	main	52.39	0.18	0.98	18.44	0.82	24.43	1.37	0.01	98.6	70	0.16	0.01	72.45
KELUT90B-cpx-z2-r2c	90B	opx	core	main	52.26	0.2	1.2	18.25	0.81	24.32	1.42	0.01	98.5	70	0.18	0.01	72.35
KELUT90B-cpx-z2-r2c	90B	opx	core	main	51.88	0.21	1.4	18.23	0.79	24.28	1.5	0.01	98.3	70	0.19	0.01	72.89
KELUT90B-cpx-z2-r2c	90B	opx	core	main	51.67	0.23	1.82	18.08	0.75	24.16	1.61	0.02	98.3	70	0.20	0.02	72.99
KELUT90B-cpx-z2-r2c	90B	opx	core	main	51.51	0.23	1.94	17.98	0.74	24.23	1.59	0.02	98.2	71	0.20	0.02	73.40
KELUT90B-cpx-z2-r2c	90B	opx	core	main	51.64	0.23	1.82	17.9	0.72	24.31	1.6	0.02	98.2	71	0.20	0.02	73.44
KELUT90B-cpx-z2-r2c	90B	opx	core	main	51.44	0.22	1.93	17.91	0.72	24.42	1.66	0.02	98.3	71	0.19	0.02	74.19
KELUT90B-cpx-z2-r2c	90B	opx	core	main	51.98	0.21	1.9	17.88	0.68	24.42	1.66	0.01	98.7	71	0.19	0.01	73.27
KELUT90B-cpx-z2-r2c	90B	opx	core	main	51.64	0.22	2.07	17.83	0.71	24.52	1.63	0.02	98.6	71	0.19	0.02	74.13
KELUT90B-cpx-z2-r2c	90B	opx	core	main	51.84	0.21	1.91	17.68	0.7	24.61	1.62	0.01	98.6	71	0.18	0.02	74.01
KELUT90B-cpx-z2-r2c	90B	opx	core	main	52.11	0.23	1.83	17.45	0.7	24.88	1.52	0.03	98.8	72	0.20	0.02	74.35
KELUT90B-cpx-z2-r2c	90B	opx	core	main	51.84	0.23	2.03	17.34	0.68	24.72	1.6	0.02	98.5	72	0.20	0.02	74.32
KELUT90B-cpx-z2-r2c	90B	opx	core	main	51.92	0.23	1.94	17.38	0.67	24.84	1.53	0.02	98.5	72	0.20	0.02	74.43
KELUT90B-cpx-z4-r2c	90B	opx	rim	main	52.75	0.23	1.54	18.37	0.8	23.99	1.59	0.02	99.3	70	0.22	0.01	70.91
KELUT90B-cpx-z4-r2c	90B	opx	rim	main	52.53	0.22	1.42	17.75	0.73	24.52	1.61	0.02	98.8	71	0.20	0.01	72.77

SAMPLE GRAIN ID	Sample	Min	Texture	stage	SiO2	TiO2	Al2O3	FeO*	MnO	MgO	CaO	Na2O	Total	Mg #	FeO	Fe2O3	Mg # (Fe2+ only)
KELUT90B-cpx-z4-r2c	90B	opx	core	main	51.83	0.23	1.13	19.9	0.93	22.8	1.65	0.03	98.5	67	0.21	0.01	68.98
KELUT90B-cpx-z4-r2c	90B	opx	core	main	52.2	0.22	1.03	20.03	0.94	23	1.52	0.02	99	67	0.20	0.01	68.84
KELUT90B-cpx-z4-r2c	90B	opx	core	main	52.08	0.19	0.91	20.07	0.96	23.22	1.48	0.01	98.9	67	0.17	0.01	69.62
KELUT90B-cpx-z4-r2c	90B	opx	core	main	52.19	0.19	0.92	19.87	0.9	23.03	1.42	0.02	98.5	67	0.18	0.01	68.76
KELUT90B-cpx-z4-r2c	90B	opx	core	main	52.19	0.18	0.98	19.91	0.9	23.31	1.42	0.02	98.9	68	0.16	0.01	69.63
KELUT90B-cpx-z4-r2c	90B	opx	core	main	52.37	0.2	0.99	19.91	0.96	23.28	1.38	0.03	99.1	68	0.19	0.01	69.33
KELUT90B-cpx-z4-r2c	90B	opx	core	main	51.91	0.2	1.01	19.79	0.91	23.18	1.47	0.02	98.5	68	0.18	0.01	69.70
KELUT90B-cpx-z4-r2c	90B	opx	core	main	52.32	0.18	0.91	19.75	0.92	23.17	1.42	0.01	98.7	68	0.17	0.01	68.98
KELUT90B-cpx-z4-r2c	90B	opx	core	main	52.52	0.21	1.24	18.37	0.84	24.16	1.6	0.02	99	70	0.19	0.01	71.85
KELUT90B-cpx-z4-r2c	90B	opx	core	main	52.41	0.22	1.52	17.55	0.71	24.55	1.7	0.02	98.7	71	0.20	0.01	73.15
KELUT90B-cpx-z4-r2c	90B	opx	core	main	52.75	0.24	1.61	17.4	0.71	24.68	1.85	0.02	99.3	72	0.22	0.01	73.25
KELUT90B-cpx-z4-r2c	90B	opx	core	main	52.52	0.23	1.58	17.24	0.69	24.78	1.9	0.02	99	72	0.21	0.01	73.96
KELUT90B-cpx-z5-r2c	90B	opx	rim	main	52.1	0.22	1.85	17.78	0.76	24.13	1.54	0.02	98.4	71	0.21	0.01	72.15
KELUT90B-cpx-z5-r2c	90B	opx	rim	main	51.54	0.22	2.26	17.74	0.69	24.21	1.52	0.01	98.2	71	0.20	0.01	73.06
KELUT90B-cpx-z5-r2c	90B	opx	rim	main	52.39	0.21	1.94	17.85	0.78	24.46	1.59	0.04	99.3	71	0.19	0.01	72.96
KELUT90B-cpx-z5-r2c	90B	opx	rim	main	51.84	0.22	2.16	17.76	0.71	24.35	1.56	0.02	98.6	71	0.20	0.01	73.18
KELUT90B-cpx-z5-r2c	90B	opx	rim	main	52.05	0.22	2.25	17.64	0.71	24.18	1.51	0.02	98.6	71	0.21	0.01	72.26
KELUT90B-cpx-z5-r2c	90B	opx	rim	main	51.9	0.23	2.08	17.48	0.71	24.37	1.54	0.03	98.3	71	0.21	0.01	73.16
KELUT90B-cpx-z5-r2c	90B	opx	rim	main	51.95	0.22	2.1	17.46	0.74	24.35	1.61	0.01	98.4	71	0.20	0.01	73.07
KELUT90B-cpx-z5-r2c	90B	opx	rim	main	57.23	0.31	5.67	13.9	0.61	19.56	1.95	0.22	99.5	71	0.65	-0.17	52.46
KELUT90B-cpx-z5-r2c	90B	opx	core	main	52.14	0.2	1.1	19.7	0.9	22.77	1.5	0.02	98.3	67	0.19	0.00	68.14
KELUT90B-cpx-z5-r2c	90B	opx	core	main	52.05	0.21	1.08	19.69	0.92	22.91	1.48	0.02	98.4	67	0.20	0.01	68.68
KELUT90B-cpx-z5-r2c	90B	opx	core	main	52.3	0.19	1.12	19.68	0.93	22.88	1.49	0.01	98.6	67	0.18	0.00	68.22
KELUT90B-cpx-z5-r2c	90B	opx	core	main	52.42	0.21	1.06	19.81	0.89	23.16	1.49	0.02	99.1	68	0.20	0.01	68.90
KELUT90B-cpx-z5-r2c	90B	opx	core	main	52.42	0.19	0.96	19.57	0.9	22.91	1.47	0.01	98.4	68	0.19	0.00	68.07

SAMPLE GRAIN ID	Sample	Min	Texture	stage	SiO2	TiO2	Al2O3	FeO*	MnO	MgO	CaO	Na2O	Total	Mg #	FeO	Fe2O3	Mg # (Fe2+ only)
KELUT90B-cpx-z5-r2c	90B	opx	core	main	52.43	0.22	1.1	19.72	0.93	23.07	1.45	0.01	98.9	68	0.21	0.01	68.53
KELUT90B-cpx-z5-r2c	90B	opx	core	main	52.26	0.21	0.97	19.59	0.89	22.94	1.44	0.02	98.3	68	0.20	0.00	68.37
KELUT90B-cpx-z5-r2c	90B	opx	core	main	52.4	0.2	0.97	19.57	0.87	23	1.45	0.01	98.5	68	0.19	0.00	68.30
KELUT90B-cpx-z5-r2c	90B	opx	core	main	52.53	0.2	0.98	19.67	0.89	23.14	1.4	0.02	98.8	68	0.19	0.00	68.55
KELUT90B-cpx-z5-r2c	90B	opx	core	main	52.32	0.19	1	19.57	0.89	23.09	1.35	0.01	98.4	68	0.18	0.00	68.57
KELUT90B-cpx-z5-r2c	90B	opx	core	main	52.3	0.2	1.01	19.55	0.89	23.09	1.48	0	98.5	68	0.19	0.01	68.73
KELUT90B-cpx-z5-r2c	90B	opx	core	main	52.75	0.19	0.98	19.7	0.87	23.24	1.43	0.02	99.2	68	0.18	0.00	68.58
KELUT90B-cpx-z5-r2c	90B	opx	core	main	52.48	0.18	0.96	19.63	0.89	23.17	1.39	0.02	98.7	68	0.17	0.00	68.72
KELUT90B-cpx-z5-r2c	90B	opx	core	main	52.6	0.19	0.94	19.54	0.87	23.12	1.48	0.01	98.8	68	0.19	0.00	68.44
KELUT90B-cpx-z5-r2c	90B	opx	core	main	52.32	0.2	1	19.48	0.86	23.06	1.43	0.02	98.4	68	0.19	0.00	68.61
KELUT90B-cpx-z5-r2c	90B	opx	core	main	52.45	0.19	0.99	19.55	0.88	23.2	1.41	0.01	98.7	68	0.18	0.01	68.80
KELUT90B-cpx-z5-r2c	90B	opx	core	main	52.37	0.19	1	19.56	0.9	23.13	1.42	0.01	98.6	68	0.18	0.01	68.74
KELUT90B-cpx-z5-r2c	90B	opx	core	main	52.42	0.2	0.97	19.51	0.92	23.13	1.37	0.02	98.5	68	0.19	0.00	68.66
KELUT90B-cpx-z5-r2c	90B	opx	core	main	52.51	0.19	1	19.55	0.88	23.24	1.46	0.02	98.9	68	0.18	0.01	68.97
KELUT90B-cpx-z5-r2c	90B	opx	core	main	52.59	0.18	0.98	19.56	0.86	23.21	1.42	0.01	98.8	68	0.17	0.00	68.63
KELUT90B-cpx-z5-r2c	90B	opx	core	main	52.5	0.18	1.05	19.47	0.83	23.24	1.5	0.02	98.8	68	0.17	0.01	68.99
KELUT90B-cpx-z5-r2c	90B	opx	core	main	52.52	0.2	1	19.53	0.89	23.24	1.4	0.01	98.8	68	0.19	0.00	68.81
KELUT90B-cpx-z5-r2c	90B	opx	core	main	52.71	0.19	0.95	19.52	0.86	23.37	1.44	0.01	99.1	68	0.18	0.00	68.97
KELUT90B-cpx-z5-r2c	90B	opx	core	main	52.45	0.18	0.96	19.32	0.86	23.14	1.41	0	98.3	68	0.18	0.00	68.54
KELUT90B-cpx-z5-r2c	90B	opx	core	main	52.74	0.18	1	19.42	0.82	23.24	1.42	0.01	98.8	68	0.18	0.00	68.46
KELUT90B-cpx-z5-r2c	90B	opx	core	main	52.56	0.2	0.98	19.5	0.89	23.36	1.42	0.02	98.9	68	0.19	0.01	69.20
KELUT90B-cpx-z5-r2c	90B	opx	core	main	52.59	0.18	0.99	19.31	0.85	23.2	1.47	0	98.6	68	0.18	0.00	68.60
KELUT90B-cpx-z5-r2c	90B	opx	core	main	52.43	0.2	1.04	19.15	0.87	23.15	1.51	0	98.4	68	0.20	0.00	68.73
KELUT90B-cpx-z5-r2c	90B	opx	core	main	52.16	0.2	1.41	18.82	0.85	23.68	1.52	0.01	98.7	69	0.19	0.01	70.78
KELUT90B-cpx-z5-r2c	90B	opx	core	main	52.2	0.2	1.77	18.03	0.79	24.28	1.59	0.02	98.9	71	0.18	0.01	72.61

SAMPLE GRAIN ID	Sample	Min	Texture	stage	SiO2	TiO2	Al2O3	FeO*	MnO	MgO	CaO	Na2O	Total	Mg #	FeO	Fe2O3	Mg # (Fe2+ only)
KELUT90B-cpx-z5-r2c	90B	opx	core	main	51.8	0.23	2.14	17.61	0.74	24.26	1.59	0.02	98.4	71	0.21	0.01	73.04
KELUT90B-cpx-z9-r2c	90B	opx	rim	main	53.22	0.23	2.34	18.06	0.81	22.3	1.67	0.06	98.7	69	0.27	-0.02	65.40
KELUT90B-cpx-z9-r2c	90B	opx	core	main	52.17	0.2	0.98	20.02	0.88	23.26	1.37	0.01	98.9	67	0.18	0.01	69.34
KELUT90B-cpx-z9-r2c	90B	opx	core	main	51.38	0.2	1.15	19.87	0.92	23.15	1.38	0.03	98.1	67	0.18	0.02	70.32
KELUT90B-cpx-z9-r2c	90B	opx	core	main	51.48	0.19	1.06	19.72	0.92	23.04	1.4	0.03	97.8	68	0.17	0.01	69.87
KELUT90B-cpx-z9-r2c	90B	opx	core	main	51.51	0.21	1.31	19.95	0.91	23.27	1.33	0.01	98.5	68	0.19	0.02	70.28
KELUT90B-cpx-z9-r2c	90B	opx	core	main	52.19	0.2	0.89	19.91	0.95	23.44	1.41	0.02	99	68	0.18	0.01	70.06
KELUT90B-cpx-z9-r2c	90B	opx	core	main	52.18	0.19	0.96	19.95	0.92	23.43	1.4	0.02	99.1	68	0.17	0.01	70.00
KELUT90B-cpx-z9-r2c	90B	opx	core	main	52.35	0.19	0.9	19.89	0.94	23.38	1.37	0.02	99	68	0.17	0.01	69.58
KELUT90B-cpx-z9-r2c	90B	opx	core	main	51.92	0.19	1.16	19.89	0.9	23.49	1.28	0.02	98.9	68	0.17	0.01	70.35
KELUT90B-cpx-z9-r2c	90B	opx	core	main	52.11	0.19	1	19.88	0.93	23.51	1.4	0.02	99	68	0.17	0.01	70.35
KELUT90B-cpx-z9-r2c	90B	opx	core	main	51.58	0.19	1.25	19.71	0.93	23.32	1.28	0.02	98.3	68	0.17	0.01	70.35
KELUT90B-cpx-z9-r2c	90B	opx	core	main	51.63	0.2	1.18	19.71	0.9	23.4	1.34	0.03	98.4	68	0.18	0.02	70.63
KELUT90B-cpx-z9-r2c	90B	opx	core	main	52.16	0.19	1.1	19.83	0.9	23.62	1.27	0.02	99.1	68	0.17	0.01	70.38
KELUT90B-cpx-z9-r2c	90B	opx	core	main	52.23	0.19	1.01	19.61	0.89	23.56	1.28	0.02	98.8	68	0.17	0.01	70.09
KELUT90B-cpx-z9-r2c	90B	opx	core	main	52.32	0.18	1.02	19.77	0.91	23.78	1.45	0.03	99.5	68	0.16	0.01	70.99
KELUT90B-cpx-z9-r2c	90B	opx	core	main	52.29	0.2	1.15	18.53	0.81	24.2	1.42	0.02	98.6	70	0.18	0.01	72.01
KELUT90B-cpx-z9-r2c	90B	opx	core	main	52.26	0.22	1.26	17.82	0.77	24.44	1.52	0.01	98.3	71	0.20	0.01	72.78
KELUT90B-cpx-z9-r2c	90B	opx	core	main	52.27	0.22	1.45	17.24	0.73	25.1	1.52	0.01	98.5	72	0.19	0.02	74.70
KELUT90B-cpx-z9-r2c	90B	opx	core	main	52.22	0.19	1.59	16.8	0.62	25.33	1.54	0.02	98.3	73	0.17	0.01	75.44
KELUT90B-glom-cpx1	90B	opx	glom	main	52.01	0.19	1.13	20.04	0.92	22.73	1.45	0.01	98.5	67	0.18	0.01	68.12
KELUT90B-glom-cpx1	90B	opx	glom	main	51.95	0.19	1.14	20.07	0.88	23	1.44	0.03	98.7	67	0.17	0.01	69.09
KELUT90B-glom-cpx1	90B	opx	glom	main	51.85	0.2	1.11	20.14	0.91	23.18	1.38	0.02	98.8	67	0.18	0.01	69.67
KELUT90B-glom-cpx1	90B	opx	glom	main	52.44	0.14	0.8	19.84	0.87	23.28	1.43	0.01	98.8	68	0.13	0.01	69.15
KELUT90B-opx-z7-r2c	90B	opx	rim	main	53.66	0.24	1.71	18.34	0.83	23.54	1.84	0.03	100.2	70	0.25	-0.01	68.70

SAMPLE GRAIN ID	Sample	Min	Texture	stage	SiO2	TiO2	Al2O3	FeO*	MnO	MgO	CaO	Na2O	Total	Mg #	FeO	Fe2O3	Mg # (Fe2+ only)
KELUT90B-opx-z7-r2c	90B	opx	core	main	52.49	0.2	1.12	19.99	0.87	23.1	1.36	0.01	99.1	67	0.19	0.01	68.36
KELUT90B-opx-z7-r2c	90B	opx	core	main	52.68	0.19	1.16	20.03	0.89	23.19	1.41	0.02	99.6	67	0.18	0.01	68.54
KELUT90B-opx-z7-r2c	90B	opx	core	main	52.76	0.2	1.09	20	0.89	23.2	1.36	0.01	99.5	67	0.19	0.01	68.31
KELUT90B-opx-z7-r2c	90B	opx	core	main	53.04	0.2	1.08	20.07	0.93	23.34	1.39	0.02	100.1	68	0.19	0.01	68.49
KELUT90B-opx-z7-r2c	90B	opx	core	main	52.92	0.19	1.03	20	0.9	23.3	1.34	0.01	99.7	68	0.18	0.00	68.38
KELUT90B-opx-z7-r2c	90B	opx	core	main	52.52	0.2	1.05	19.86	0.89	23.25	1.39	0.03	99.2	68	0.19	0.01	68.95
KELUT90B-opx-z7-r2c	90B	opx	core	main	52.76	0.19	0.97	19.95	0.94	23.47	1.43	0.02	99.7	68	0.18	0.01	69.36
KELUT90B-opx-z7-r2c	90B	opx	core	main	52.84	0.19	1.04	19.73	0.91	23.53	1.49	0.03	99.8	68	0.18	0.01	69.53
KELUT90B-opx-z7-r2c	90B	opx	core	main	52.46	0.25	1.57	17.8	0.79	24.09	1.85	0.02	98.8	71	0.24	0.01	71.99
KELUT90B-opx-z7-r2c	90B	opx	core	main	52.43	0.25	1.85	17.62	0.68	24.59	2.01	0.01	99.4	71	0.22	0.02	73.62
KELUT90B-opx-z7-r2c	90B	opx	core	main	52.86	0.22	1.76	17.7	0.68	25.03	1.89	0.02	100.2	72	0.19	0.02	74.20
KELUT90B-opx-z7-r2c	90B	opx	core	main	52.55	0.24	1.65	17.5	0.7	24.74	1.71	0.01	99.1	72	0.22	0.01	73.44
KELUT90B-opx-z7-r2c	90B	opx	core	main	52.57	0.22	1.64	17.24	0.68	24.87	1.7	0	98.9	72	0.20	0.01	73.71
KELUT90B-opx-z7-r2c	90B	opx	core	main	52.58	0.23	1.8	17.04	0.67	24.91	1.78	0.02	99	72	0.21	0.01	74.04
KELUT90B-opx-z7-r2c	90B	opx	core	main	52.66	0.27	2.03	16.9	0.63	25.07	1.86	0.02	99.4	73	0.25	0.01	74.43
KELUT90B-opx-z7-r2c	90B	opx	core	main	52.37	0.25	2.09	16.69	0.6	24.99	2.14	0.02	99.2	73	0.22	0.02	75.07
KELUT90B-opx-z7-r2c	90B	opx	core	main	52.53	0.24	1.96	16.69	0.61	25.16	1.9	0.02	99.1	73	0.22	0.01	74.96
KELUT90B-opx-z7-r2c	90B	opx	core	main	52.47	0.26	2.11	16.71	0.6	25.19	2.19	0.02	99.6	73	0.23	0.02	75.59
KELUT90B-opx-z7-r2c	90B	opx	core	main	52.59	0.25	2.03	16.53	0.62	25.04	2.02	0.01	99.1	73	0.23	0.01	74.64
KELUT90B-opxcpxrim-1	90B	opx	overgrowth	main	51.65	0.16	0.78	19.65	0.84	23.58	1.42	0.02	98.1	68	0.14	0.01	71.19
KELUT90B-opxcpx17	90B	opx	overgrowth	main	51.8	0.12	0.91	20.55	1.02	23.35	1.12	0.01	98.9	67	0.10	0.01	70.04
KELUT90B-opxcpx17	90B	opx	overgrowth	main	51.83	0.12	0.96	20.35	0.96	23.13	1.25	0.01	98.6	67	0.11	0.01	69.44
KELUT90B-opxcpx17	90B	opx	overgrowth	main	51.55	0.13	0.86	20.36	0.98	23.34	1.15	0.02	98.4	67	0.11	0.01	70.41
KELUT90B-opxcpx17	90B	opx	overgrowth	main	52.19	0.12	0.95	20.35	0.94	23.51	1.19	0.02	99.3	67	0.11	0.01	70.02
KELUT90B-opxcpx17	90B	opx	overgrowth	main	51.42	0.1	0.97	20.18	0.97	23.33	1.19	0.02	98.2	67	0.09	0.01	70.64

SAMPLE GRAIN ID	Sample	Min	Texture	stage	SiO2	TiO2	Al2O3	FeO*	MnO	MgO	CaO	Na2O	Total	Mg #	FeO	Fe2O3	Mg # (Fe2+ only)
KELUT90B-opxcpx17	90B	opx	overgrowth	main	51.39	0.15	0.99	20.11	0.93	23.43	1.17	0.02	98.2	67	0.13	0.01	70.86
KELUT90B-opxcpx17	90B	opx	overgrowth	main	52.13	0.15	1.38	20.09	0.86	23.39	1.21	0.01	99.2	67	0.14	0.01	69.58
KELUT90B-opxcpx17	90B	opx	overgrowth	main	52.5	0.13	0.98	20.01	0.89	23.29	1.26	0.02	99.1	67	0.12	0.01	68.93
KELUT90B-opxcpx17	90B	opx	overgrowth	main	52.1	0.18	1.09	20.21	0.9	23.62	1.27	0.03	99.4	68	0.16	0.02	70.55
KELUT90B-opxcpx17	90B	opx	overgrowth	main	52.03	0.14	1.01	19.94	0.88	23.36	1.32	0.03	98.7	68	0.13	0.01	69.94
KELUT90B-opxcpx17	90B	opx	overgrowth	main	51.91	0.17	1.04	19.84	0.89	23.37	1.34	0.01	98.6	68	0.15	0.01	70.04
KELUT90B-opxcpx17	90B	opx	overgrowth	main	52.15	0.13	0.95	19.66	0.89	23.28	1.34	0.03	98.4	68	0.12	0.01	69.56
KELUT90B-opxcpx4	90B	opx	glom	main	52.31	0.16	0.94	20.02	0.86	23.29	1.31	0.02	98.9	67	0.15	0.01	69.21
KELUT90B-opxcpx4	90B	opx	glom	main	51.92	0.19	1.27	19.98	0.89	23.23	1.35	0.02	98.9	67	0.17	0.01	69.65
KELUT90B-opxcpx4	90B	opx	glom	main	51.97	0.19	1.11	20.01	0.89	23.41	1.39	0.02	99	68	0.17	0.01	70.19
KELUT90B-opxcpx4	90B	opx	glom	main	51.8	0.19	1.38	19.66	0.83	23.03	1.46	0.01	98.4	68	0.18	0.01	69.24
KELUT90B-opxcpx4	90B	opx	glom	main	52.44	0.16	1.04	20.07	0.85	23.65	1.31	0.01	99.5	68	0.14	0.01	70.05
KELUT90B-opxcpx4	90B	opx	glom	main	52.19	0.18	1.01	19.85	0.92	23.48	1.32	0.02	99	68	0.16	0.01	70.02
KELUT90B-opxcpx4	90B	opx	glom	main	52.71	0.14	0.87	19.36	0.83	23.93	1.49	0.02	99.4	69	0.13	0.01	70.81
KELUT90B-opxcpx4	90B	opx	glom	main	52.71	0.17	0.83	19.3	0.84	24.04	1.54	0.02	99.5	69	0.15	0.01	71.20
KELUT90B-opxcpx5	90B	opx	pheno	main	52.41	0.18	0.88	20.16	0.9	23.17	1.44	0.02	99.2	67	0.17	0.01	68.93
KELUT90B-opxcpx5	90B	opx	pheno	main	52.93	0.16	1	19.69	0.84	23.81	1.38	0.02	99.8	68	0.15	0.01	69.97
KELUT90B-opxcpx5	90B	opx	pheno	main	52.8	0.14	0.84	19.46	0.81	23.86	1.42	0.03	99.4	69	0.13	0.01	70.40
KELUT90B-opxcpx5	90B	opx	pheno	main	53.26	0.14	0.91	19.37	0.79	23.87	1.48	0.01	99.8	69	0.13	0.00	69.72
KELUT90B-opxcpx5	90B	opx	pheno	main	53.32	0.16	0.85	19.27	0.78	24.01	1.4	0.01	99.8	69	0.15	0.00	69.89
KELUT90B-opxcpx5	90B	opx	pheno	main	53.51	0.15	0.79	19.21	0.8	24.04	1.41	0.02	99.9	69	0.14	0.00	69.82
KELUT90B-opxcpx5	90B	opx	pheno	main	53.73	0.14	0.79	18.87	0.78	23.88	1.5	0.02	99.7	69	0.14	-0.00	69.13
KELUT90B-opxcpx5	90B	opx	pheno	main	53.29	0.14	0.72	18.88	0.78	24.18	1.49	0.02	99.5	69	0.13	0.00	70.64
KELUT90B-opxcpx8	90B	opx	pheno	main	52.3	0.19	0.97	20.45	0.92	23.1	1.4	0.02	99.4	67	0.17	0.01	68.84
KELUT90B-opxcpx8	90B	opx	pheno	main	51.93	0.17	1.19	20.33	0.89	23.16	1.44	0.02	99.1	67	0.15	0.01	69.60

SAMPLE GRAIN ID	Sample	Min	Texture	stage	SiO2	TiO2	Al2O3	FeO*	MnO	MgO	CaO	Na2O	Total	Mg #	FeO	Fe2O3	Mg # (Fe2+ only)
KELUT90B-opxcpx8	90B	opx	pheno	main	51.95	0.2	1.05	20.25	0.93	23.11	1.43	0.02	98.9	67	0.18	0.01	69.41
KELUT90B-opxcpx8	90B	opx	pheno	main	51.93	0.18	0.89	20.16	0.96	23.33	1.42	0.03	98.9	67	0.16	0.02	70.21
KELUT90B-opxcpx9	90B	opx	glom	main	52.1	0.15	0.78	19.58	0.87	23.69	1.49	0.02	98.7	68	0.13	0.01	71.02
KELUT90B-opxcpx9	90B	opx	glom	main	51.92	0.15	0.7	19.61	0.89	23.77	1.44	0.02	98.5	68	0.13	0.01	71.47
KELUT90B-opxcpx9	90B	opx	glom	main	52.17	0.16	0.72	19.63	0.89	23.77	1.44	0.01	98.8	68	0.14	0.01	71.04
KELUT90B-opxcpx9	90B	opx	glom	main	51.9	0.15	0.75	19.5	0.89	23.78	1.5	0.01	98.5	69	0.13	0.01	71.57
PL1-1-2px2	PL1	opx	glom	main	53.67	0.12	0.81	21.18	0.8	23.84	1.35	0.02	101.8	69	0.11	0.01	69.03
PL1-1-2px3	PL1	opx	glom	main	52.47	0.24	1.91	21.97	0.85	22.97	1.53	0.02	102	67	0.21	0.02	68.33
PL1-1-pseudozone-20-r2c	PL1	opx	rim	main	52.34	0.23	1.52	20	0.79	24.17	1.44	0	100.5	71	0.20	0.02	71.76
PL1-1-pseudozone-20-r2c	PL1	opx	rim	main	52.87	0.15	1.2	19.61	0.75	24.29	1.62	0.01	100.5	71	0.13	0.01	71.71
PL1-1-pseudozone-20-r2c	PL1	opx	rim	main	52.55	0.2	2.22	18.33	0.65	24.88	1.54	0.02	100.4	73	0.17	0.02	73.66
PL1-1-pseudozone-20-r2c	PL1	opx	rim	main	53.29	0.17	1.36	17.62	0.62	25.71	1.78	0.01	100.6	74	0.15	0.01	75.33
PL1-1-pseudozone-20-r2c	PL1	opx	core	main	52.72	0.13	0.73	21.69	0.95	22.9	1.48	0.01	100.6	68	0.12	0.01	67.86
PL1-1-pseudozone-20-r2c	PL1	opx	core	main	52.73	0.15	0.75	21.74	0.95	22.98	1.5	0.02	100.8	68	0.13	0.01	68.16
PL1-1-pseudozone-20-r2c	PL1	opx	core	main	52.77	0.15	0.64	21.73	0.95	23.01	1.48	0.02	100.8	68	0.13	0.01	68.16
PL1-1-PX-1a	PL1	opx	pheno	main	52.96	0.18	0.84	21.77	0.82	23.33	1.42	0.01	101.3	68	0.16	0.02	68.53
PL1-1-px-21	PL1	opx	pheno	main	52.43	0.17	0.99	22.1	0.89	23.23	1.41	0.01	101.2	68	0.14	0.02	69.06
PL1-1-px-21	PL1	opx	pheno	main	52.77	0.12	0.71	21.58	0.88	23.27	1.43	0.05	100.8	68	0.10	0.01	68.98
PL1-1-px-21-opxcpx	PL1	opx	glom	main	53.35	0.23	2.46	19.08	0.73	22.06	1.75	0.09	99.8	70	0.26	-0.02	64.75
PL1-1-px-21-opxcpx	PL1	opx	glom	main	52.55	0.25	1.58	19.28	0.72	24.19	1.98	0.03	100.6	71	0.21	0.02	72.40
PL1-1-px-23	PL1	opx	glom	main	51.02	0.17	0.95	22.04	0.92	22.32	1.43	0.02	98.9	67	0.14	0.02	68.40
PL1-1-px-23	PL1	opx	glom	main	51.64	0.2	1.52	21.93	0.81	22.75	1.38	0.02	100.3	67	0.17	0.02	68.60
PL1-1-px-23	PL1	opx	glom	main	51.97	0.15	0.74	21.9	0.89	23.05	1.38	0.02	100.1	68	0.13	0.02	69.19
PL1-1-px-23	PL1	opx	glom	main	52.03	0.22	1.62	19.1	0.65	25.07	1.59	0.01	100.3	72	0.17	0.03	75.04
PL1-1-px-23	PL1	opx	glom	main	52.15	0.2	1.85	18.87	0.67	25.24	1.47	0.03	100.5	73	0.16	0.03	75.33

SAMPLE GRAIN ID	Sample	Min	Texture	stage	SiO2	TiO2	Al2O3	FeO*	MnO	MgO	CaO	Na2O	Total	Mg #	FeO	Fe2O3	Mg # (Fe2+ only)
PL1-1-px-23	PL1	opx	glom	main	51.74	0.22	1.95	18.36	0.62	24.95	1.44	0.03	99.3	73	0.18	0.03	74.93
PL1-1-px-23	PL1	opx	glom	main	52.16	0.21	2.37	18.39	0.59	25.18	1.69	0	100.6	73	0.17	0.02	75.19
PL1-1-px-MX1	PL1	opx	glom	main	52.74	0.16	0.83	22.05	0.94	23.03	1.46	0.02	101.2	67	0.14	0.02	68.22
PL1-1-px-MX1	PL1	opx	glom	main	53.02	0.17	0.84	22.19	0.94	23.16	1.37	0.01	101.7	67	0.15	0.02	68.03
PL1-1-px-MX1	PL1	opx	glom	main	53.41	0.16	0.78	21.9	0.88	23.38	1.44	0.01	102	68	0.14	0.01	68.18
PL1-1-px-Z18	PL1	opx	rim	main	52.3	0.26	1.12	22.01	0.96	22.85	1.58	0.01	101.1	67	0.22	0.03	68.34
PL1-1-px-Z18	PL1	opx	rim	main	52.22	0.23	1.93	19.12	0.67	24.39	1.98	0.02	100.6	72	0.19	0.03	73.40
PL1-1-px-Z18	PL1	opx	rim	main	52.05	0.26	2.07	18.77	0.66	24.33	2.04	0.02	100.2	72	0.22	0.03	73.51
PL1-1-px-Z18	PL1	opx	rim	main	51.64	0.24	2.42	18.44	0.62	24.08	2.06	0.03	99.5	72	0.20	0.02	73.42
PL1-1-px-Z18	PL1	opx	rim	main	51.53	0.26	2.72	18.36	0.63	24.06	2.04	0.02	99.6	72	0.22	0.02	73.42
PL1-1-px-Z18	PL1	opx	rim	main	51.38	0.24	2.93	18.34	0.61	24.31	2.01	0.03	99.9	72	0.20	0.03	74.43
PL1-1-px-Z18	PL1	opx	rim	main	51.97	0.23	2.86	18.33	0.57	24.39	2.03	0.02	100.4	72	0.20	0.02	73.70
PL1-1-px-Z18	PL1	opx	rim	main	52.15	0.25	2.15	18.45	0.62	24.68	1.96	0.01	100.3	73	0.21	0.03	74.19
PL1-1-px-Z18	PL1	opx	rim	main	52.15	0.25	2.3	18.26	0.61	24.47	2.1	0.02	100.2	73	0.21	0.02	73.81
PL1-1-px-Z18	PL1	opx	rim	main	51.89	0.23	2.42	18.27	0.61	24.57	2.04	0.02	100.1	73	0.19	0.02	74.44
PL1-1-px-Z18	PL1	opx	rim	main	51.93	0.2	2.1	18.37	0.59	24.73	1.92	0.02	99.9	73	0.16	0.02	74.68
PL1-1-px-Z18	PL1	opx	core	main	52.49	0.2	1.07	22.25	0.92	22.89	1.47	0.02	101.3	67	0.17	0.02	68.10
PL1-1-px-Z18	PL1	opx	core	main	52.37	0.24	1.17	22.15	0.92	22.83	1.66	0.01	101.4	67	0.21	0.03	68.28
PL1-1-px-Z18	PL1	opx	core	main	52.38	0.23	1.14	22.04	0.93	22.73	1.6	0.02	101.1	67	0.20	0.02	67.94
PL1-1-px-Z18	PL1	opx	core	main	52.53	0.2	1.02	22.17	0.91	23.06	1.44	0.03	101.4	67	0.17	0.02	68.56
PL1-1-px-Z18	PL1	opx	core	main	52.31	0.23	1.2	21.73	0.92	22.9	1.66	0.02	101	68	0.20	0.02	68.62
PL1-1-px-Z18	PL1	opx	core	main	55.71	0.31	4.94	17.1	0.65	18.63	2.19	0.3	99.8	68	0.52	-0.13	52.47
PL1-1-px-Z18	PL1	opx	core	main	52.54	0.22	1.26	21.25	0.85	23.28	1.63	0	101	68	0.19	0.02	69.20
PL1-1-px-z18	PL1	opx	core	main	52.95	0.18	1.03	21.32	0.88	23.77	1.41	-0.01	101.5	69	0.16	0.02	69.79
PL1-1-px-Z18	PL1	opx	core	main	53.65	0.29	3.07	18.8	0.7	21.79	1.85	0.09	100.2	70	0.34	-0.03	63.54

SAMPLE GRAIN ID	Sample	Min	Texture	stage	SiO2	TiO2	Al2O3	FeO*	MnO	MgO	CaO	Na2O	Total	Mg #	FeO	Fe2O3	Mg # (Fe2+ only)
PL1-1-px-Z18	PL1	opx	core	main	52.58	0.21	1.34	20.43	0.79	23.88	1.61	0	100.8	70	0.18	0.02	70.84
PL1-1-px-Z18	PL1	opx	core	main	52.39	0.24	1.88	19.54	0.68	23.47	1.79	0.04	100	70	0.22	0.01	70.17
PL1-1-px-z18	PL1	opx	core	main	52.92	0.21	1.43	19.9	0.74	24.39	1.42	0.02	101	71	0.18	0.02	71.61
PL1-1-px-Z18	PL1	opx	core	main	52.44	0.24	1.85	19.2	0.68	23.98	1.85	0.03	100.3	71	0.21	0.02	71.67
PL1-1-px-Z18	PL1	opx	core	main	53.07	0.22	1.66	18.67	0.64	25.07	1.62	0	101	73	0.19	0.02	73.44
PL1-1-px-Z18	PL1	opx	core	main	52.68	0.2	2.03	18.24	0.61	24.97	1.88	0.02	100.6	73	0.17	0.02	74.23
PL1-1-px-Z18	PL1	opx	core	main	52.59	0.21	1.97	18.3	0.58	25.18	1.8	0.03	100.7	73	0.17	0.02	74.88
PL1-1-px-Z18	PL1	opx	core	main	52.85	0.2	1.91	18.2	0.57	25.44	1.73	0.02	100.9	73	0.17	0.02	75.09
PL1-1-px-Z18	PL1	opx	core	main	53.03	0.2	1.75	18.22	0.6	25.54	1.63	0	101	74	0.17	0.02	74.87
PL1-1-px-Z18	PL1	opx	core	main	52.71	0.19	1.83	18.11	0.58	25.6	1.67	0.01	100.7	74	0.16	0.02	75.64
PL1-1-px-Z18	PL1	opx	core	main	53.14	0.18	1.79	18.03	0.6	25.45	1.67	0.01	100.9	74	0.16	0.02	74.58
PL1-1-px-Z18	PL1	opx	core	main	52.96	0.17	1.78	17.99	0.58	25.48	1.62	0.01	100.6	74	0.15	0.02	74.84
PL1-1-px-z19-r2c	PL1	opx	rim	main	51.92	0.24	1.35	21.39	0.83	23.2	1.46	0.02	100.4	68	0.20	0.03	69.66
PL1-1-px-z19-r2c	PL1	opx	rim	main	51.88	0.21	1.36	21.49	0.85	23.32	1.48	0.02	100.6	68	0.17	0.03	70.17
PL1-1-px-z19-r2c	PL1	opx	rim	main	51.85	0.18	1.06	21.32	0.86	23.28	1.51	0.02	100.1	68	0.15	0.02	70.18
PL1-1-px-z19-r2c	PL1	opx	rim	main	51.9	0.22	1.33	21.29	0.84	23.25	1.45	0.02	100.3	68	0.19	0.02	69.85
PL1-1-px-z19-r2c	PL1	opx	rim	main	51.83	0.19	1.05	21.16	0.83	23.26	1.47	0.02	99.8	69	0.16	0.02	70.03
PL1-1-px-z19-r2c	PL1	opx	rim	main	51.92	0.21	1.06	21.22	0.83	23.34	1.48	0.01	100.1	69	0.18	0.02	70.08
PL1-1-px-z19-r2c	PL1	opx	rim	main	51.53	0.22	2.07	20.66	0.79	23.62	1.55	0.02	100.5	69	0.18	0.03	71.60
PL1-1-px-z19-r2c	PL1	opx	rim	main	51.57	0.22	2.19	20.48	0.72	23.63	1.56	0.01	100.4	70	0.18	0.03	71.43
PL1-1-px-z19-r2c	PL1	opx	rim	main	51.52	0.22	2.14	20.43	0.77	23.79	1.53	0.02	100.4	70	0.18	0.03	72.07
PL1-1-px-z19-r2c	PL1	opx	rim	main	51.54	0.22	2.01	20.25	0.73	23.76	1.55	0.02	100.1	70	0.18	0.03	71.92
PL1-1-px-z19-r2c	PL1	opx	rim	main	51.89	0.23	1.89	19.25	0.67	24.47	1.53	-0.01	99.9	72	0.19	0.03	73.24
PL1-1-px-z19-r2c	PL1	opx	rim	main	51.76	0.25	2.27	18.55	0.66	24.7	1.59	0.02	99.8	72	0.21	0.03	74.35
PL1-1-px-z19-r2c	PL1	opx	rim	main	51.67	0.24	2.3	18.71	0.65	24.87	1.57	0.01	100	72	0.19	0.03	74.91

SAMPLE GRAIN ID	Sample	Min	Texture	stage	SiO2	TiO2	Al2O3	FeO*	MnO	MgO	CaO	Na2O	Total	Mg #	FeO	Fe2O3	Mg # (Fe2+ only)
PL1-1-px-z19-r2c	PL1	opx	rim	main	51.88	0.22	2.36	18.5	0.65	24.91	1.6	0	100.1	73	0.18	0.03	74.72
PL1-1-px-z19-r2c	PL1	opx	core	main	52.31	0.18	1.06	21.59	0.88	23.18	1.34	0	100.5	68	0.16	0.02	68.88
PL1-1-px-z19-r2c	PL1	opx	core	main	52.26	0.2	1.05	21.6	0.89	23.3	1.39	0.01	100.7	68	0.17	0.02	69.44
PL1-1-px-z19-r2c	PL1	opx	core	main	52	0.21	1.24	21.44	0.85	23.28	1.46	0.02	100.5	68	0.18	0.02	69.84
PL1-1-px-z19-r2c	PL1	opx	core	main	51.94	0.19	1.12	21.43	0.82	23.38	1.49	0.01	100.4	68	0.16	0.02	70.21
PL1-1-px-z19-r2c	PL1	opx	core	main	52.19	0.21	1.06	21.47	0.83	23.48	1.38	0.01	100.6	68	0.18	0.02	69.98
PL1-1-px-z19-r2c	PL1	opx	core	main	51.94	0.23	1.1	21.3	0.82	23.29	1.47	0.02	100.2	68	0.19	0.03	69.91
PL1-1-px-z19-r2c	PL1	opx	core	main	52.02	0.2	1.12	21.28	0.86	23.35	1.47	0	100.3	68	0.17	0.02	69.95
PL1-1-px-z19-r2c	PL1	opx	core	main	52.03	0.23	1.3	21.1	0.87	23.21	1.49	0.01	100.2	69	0.20	0.02	69.57
PL1-1-px-z19-r2c	PL1	opx	core	main	52	0.19	1.08	21.36	0.86	23.45	1.47	0.02	100.4	69	0.16	0.02	70.41
PL1-1-px-z19-r2c	PL1	opx	core	main	52.05	0.19	1.05	21.34	0.83	23.48	1.43	0.02	100.4	69	0.16	0.02	70.33
PL1-1-px-z19-r2c	PL1	opx	core	main	52.34	0.25	1.28	21.24	0.85	23.44	1.51	0.03	100.9	69	0.21	0.03	69.92
PL1-1-px-z19-r2c	PL1	opx	core	main	52.14	0.22	1.29	21.26	0.85	23.39	1.5	0	100.7	69	0.19	0.02	69.91
PL1-1-px-z19-r2c	PL1	opx	core	main	52.01	0.21	1.11	21.14	0.82	23.3	1.45	0.02	100.1	69	0.18	0.02	69.83
PL1-1-px-z19-r2c	PL1	opx	core	main	52.22	0.21	1.3	21.11	0.84	23.44	1.48	0	100.6	69	0.18	0.02	69.91
PL1-1-px-z19-r2c	PL1	opx	core	main	52.26	0.19	1.09	21.03	0.82	23.46	1.4	0.01	100.3	69	0.16	0.02	69.84
PL1-1-px-z19-r2c	PL1	opx	core	main	52.3	0.2	1.13	20.96	0.82	23.5	1.42	0	100.3	69	0.17	0.02	69.87
PL1-1-px-z19-r2c	PL1	opx	core	main	52.21	0.2	1.22	20.88	0.83	23.5	1.44	0.02	100.3	69	0.17	0.02	70.15
PL1-1-px-z19-r2c	PL1	opx	core	main	52.24	0.24	1.2	20.8	0.85	23.65	1.46	0	100.4	69	0.21	0.02	70.45
PL1-1-px-z19-r2c	PL1	opx	core	main	52.39	0.21	1.14	20.68	0.81	23.64	1.42	0.01	100.3	69	0.18	0.02	70.18
PL1-1-px-z19-r2c	PL1	opx	core	main	52.37	0.21	1.18	20.63	0.8	23.81	1.52	0.01	100.5	70	0.18	0.02	70.86
PL1-1-px-z19-r2c	PL1	opx	core	main	52.25	0.19	1.44	20.52	0.79	23.72	1.43	0.01	100.4	70	0.16	0.02	70.63
PL1-1-px-z19-r2c	PL1	opx	core	main	53.86	0.23	2.07	19.88	0.8	22.93	1.61	0.03	101.4	70	0.24	-0.01	66.31
PL1-1-px-z19-r2c	PL1	opx	core	main	52.37	0.2	1.27	20.56	0.79	23.86	1.39	0.04	100.5	70	0.17	0.02	70.98
PL1-1-px-z19-r2c	PL1	opx	core	main	52.36	0.2	1.55	20.61	0.73	23.89	1.48	0	100.8	70	0.17	0.02	70.93

SAMPLE GRAIN ID	Sample	Min	Texture	stage	SiO2	TiO2	Al2O3	FeO*	MnO	MgO	CaO	Na2O	Total	Mg #	FeO	Fe2O3	Mg # (Fe2+ only)
PL1-1-px-z19-r2c	PL1	opx	core	main	52.23	0.21	1.57	20.52	0.75	23.99	1.42	0.01	100.7	70	0.18	0.02	71.39
PL1-1-px-z19-r2c	PL1	opx	core	main	52.26	0.2	1.29	20.48	0.82	23.94	1.51	0.02	100.5	70	0.17	0.02	71.49
PL1-1-px-z19-r2c	PL1	opx	core	main	51.95	0.2	1.81	20.33	0.77	23.74	1.55	0.01	100.4	70	0.17	0.02	71.27
PL1-1-px-z19-r2c	PL1	opx	core	main	52.08	0.23	1.73	20.35	0.74	23.95	1.5	0.02	100.6	70	0.19	0.03	71.63
PL1-1-px-z19-r2c	PL1	opx	core	main	52.23	0.21	1.66	20	0.71	23.95	1.51	0.02	100.3	70	0.18	0.02	71.40
PL1-1-px-z19-r2c	PL1	opx	core	main	52.3	0.2	1.41	20.02	0.82	24.04	1.51	0.02	100.3	70	0.17	0.02	71.72
PL1-1-px-z19-r2c	PL1	opx	core	main	52.3	0.2	1.52	19.8	0.76	24.15	1.56	0.01	100.3	71	0.17	0.02	71.99
PL1-1-px-z19-r2c	PL1	opx	core	main	52.27	0.23	1.68	19.34	0.76	24.2	1.51	0.02	100	71	0.20	0.02	72.11
PL1-1-px-z19-r2c	PL1	opx	core	main	52.19	0.2	2.03	19.33	0.69	24.46	1.55	0.01	100.5	71	0.17	0.02	72.97
PL1-1-px-z19-r2c	PL1	opx	core	main	52.05	0.23	2.02	19.12	0.67	24.7	1.54	0.01	100.3	72	0.19	0.03	73.82
PL1-1-px-z19-r2c	PL1	opx	core	main	52.12	0.24	2.18	18.83	0.65	24.78	1.56	0.01	100.4	72	0.20	0.03	73.95
PL1-1-px-z1a	PL1	opx	pheno	main	51.73	0.14	0.99	21.65	0.85	22.86	1.43	0.04	99.7	68	0.12	0.02	69.10
PL1-1-px-z1a	PL1	opx	pheno	main	53.36	0.18	1.07	21.51	0.85	23.23	1.42	0.01	101.6	68	0.17	0.01	67.70
PL1-1-px-z1a	PL1	opx	pheno	main	53.25	0.19	0.93	21.18	0.87	23.33	1.46	0.01	101.2	69	0.17	0.01	68.21
PL1-1-px-zone3-r2r	PL1	opx	rim	main	52.52	0.21	1.25	22.62	0.93	22.7	1.44	0.03	101.7	67	0.18	0.02	67.51
PL1-1-px-zone3-r2r	PL1	opx	rim	main	52.18	0.19	1.29	22.36	0.96	22.62	1.44	0.04	101.1	67	0.16	0.02	67.84
PL1-1-px-zone3-r2r	PL1	opx	rim	main	52.22	0.19	1.3	22.33	0.96	22.61	1.45	0.03	101.1	67	0.16	0.02	67.72
PL1-1-px-zone3-r2r	PL1	opx	rim	main	52.36	0.21	1.28	22.45	0.93	22.73	1.48	0.04	101.5	67	0.18	0.02	67.93
PL1-1-px-zone3-r2r	PL1	opx	rim	main	52.27	0.2	1.3	22.34	0.95	22.72	1.44	0.02	101.2	67	0.17	0.02	67.89
PL1-1-px-zone3-r2r	PL1	opx	rim	main	52.46	0.2	1.24	22.09	0.98	22.57	1.43	0.02	101	67	0.18	0.02	67.18
PL1-1-px-zone3-r2r	PL1	opx	rim	main	52.33	0.2	1.28	22.2	0.97	22.72	1.47	0.04	101.2	67	0.17	0.02	67.98
PL1-1-px-zone3-r2r	PL1	opx	rim	main	52.24	0.17	1.22	22.16	0.92	22.67	1.43	0.03	100.8	67	0.15	0.02	67.81
PL1-1-px-zone3-r2r	PL1	opx	rim	main	52.41	0.18	1.28	22.12	0.97	22.63	1.47	0.03	101.1	67	0.16	0.02	67.56
PL1-1-px-zone3-r2r	PL1	opx	rim	main	52.38	0.2	1.22	21.99	0.94	22.77	1.44	0.02	101	67	0.18	0.02	67.86
PL1-1-px-zone3-r2r	PL1	opx	rim	main	52.47	0.19	1.3	21.86	0.9	23.05	1.51	0.03	101.3	68	0.16	0.02	68.70

SAMPLE GRAIN ID	Sample	Min	Texture	stage	SiO2	TiO2	Al2O3	FeO*	MnO	MgO	CaO	Na2O	Total	Mg #	FeO	Fe2O3	Mg # (Fe2+ only)
PL1-1-px-zone3-r2r	PL1	opx	rim	main	52.45	0.2	1.21	21.88	0.95	23.17	1.48	0.01	101.4	68	0.17	0.02	68.99
PL1-1-px-zone3-r2r	PL1	opx	rim	main	52.49	0.18	1.32	21.47	0.86	23.13	1.56	0.02	101	68	0.16	0.02	68.89
PL1-1-px-zone3-r2r	PL1	opx	rim	main	52.92	0.18	1.16	21.32	0.84	23.4	1.57	0.04	101.4	69	0.16	0.02	69.19
PL1-1-px-zone3-r2r	PL1	opx	rim	main	52.74	0.21	1.16	20.95	0.85	23.51	1.55	0.01	101	69	0.18	0.02	69.55
PL1-1-px-zone3-r2r	PL1	opx	rim	main	52.83	0.18	1.19	20.45	0.83	23.85	1.64	0.04	101	70	0.16	0.02	70.74
PL1-1-px-zone3-r2r	PL1	opx	rim	main	55.29	0.27	4.65	16.87	0.6	19.95	2.37	0.52	100.5	70	0.39	-0.07	58.34
PL1-1-px-zone3-r2r	PL1	opx	rim	main	52.92	0.2	1.53	19.98	0.77	24.02	1.74	0.02	101.2	70	0.18	0.02	71.05
PL1-1-px-zone3-r2r	PL1	opx	rim	main	53.01	0.19	1.2	20.06	0.78	24.12	1.65	0.04	101.1	70	0.17	0.02	71.22
PL1-1-px-zone3-r2r	PL1	opx	rim	main	54.91	0.28	4.13	17.22	0.61	20.75	2.22	0.41	100.5	71	0.38	-0.06	60.60
PL1-1-px-zone3-r2r	PL1	opx	rim	main	54.55	0.27	3.7	17.6	0.64	21.3	2.13	0.33	100.5	71	0.35	-0.05	62.33
PL1-1-px-zone3-r2r	PL1	opx	rim	main	52.45	0.21	1.27	19.79	0.77	23.99	1.69	0.03	100.2	71	0.18	0.02	71.60
PL1-1-px-zone3-r2r	PL1	opx	rim	main	52.76	0.21	1.57	19.77	0.76	24.09	1.72	0.03	100.9	71	0.18	0.02	71.49
PL1-1-px-zone3-r2r	PL1	opx	rim	main	52.75	0.23	1.59	19.66	0.73	24.17	1.77	0.02	100.9	71	0.20	0.02	71.70
PL1-1-px-zone3-r2r	PL1	opx	rim	main	52.49	0.21	1.66	19.63	0.74	24.26	1.85	0.03	100.9	71	0.18	0.02	72.57
PL1-1-px-zone3-r2r	PL1	opx	rim	main	54.41	0.27	3.42	17.85	0.6	22.08	2.09	0.25	101	71	0.33	-0.03	64.42
PL1-1-px-zone3-r2r	PL1	opx	rim	main	52.42	0.18	1.39	19.42	0.7	24.1	1.74	0.03	100	71	0.16	0.02	71.99
PL1-1-px-zone3-r2r	PL1	opx	rim	main	52.33	0.2	1.49	19.43	0.75	24.19	1.75	0.04	100.2	71	0.17	0.02	72.52
PL1-1-px-zone3-r2r	PL1	opx	rim	main	52.95	0.21	1.66	19.47	0.71	24.51	1.85	0.03	101.4	71	0.18	0.02	72.60
PL1-1-px-zone3-r2r	PL1	opx	rim	main	54.32	0.23	3.09	18.12	0.65	22.71	2.09	0.2	101.4	71	0.26	-0.02	66.33
PL1-1-px-zone3-r2r	PL1	opx	rim	main	51.45	0.28	2.66	18.26	0.65	22.99	1.91	0.16	98.4	71	0.26	0.01	70.81
PL1-1-px-zone3-r2r	PL1	opx	rim	main	52.41	0.21	1.56	19.2	0.74	24.24	1.76	0.02	100.1	71	0.18	0.02	72.42
PL1-1-px-zone3-r2r	PL1	opx	rim	main	53.91	0.25	2.61	18.45	0.66	23.4	1.93	0.11	101.3	72	0.26	-0.01	68.29
PL1-1-px-zone3-r2r	PL1	opx	rim	main	51.89	0.24	2.4	18.47	0.66	23.62	1.91	0.1	99.3	72	0.22	0.02	71.83
PL1-1-px-zone3-r2r	PL1	opx	rim	main	52.26	0.2	1.62	19.04	0.69	24.28	1.76	0.04	99.9	72	0.17	0.02	72.82
PL1-1-px-zone3-r2r	PL1	opx	rim	main	53.4	0.23	2.18	18.69	0.66	23.99	1.94	0.05	101.1	72	0.22	0.01	70.52

SAMPLE GRAIN ID	Sample	Min	Texture	stage	SiO2	TiO2	Al2O3	FeO*	MnO	MgO	CaO	Na2O	Total	Mg #	FeO	Fe2O3	Mg # (Fe2+ only)
PL1-1-px-zone3-r2r	PL1	opx	rim	main	51.92	0.22	2.13	18.63	0.65	23.93	1.86	0.06	99.4	72	0.19	0.02	72.45
PL1-1-px-zone3-r2r	PL1	opx	rim	main	52.4	0.18	1.68	18.9	0.7	24.3	1.8	0.03	100	72	0.16	0.02	72.71
PL1-1-px-zone3-r2r	PL1	opx	rim	main	52.46	0.18	1.71	18.99	0.67	24.43	1.76	0.04	100.2	72	0.15	0.02	72.97
PL1-1-px-zone3-r2r	PL1	opx	rim	main	52.77	0.2	1.7	19.11	0.68	24.56	1.86	0.02	100.9	72	0.17	0.02	72.94
PL1-1-px-zone3-r2r	PL1	opx	rim	main	52.96	0.21	1.71	18.95	0.71	24.48	1.87	0.01	100.9	72	0.19	0.02	72.40
PL1-1-px-zone3-r2r	PL1	opx	rim	main	52.93	0.21	1.77	19.11	0.68	24.71	1.9	0.02	101.3	72	0.18	0.02	73.21
PL1-1-px-zone3-r2r	PL1	opx	rim	main	52.26	0.21	1.69	18.9	0.69	24.42	1.81	0.02	100	72	0.18	0.02	73.19
PL1-1-px-zone3-r2r	PL1	opx	rim	main	52.12	0.21	1.92	18.78	0.66	24.34	1.85	0.02	99.9	72	0.18	0.02	73.18
PL1-1-px-zone3-r2r	PL1	opx	rim	main	52.89	0.25	1.89	18.92	0.67	24.52	1.86	0.03	101	72	0.22	0.02	72.63
PL1-1-px-zone3-r2r	PL1	opx	rim	main	52.81	0.24	1.75	18.97	0.67	24.6	1.81	0.01	100.9	72	0.21	0.02	72.80
PL1-1-px-zone3-r2r	PL1	opx	rim	main	52.36	0.23	1.88	18.78	0.69	24.33	1.88	0.02	100.2	72	0.20	0.02	72.86
PL1-1-px-zone3-r2r	PL1	opx	rim	main	52.3	0.23	1.87	18.83	0.69	24.51	1.87	0.02	100.3	72	0.19	0.02	73.48
PL1-1-px-zone3-r2r	PL1	opx	rim	main	52.35	0.22	1.8	18.81	0.67	24.47	1.83	0.03	100.2	72	0.19	0.02	73.26
PL1-1-px-zone3-r2r	PL1	opx	rim	main	52.42	0.2	1.75	18.71	0.67	24.39	1.83	0.04	100	72	0.17	0.02	72.99
PL1-1-px-zone3-r2r	PL1	opx	rim	main	52.98	0.2	1.82	18.88	0.68	24.59	1.94	0.01	101.1	72	0.17	0.02	72.78
PL1-1-px-zone3-r2r	PL1	opx	rim	main	52.75	0.25	1.78	18.82	0.66	24.65	1.89	0.03	100.8	72	0.21	0.02	73.26
PL1-1-px-zone3-r2r	PL1	opx	rim	main	52.24	0.22	1.82	18.47	0.67	24.45	1.84	0.03	99.7	72	0.19	0.02	73.37
PL1-1-px-zone3-r2r	PL1	opx	core	main	52.56	0.21	1.22	22.42	0.93	22.58	1.45	0.02	101.4	67	0.19	0.02	67.05
PL1-1-px-zone3-r2r	PL1	opx	core	main	52.63	0.21	1.23	22.5	0.95	22.79	1.43	0.03	101.8	67	0.18	0.02	67.64
PL1-1-px-zone3-r2r	PL1	opx	core	main	52.54	0.18	1.29	22.35	0.94	22.71	1.46	0.04	101.5	67	0.16	0.02	67.63
PL1-1-px-zone3-r2r	PL1	opx	core	main	52.62	0.22	1.22	22.33	0.95	22.66	1.41	0.04	101.5	67	0.19	0.02	67.26
PL1-1-px-zone3-r2r	PL1	opx	core	main	52.57	0.24	1.2	22.29	0.94	22.74	1.42	0.02	101.4	67	0.21	0.02	67.45
PL1-1-px-zone3-r2r	PL1	opx	core	main	52.65	0.21	1.2	22.22	0.94	22.7	1.41	0.03	101.4	67	0.19	0.02	67.28
PL1-1-px-zone3-r2r	PL1	opx	core	main	52.59	0.21	1.2	22.14	0.98	22.75	1.42	0.02	101.3	67	0.19	0.02	67.52
PL1-1-px-zone3-r2r	PL1	opx	core	main	52.53	0.19	1.17	22.02	0.94	22.76	1.46	0.04	101.1	67	0.17	0.02	67.77

SAMPLE GRAIN ID	Sample	Min	Texture	stage	SiO2	TiO2	Al2O3	FeO*	MnO	MgO	CaO	Na2O	Total	Mg #	FeO	Fe2O3	Mg # (Fe2+ only)
PL1-1-px-zone3-r2r	PL1	opx	core	main	52.57	0.2	1.29	21.85	0.94	22.76	1.54	0.03	101.2	67	0.18	0.02	67.77
PL1-1-px-zone3-r2r	PL1	opx	core	main	52.56	0.22	1.21	21.75	0.89	23.01	1.5	0.03	101.2	68	0.19	0.02	68.39
PL1-1-px-zone3-r2r	PL1	opx	core	main	52.63	0.19	1.2	21.63	0.91	22.89	1.54	0.02	101	68	0.17	0.02	67.99
PL1-1-px-zone3-r2r	PL1	opx	core	main	52.68	0.2	1.3	21.45	0.92	22.95	1.54	0.03	101.1	68	0.18	0.02	68.15
PL1-1-px-zone3-r2r	PL1	opx	core	main	52.69	0.19	1.21	21.47	0.95	23.06	1.54	0.03	101.1	68	0.17	0.02	68.51
PL1-1-px-zone3-r2r	PL1	opx	core	main	52.73	0.19	1.18	21.3	0.88	23.4	1.56	0.03	101.3	69	0.16	0.02	69.43
PL1-1-px-zone3-r2r	PL1	opx	core	main	52.68	0.2	1.35	21.06	0.86	23.38	1.64	0.03	101.2	69	0.17	0.02	69.51
PL1-1-px-zone3-r2r	PL1	opx	core	main	52.54	0.2	1.37	20.86	0.86	23.38	1.6	0.03	100.8	69	0.18	0.02	69.65
PL1-1-px-zone3-r2r	PL1	opx	core	main	52.72	0.21	1.39	20.71	0.83	23.63	1.65	0.03	101.2	69	0.18	0.02	70.17
PL1-1-px-zone3-r2r	PL1	opx	core	main	52.66	0.2	1.15	20.64	0.86	23.64	1.58	0.03	100.8	69	0.17	0.02	70.22
PL1-1-px-zone3-r2r	PL1	opx	core	main	52.68	0.2	1.41	20.42	0.79	23.78	1.68	0.01	101	70	0.17	0.02	70.56
PL1-1-px-zone3-r2r	PL1	opx	core	main	52.54	0.22	1.47	20.41	0.8	23.93	1.71	0.02	101.1	70	0.19	0.02	71.31
PL1-1-px-zone3-r2r	PL1	opx	core	main	52.65	0.18	1.19	20.3	0.81	23.94	1.62	0.05	100.7	70	0.15	0.02	71.27
PL1-1-px-zone3-r2r	PL1	opx	core	main	52.73	0.18	1.32	19.65	0.77	24.28	1.72	0.03	100.7	71	0.15	0.02	72.15
PL1-1-px-zone3-r2r	PL1	opx	core	main	52.67	0.21	1.66	19.36	0.72	24.24	1.79	0.01	100.7	71	0.18	0.02	72.00
PL1-1-px-zone3-r2r	PL1	opx	core	main	52.64	0.2	1.78	18.58	0.7	24.5	1.8	0.02	100.2	72	0.18	0.02	72.87
PL1-1-px8	PL1	opx	pheno	main	52.55	0.19	0.91	21.82	0.9	23.13	1.42	0	100.9	68	0.17	0.02	68.53
PL1-1-pxz-7	PL1	opx	pheno	main	51.8	0.16	1.01	25.04	1.39	21.08	0.99	0.03	101.5	63	0.14	0.02	63.57
PL1-1-z-px14-point	PL1	opx	glom	main	53	0.21	1.2	21.49	0.89	22.66	2.12	0.05	101.6	68	0.19	0.02	67.75
PL1-1-z-px14-point	PL1	opx	glom	main	53.21	0.21	2.34	19.1	0.64	24.9	1.57	0.02	102	72	0.18	0.02	72.79
PL1-site1-px1	PL1	opx	microlite	main	52.12	0.24	2.27	18.51	0.58	24.88	1.71	0.21	100.5	73	0.19	0.03	75.58
PL1-site1-px2	PL1	opx	microlite	main	53.88	0.12	0.69	19.25	0.76	24.6	1.57	0.14	101	72	0.11	0.01	71.85
PL1-site1-px3	PL1	opx	microlite	main	52.94	0.15	0.79	19.02	0.74	24.57	1.74	0.13	100.1	72	0.13	0.02	73.29
PL1-site1-px4	PL1	opx	microlite	main	52.23	0.22	1.76	18.93	0.65	24.52	1.48	0.14	99.9	72	0.18	0.02	73.65
PL1-site1-px4	PL1	opx	microlite	main	53.41	0.13	0.91	17.51	0.59	25.79	1.71	0.1	100.2	74	0.11	0.01	75.80

SAMPLE GRAIN ID	Sample	Min	Texture	stage	SiO2	TiO2	Al2O3	FeO*	MnO	MgO	CaO	Na2O	Total	Mg #	FeO	Fe2O3	Mg # (Fe2+ only)
PL1-site1-px5	PL1	opx	microlite	main	52.43	0.21	1.25	20.68	0.78	23.43	1.5	0.15	100.4	69	0.18	0.02	70.36
PL1-site1-px6	PL1	opx	microlite	main	52.66	0.15	0.84	17.83	0.62	25.38	1.66	0.16	99.3	74	0.12	0.02	76.02
PL1-site1-px7	PL1	opx	microlite	main	52.09	0.29	2.4	18.24	0.58	24.92	1.94	0.04	100.5	73	0.24	0.03	75.05
PL1-site1-px9	PL1	opx	microlite	main	53.45	0.13	0.86	19.65	0.65	24.34	1.57	0.19	100.8	71	0.11	0.01	71.85
PL2-site1-px1	PL2	opx	microlite	late	50.8	0.23	1.1	26.72	1.23	19.26	1.52	0.04	100.9	59	0.20	0.03	59.82
PL2-site1-px3	PL2	opx	microlite	late	52.58	0.13	0.81	21.35	0.81	23.53	1.49	0.09	100.8	69	0.11	0.02	70.24
PL2-site1-px4	PL2	opx	microlite	late	50.55	0.24	0.98	26.62	1.23	19.61	1.36	0.08	100.7	59	0.20	0.04	61.22
PL2-site1-px5	PL2	opx	microlite	late	52.12	0.21	0.57	23.67	0.92	21.66	1.21	0.06	100.4	64	0.19	0.02	64.75
PL2-site1-px6	PL2	opx	microlite	late	52.1	0.16	0.69	22.6	0.9	22.8	1.35	0.08	100.7	67	0.13	0.02	68.56
PL2-site1-px7	PL2	opx	microlite	late	51.5	0.19	0.44	25.64	1.19	19.95	1.55	0.21	100.7	61	0.16	0.02	61.94
PL2-site1-px7	PL2	opx	microlite	late	51.02	0.21	1.65	21.11	0.73	22.78	1.54	0.08	99.1	68	0.17	0.03	70.03
PL2-site1-px7	PL2	opx	microlite	late	51.26	0.19	1.57	21.23	0.72	22.92	1.57	0.19	99.7	68	0.15	0.03	70.80

Table S2.2.3: Major element compositions of whole rocks, glasses, and minerals (Plag).

SAMPLE	stage	type	analyses	zone	SiO2	Al2O3	Na2O	CaO	K2O	FeO	MgO	Total	An	Ab	An (Ternary)	Ab (Ternary)	Or (Ternary)
KELUT90B-PLG-b2	main	type 2	traverse	rim	53.8	27.6	4.6	11.8	0.11	0.76	NA	98.6	58.4	41.6	58.1	41.2	0.6
KELUT90B-PLG-b2	main	type 2	traverse	rim	54.0	28.3	4.6	11.9	0.11	0.66	NA	99.5	59.0	41.0	58.7	40.7	0.6
KELUT90B-PLG-b2	main	type 2	traverse	rim	54.0	27.8	4.2	11.7	0.11	1.14	NA	99.0	60.7	39.3	60.2	39.1	0.7
KELUT90B-PLG-b2	main	type 2	traverse	rim	53.2	28.3	4.3	12.3	0.10	0.65	NA	98.8	60.9	39.1	60.6	38.8	0.6
KELUT90B-PLG-b2	main	type 2	traverse	rim	54.1	28.1	4.2	12.0	0.16	0.78	NA	99.4	61.1	38.9	60.6	38.4	1.0
KELUT90B-PLG-b2	main	type 2	traverse	rim	52.6	28.6	4.3	12.4	0.10	0.66	NA	98.6	61.3	38.7	61.0	38.4	0.6
KELUT90B-PLG-b2	main	type 2	traverse	rim	52.8	29.1	4.4	12.8	0.09	0.65	NA	99.9	61.6	38.4	61.4	38.1	0.5
KELUT90B-PLG-b2	main	type 2	traverse	rim	53.6	28.7	4.3	12.5	0.10	0.67	NA	99.7	61.7	38.3	61.3	38.1	0.6
KELUT90B-PLG-b2	main	type 2	traverse	rim	53.1	29.0	4.3	12.6	0.10	0.65	NA	99.8	62.1	37.9	61.6	37.8	0.6
KELUT90B-PLG-b2	main	type 2	traverse	rim	53.0	28.8	4.2	12.5	0.09	0.68	NA	99.2	62.2	37.8	62.0	37.5	0.5
KELUT90B-PLG-b2	main	type 2	traverse	rim	52.6	29.2	4.2	12.8	0.09	0.58	NA	99.5	62.7	37.3	62.5	37.0	0.5
KELUT90B-PLG-b2	main	type 2	traverse	rim	52.7	28.8	4.1	12.7	0.09	0.68	NA	99.1	63.2	36.8	62.8	36.7	0.5
KELUT90B-PLG-b2	main	type 2	traverse	rim	52.6	29.0	4.0	12.8	0.08	0.67	NA	99.2	63.9	36.2	63.5	36.0	0.5
KELUT90B-PLG-b2	main	type 2	traverse	rim	52.7	29.3	4.0	13.0	0.08	0.61	NA	99.6	64.0	36.0	63.7	35.8	0.5
KELUT90B-PLG-b2	main	type 2	traverse	rim	52.9	29.4	4.0	12.9	0.09	0.61	NA	99.8	64.3	35.7	64.1	35.4	0.5
KELUT90B-PLG-b2	main	type 2	traverse	rim	51.9	29.4	4.0	13.4	0.08	0.58	NA	99.2	65.0	35.0	64.8	34.7	0.5
KELUT90B-PLG-b2	main	type 2	traverse	rim	52.8	29.4	3.9	13.1	0.08	0.56	NA	99.8	65.1	34.9	64.7	34.8	0.5
KELUT90B-PLG-b2	main	type 2	traverse	rim	52.3	29.7	3.9	13.2	0.08	0.60	NA	99.8	65.3	34.7	65.0	34.5	0.5
KELUT90B-PLG-b2	main	type 2	traverse	rim	51.8	29.7	3.8	13.6	0.07	0.61	NA	99.6	66.5	33.6	66.3	33.3	0.4
KELUT90B-PLG-b2	main	type 2	traverse	rim	51.5	29.5	3.7	13.4	0.07	0.61	NA	98.8	66.7	33.3	66.4	33.2	0.4
KELUT90B-PLG-b2	main	type 2	traverse	rim	51.5	29.8	3.7	13.6	0.07	0.60	NA	99.3	67.5	32.6	67.1	32.5	0.4
KELUT90B-PLG-b2	main	type 2	traverse	rim	51.4	29.9	3.6	13.8	0.08	0.61	NA	99.4	68.0	32.0	67.7	31.8	0.5
KELUT90B-PLG-b2	main	type 2	traverse	rim	51.2	30.0	3.6	13.7	0.07	0.61	NA	99.1	68.0	32.0	67.7	31.9	0.4

SAMPLE	stage	type	analyses	zone	SiO2	Al2O3	Na2O	CaO	K2O	FeO	MgO	Total	An	Ab	An (Ternary)	Ab (Ternary)	Or (Ternary)
KELUT90B-PLG-b2	main	type 2	traverse	rim	51.4	30.0	3.5	13.8	0.07	0.57	NA	99.4	68.2	31.8	68.1	31.5	0.4
KELUT90B-PLG-b2	main	type 2	traverse	rim	51.7	30.1	3.5	13.8	0.07	0.57	NA	99.7	68.8	31.2	68.4	31.1	0.4
KELUT90B-PLG-b2	main	type 2	traverse	rim	51.0	30.2	3.5	14.1	0.07	0.58	NA	99.4	68.9	31.1	68.6	31.0	0.4
KELUT90B-PLG-b2	main	type 2	traverse	rim	51.3	29.9	3.4	13.8	0.07	0.59	NA	99.2	69.2	30.9	68.8	30.8	0.4
KELUT90B-PLG-b2	main	type 2	traverse	rim	51.1	30.3	3.4	14.1	0.06	0.61	NA	99.5	69.8	30.2	69.6	30.0	0.4
KELUT90B-PLG-b2	main	type 2	traverse	rim	50.8	30.3	3.4	14.3	0.06	0.58	NA	99.3	70.1	29.9	69.7	29.9	0.3
KELUT90B-PLG-b2	main	type 2	traverse	rim	50.8	30.4	3.3	14.2	0.06	0.59	NA	99.3	70.1	29.9	70.0	29.6	0.4
KELUT90B-PLG-b2	main	type 2	traverse	rim	51.3	30.3	3.3	14.1	0.06	0.64	NA	99.6	70.2	29.8	70.0	29.6	0.4
KELUT90B-PLG-b2	main	type 2	traverse	rim	50.7	30.4	3.3	14.3	0.06	0.61	NA	99.4	70.3	29.7	70.0	29.6	0.4
KELUT90B-PLG-b2	main	type 2	traverse	rim	50.7	30.2	3.3	14.3	0.06	0.58	NA	99.1	70.3	29.7	70.0	29.7	0.4
KELUT90B-PLG-b2	main	type 2	traverse	rim	50.8	30.4	3.3	14.0	0.07	0.61	NA	99.2	70.4	29.6	70.1	29.5	0.4
KELUT90B-PLG-b2	main	type 2	traverse	rim	50.7	30.3	3.3	14.3	0.06	0.61	NA	99.2	70.6	29.4	70.3	29.3	0.4
KELUT90B-PLG-b2	main	type 2	traverse	rim	50.7	30.6	3.2	14.2	0.06	0.62	NA	99.3	71.1	28.9	70.7	28.9	0.4
KELUT90B-PLG-b2	main	type 2	traverse	rim	50.5	30.9	3.2	14.4	0.06	0.61	NA	99.8	71.1	28.9	70.9	28.7	0.4
KELUT90B-PLG-b2	main	type 2	traverse	rim	51.0	30.6	3.2	14.3	0.06	0.58	NA	99.7	71.2	28.8	70.9	28.7	0.4
KELUT90B-PLG-b2	main	type 2	traverse	rim	50.5	30.6	3.2	14.4	0.05	0.60	NA	99.2	71.6	28.4	71.3	28.4	0.3
KELUT90B-PLG-b2	main	type 2	traverse	rim	50.4	30.4	3.2	14.6	0.06	0.58	NA	99.2	71.9	28.2	71.5	28.2	0.3
KELUT90B-PLG-b2	main	type 2	traverse	rim	50.5	30.6	3.1	14.6	0.06	0.55	NA	99.4	71.9	28.1	71.7	27.9	0.4
KELUT90B-PLG-b2	main	type 2	traverse	rim	49.7	31.0	3.1	14.8	0.06	0.60	NA	99.2	72.5	27.5	72.3	27.3	0.3
KELUT90B-PLG-b2	main	type 2	traverse	rim	49.9	30.7	3.0	14.7	0.05	0.61	NA	98.9	73.2	26.9	73.0	26.7	0.3
KELUT90B-PLG-b2	main	type 2	traverse	rim	50.0	30.8	3.0	14.8	0.05	0.60	NA	99.2	73.2	26.8	73.1	26.6	0.3
KELUT90B-PLG-b2	main	type 2	traverse	rim	49.9	30.9	2.9	14.9	0.05	0.60	NA	99.1	74.1	25.9	73.9	25.8	0.3
KELUT90B-PLG-b2	main	type 2	traverse	rim	49.8	30.9	2.9	15.0	0.06	0.63	NA	99.2	74.3	25.7	74.2	25.5	0.4
KELUT90B-PLG-b2	main	type 2	traverse	rim	49.4	31.2	2.8	15.1	0.05	0.59	NA	99.2	75.2	24.8	74.9	24.8	0.3
KELUT90B-PLG-b2	main	type 2	traverse	rim	49.3	31.3	2.7	15.2	0.05	0.64	NA	99.2	75.5	24.5	75.2	24.5	0.3

SAMPLE	stage	type	analyses	zone	SiO2	Al2O3	Na2O	CaO	K2O	FeO	MgO	Total	An	Ab	An (Ternary)	Ab (Ternary)	Or (Ternary)
KELUT90B-PLG-b2	main	type 2	traverse	core	46.7	32.8	1.6	16.8	0.03	0.59	NA	98.5	85.4	14.6	85.4	14.4	0.2
KELUT90B-PLG-b2	main	type 2	traverse	core	46.7	33.0	1.5	17.1	0.02	0.58	NA	98.9	85.9	14.1	85.9	14.0	0.1
KELUT90B-PLG-b2	main	type 2	traverse	core	46.7	33.1	1.6	17.3	0.03	0.61	NA	99.3	86.1	14.0	85.8	14.0	0.2
KELUT90B-PLG-b2	main	type 2	traverse	core	46.7	33.1	1.5	17.5	0.03	0.63	NA	99.4	86.4	13.6	86.3	13.5	0.2
KELUT90B-PLG-b2	main	type 2	traverse	core	46.1	33.5	1.5	17.5	0.02	0.58	NA	99.1	86.7	13.3	86.5	13.4	0.1
KELUT90B-PLG-b2	main	type 2	traverse	core	46.8	33.5	1.5	17.3	0.03	0.64	NA	99.6	86.8	13.2	86.6	13.3	0.2
KELUT90B-PLG-b2	main	type 2	traverse	core	46.3	33.3	1.4	17.5	0.03	0.64	NA	99.2	87.0	13.0	86.9	12.9	0.2
KELUT90B-PLG-b2	main	type 2	traverse	core	46.5	33.2	1.4	17.3	0.03	0.58	NA	98.9	87.2	12.8	87.1	12.7	0.2
KELUT90B-PLG-b2	main	type 2	traverse	core	46.5	33.4	1.4	17.3	0.03	0.62	NA	99.3	87.2	12.8	86.9	12.9	0.2
KELUT90B-PLG-b2	main	type 2	traverse	core	46.4	33.3	1.4	17.4	0.03	0.63	NA	99.1	87.2	12.8	87.0	12.8	0.2
KELUT90B-PLG-b2	main	type 2	traverse	core	46.4	33.2	1.4	17.3	0.02	0.61	NA	99.0	87.2	12.8	87.0	12.9	0.1
KELUT90B-PLG-b2	main	type 2	traverse	core	46.6	33.2	1.4	17.4	0.02	0.61	NA	99.3	87.3	12.8	87.2	12.7	0.1
KELUT90B-PLG-b2	main	type 2	traverse	core	46.4	33.5	1.4	17.6	0.02	0.67	NA	99.5	87.3	12.7	87.1	12.8	0.1
KELUT90B-PLG-b2	main	type 2	traverse	core	46.6	33.3	1.4	17.3	0.03	0.60	NA	99.3	87.5	12.5	87.3	12.5	0.2
KELUT90B-PLG-b2	main	type 2	traverse	core	46.7	33.4	1.4	17.5	0.02	0.60	NA	99.5	87.5	12.5	87.5	12.3	0.1
KELUT90B-PLG-b2	main	type 2	traverse	core	46.6	33.4	1.4	17.6	0.03	0.59	NA	99.5	87.6	12.4	87.5	12.3	0.2
KELUT90B-PLG-b2	main	type 2	traverse	core	46.4	33.3	1.4	17.7	0.02	0.65	NA	99.5	87.7	12.3	87.5	12.4	0.1
KELUT90B-PLG-b2	main	type 2	traverse	core	46.4	33.5	1.3	17.4	0.02	0.58	NA	99.2	87.8	12.2	87.8	12.1	0.1
KELUT90B-PLG-b2	main	type 2	traverse	core	46.5	33.3	1.4	17.6	0.03	0.62	NA	99.4	87.9	12.1	87.7	12.2	0.2
KELUT90B-PLG-b2	main	type 2	traverse	core	46.3	33.3	1.3	17.6	0.02	0.64	NA	99.2	88.0	12.0	88.0	11.8	0.1
KELUT90B-PLG-r1	main	type 3	traverse	rim	53.4	28.5	4.5	12.1	0.10	0.59	NA	99.1	59.8	40.2	59.4	40.0	0.6
KELUT90B-PLG-r1	main	type 3	traverse	rim	53.7	28.3	4.4	12.1	0.10	0.63	NA	99.3	60.2	39.8	59.9	39.5	0.6
KELUT90B-PLG-r1	main	type 3	traverse	rim	53.4	28.5	4.3	12.2	0.09	0.60	NA	99.0	61.1	38.9	60.8	38.7	0.5
KELUT90B-PLG-r1	main	type 3	traverse	rim	53.3	28.6	4.2	12.1	0.09	0.56	NA	98.8	61.6	38.4	61.3	38.2	0.5
KELUT90B-PLG-r1	main	type 3	traverse	core	52.4	29.0	4.1	12.5	0.09	0.57	NA	98.6	62.5	37.5	62.2	37.3	0.5

SAMPLE	stage	type	analyses	zone	SiO2	Al2O3	Na2O	CaO	K2O	FeO	MgO	Total	An	Ab	An (Ternary)	Ab (Ternary)	Or (Ternary)
KELUT90B-PLG-r1	main	type 3	traverse	core	52.8	29.1	4.1	12.5	0.09	0.61	NA	99.2	62.9	37.1	62.5	37.0	0.5
KELUT90B-PLG-r1	main	type 3	traverse	core	53.0	29.0	4.1	12.6	0.08	0.58	NA	99.2	63.0	37.0	62.8	36.7	0.5
KELUT90B-PLG-r1	main	type 3	traverse	core	52.9	29.0	4.0	12.7	0.09	0.61	NA	99.4	63.5	36.5	63.2	36.3	0.5
KELUT90B-PLG-r1	main	type 3	traverse	core	52.7	28.9	4.0	12.6	0.09	0.60	NA	98.8	63.6	36.4	63.2	36.3	0.5
KELUT90B-PLG-r1	main	type 3	traverse	core	52.6	29.1	4.0	12.6	0.09	0.62	NA	98.9	63.9	36.1	63.5	36.0	0.5
KELUT90B-PLG-r1	main	type 3	traverse	core	52.0	29.3	3.9	12.7	0.10	0.60	NA	98.6	64.2	35.8	63.9	35.5	0.6
KELUT90B-PLG-r1	main	type 3	traverse	core	52.8	28.9	3.6	12.9	0.13	0.70	NA	99.1	66.4	33.6	65.9	33.4	0.8
KELUT90B-PLG-r1	main	type 3	traverse	core	51.2	29.8	3.4	13.6	0.07	0.63	NA	98.7	68.7	31.3	68.4	31.2	0.4
KELUT90B-PLG-r1	main	type 3	traverse	core	51.1	30.0	3.4	13.9	0.07	0.62	NA	99.1	69.3	30.7	68.8	30.8	0.4
KELUT90B-PLG-r3	main	type 3	traverse	rim	53.1	28.9	4.4	12.0	0.09	0.58	NA	99.1	59.9	40.1	59.6	39.9	0.5
KELUT90B-PLG-r3	main	type 3	traverse	rim	53.2	28.7	4.4	12.2	0.09	0.57	NA	99.1	60.5	39.5	60.1	39.3	0.5
KELUT90B-PLG-r3	main	type 3	traverse	rim	52.7	28.9	4.2	12.5	0.11	0.64	NA	99.0	62.2	37.8	61.8	37.5	0.6
KELUT90B-PLG-r3	main	type 3	traverse	rim	52.7	29.1	4.2	12.5	0.08	0.59	NA	99.2	62.2	37.8	61.8	37.7	0.5
KELUT90B-PLG-r3	main	type 3	traverse	rim	53.0	29.1	4.1	12.5	0.09	0.62	NA	99.3	63.0	37.0	62.6	36.9	0.5
KELUT90B-PLG-r3	main	type 3	traverse	rim	52.5	29.3	3.9	12.8	0.08	0.55	NA	99.1	64.7	35.3	64.3	35.2	0.5
KELUT90B-PLG-r3	main	type 3	traverse	rim	52.3	29.6	3.9	13.1	0.08	0.62	NA	99.6	65.1	34.9	64.7	34.8	0.5
KELUT90B-PLG-r3	main	type 3	traverse	rim	51.5	29.7	3.8	13.2	0.07	0.60	NA	98.8	65.9	34.1	65.7	33.9	0.4
KELUT90B-PLG-r3	main	type 3	traverse	rim	51.6	29.9	3.8	13.4	0.07	0.61	NA	99.3	65.9	34.1	65.7	33.9	0.4
KELUT90B-PLG-r3	main	type 3	traverse	rim	51.5	29.8	3.7	13.4	0.07	0.61	NA	98.9	66.8	33.2	66.6	33.0	0.4
KELUT90B-PLG-r3	main	type 3	traverse	rim	51.2	29.7	3.6	13.3	0.07	0.60	NA	98.5	67.4	32.7	67.1	32.5	0.4
KELUT90B-PLG-r3	main	type 3	traverse	rim	51.2	29.9	3.6	13.6	0.07	0.60	NA	99.0	67.5	32.6	67.3	32.3	0.4
KELUT90B-PLG-r3	main	type 3	traverse	rim	51.6	30.0	3.6	13.4	0.07	0.60	NA	99.1	67.5	32.5	67.2	32.4	0.4
KELUT90B-PLG-r3	main	type 3	traverse	rim	50.8	29.8	3.6	13.6	0.08	0.61	NA	98.5	67.6	32.4	67.1	32.4	0.5
KELUT90B-PLG-r3	main	type 3	traverse	rim	50.8	29.8	3.6	13.4	0.07	0.58	NA	98.3	67.6	32.4	67.2	32.4	0.4
KELUT90B-PLG-r3	main	type 3	traverse	rim	51.3	30.2	3.6	13.6	0.07	0.58	NA	99.4	67.7	32.3	67.3	32.2	0.4

SAMPLE	stage	type	analyses	zone	SiO2	Al2O3	Na2O	CaO	K2O	FeO	MgO	Total	An	Ab	An (Ternary)	Ab (Ternary)	Or (Ternary)
KELUT90B-PLG-r3	main	type 3	traverse	rim	51.0	29.8	3.5	13.3	0.08	0.62	NA	98.3	67.8	32.2	67.5	32.0	0.5
KELUT90B-PLG-r3	main	type 3	traverse	rim	51.2	30.0	3.5	13.7	0.07	0.60	NA	99.1	68.2	31.8	67.9	31.7	0.4
KELUT90B-PLG-r3	main	type 3	traverse	rim	51.1	30.1	3.5	13.6	0.06	0.63	NA	99.1	68.5	31.5	68.1	31.5	0.4
KELUT90B-PLG-r3	main	type 3	traverse	core	50.4	30.8	3.3	14.3	0.06	0.59	NA	99.4	70.8	29.2	70.6	29.1	0.4
KELUT90B-PLG-r3	main	type 3	traverse	core	50.2	30.5	3.2	14.3	0.06	0.65	NA	98.9	71.1	28.9	70.8	28.8	0.4
KELUT90B-PLG-r3	main	type 3	traverse	core	50.0	30.7	3.2	14.3	0.05	0.63	NA	98.9	71.5	28.5	71.3	28.4	0.3
KELUT90B-PLG-r3	main	type 3	traverse	core	50.0	30.9	3.1	14.3	0.06	0.62	NA	99.0	71.5	28.5	71.3	28.4	0.4
KELUT90B-PLG-r3	main	type 3	traverse	core	50.1	30.7	3.1	14.1	0.06	0.58	NA	98.7	71.6	28.4	71.3	28.4	0.4
KELUT90B-PLG-r3	main	type 3	traverse	core	50.3	30.9	3.1	14.4	0.06	0.61	NA	99.3	72.0	28.0	71.7	27.9	0.4
KELUT90B-PLG-r3	main	type 3	traverse	core	50.2	30.8	3.1	14.4	0.06	0.64	NA	99.2	72.0	28.0	71.7	27.9	0.4
KELUT90B-PLG-r3	main	type 3	traverse	core	49.8	31.0	3.0	14.7	0.05	0.62	NA	99.1	72.9	27.1	72.7	27.0	0.3
KELUT90B-PLG-r3	main	type 3	traverse	core	49.6	31.2	3.0	14.7	0.05	0.63	NA	99.2	73.2	26.9	72.9	26.8	0.3
KELUT90B-PLG-r3	main	type 3	traverse	core	50.0	30.9	3.0	14.6	0.05	0.60	NA	99.1	73.2	26.8	72.8	26.9	0.3
KELUT90B-PLG-r3	main	type 3	traverse	core	49.4	31.0	2.9	14.6	0.06	0.58	NA	98.5	73.6	26.4	73.4	26.2	0.4
KELUT90B-PLG-r3	main	type 3	traverse	core	49.7	31.3	2.9	14.9	0.05	0.62	NA	99.4	73.8	26.2	73.7	26.0	0.3
KELUT90B-PLG-r3	main	type 3	traverse	core	49.3	31.2	2.9	15.0	0.06	0.60	NA	99.0	74.3	25.7	74.2	25.5	0.4
KELUT90B-PLG-r3	main	type 3	traverse	core	48.8	31.3	2.6	15.1	0.05	0.62	NA	98.4	76.5	23.5	76.3	23.4	0.3
KELUT90B-PLG-r3	main	type 3	traverse	core	48.4	31.7	2.5	15.0	0.04	0.61	NA	98.3	76.5	23.5	76.4	23.4	0.2
KELUT90B-PLG-r3	main	type 3	traverse	core	48.6	31.6	2.5	15.3	0.04	0.61	NA	98.7	77.0	23.0	76.9	22.9	0.2
KELUT90B-PLG-r3	main	type 3	traverse	core	49.4	31.3	2.5	15.1	0.07	0.68	NA	99.1	77.2	22.8	77.0	22.6	0.4
KELUT90B-PLG-r3	main	type 3	traverse	core	48.7	31.6	2.4	15.2	0.05	0.62	NA	98.5	77.4	22.6	77.3	22.4	0.3
KELUT90B-PLG-r3	main	type 3	traverse	core	48.6	31.7	2.4	15.5	0.04	0.58	NA	98.8	78.0	22.0	77.7	22.1	0.2
KELUT90B-PLG-r3	main	type 3	traverse	core	48.6	31.8	2.4	15.5	0.03	0.60	NA	98.9	78.3	21.7	78.2	21.6	0.2
KELUT90B-PLG-r3	main	type 3	traverse	core	48.0	32.0	2.4	15.6	0.04	0.61	NA	98.5	78.5	21.6	78.3	21.5	0.2
KELUT90B-PLG-r3	main	type 3	traverse	core	48.4	31.9	2.4	15.7	0.05	0.61	NA	99.1	78.5	21.5	78.3	21.4	0.3

SAMPLE	stage	type	analyses	zone	SiO2	Al2O3	Na2O	CaO	K2O	FeO	MgO	Total	An	Ab	An (Ternary)	Ab (Ternary)	Or (Ternary)
KELUT90B-PLG-r3	main	type 3	traverse	core	48.3	31.7	2.3	15.4	0.05	0.62	NA	98.3	78.6	21.4	78.4	21.3	0.3
KELUT90B-PLG-r3	main	type 3	traverse	core	47.8	31.9	2.3	15.7	0.05	0.65	NA	98.4	78.6	21.4	78.5	21.2	0.3
KELUT90B-PLG-r3	main	type 3	traverse	core	48.3	31.8	2.3	15.5	0.04	0.62	NA	98.6	78.6	21.4	78.5	21.2	0.2
KELUT90B-PLG-r3	main	type 3	traverse	core	47.8	32.0	2.3	15.9	0.04	0.65	NA	98.8	79.1	20.9	78.8	21.0	0.2
KELUT90B-PLG-r3	main	type 3	traverse	core	48.2	31.9	2.2	15.6	0.04	0.60	NA	98.6	79.2	20.8	79.1	20.6	0.2
KELUT90B-PLG-r3	main	type 3	traverse	core	47.8	32.3	2.3	15.7	0.04	0.63	NA	98.7	79.4	20.6	79.1	20.7	0.2
KELUT90B-PLG-r3	main	type 3	traverse	core	48.5	32.2	2.3	16.0	0.04	0.62	NA	99.5	79.8	20.2	79.5	20.2	0.2
KELUT90B-PLG-r3	main	type 3	traverse	core	48.1	32.6	2.3	16.0	0.03	0.62	NA	99.6	79.8	20.2	79.6	20.2	0.2
KELUT90B-PLG-r3	main	type 3	traverse	core	48.2	32.3	2.2	15.8	0.04	0.63	NA	99.1	79.9	20.1	79.8	20.0	0.2
KELUT90B-PLG-r3	main	type 3	traverse	core	48.4	32.3	2.2	15.9	0.04	0.59	NA	99.4	80.0	20.0	79.7	20.1	0.2
KELUT90B-PLG-r3	main	type 3	traverse	core	48.3	32.4	2.2	15.9	0.03	0.64	NA	99.4	80.0	20.0	79.9	20.0	0.2
KELUT90B-PLG-r3	main	type 3	traverse	core	47.8	32.2	2.2	16.0	0.04	0.60	NA	98.8	80.2	19.8	80.0	19.8	0.2
KELUT90B-PLG-r3	main	type 3	traverse	core	47.7	32.3	2.2	15.7	0.04	0.62	NA	98.6	80.2	19.8	79.9	19.9	0.2
KELUT90B-PLG-r3	main	type 3	traverse	core	48.1	32.1	2.2	16.1	0.03	0.60	NA	99.1	80.2	19.8	80.2	19.7	0.2
KELUT90B-PLG-r3	main	type 3	traverse	core	48.1	32.3	2.1	15.9	0.04	0.62	NA	99.0	80.6	19.4	80.5	19.2	0.2
KELUT90B-PLG-r3	main	type 3	traverse	core	48.0	32.6	2.1	16.3	0.03	0.61	NA	99.7	80.9	19.1	80.9	19.0	0.2
KELUT90B-PLG-r3	main	type 3	traverse	core	47.9	32.4	2.1	16.0	0.04	0.62	NA	99.1	81.0	19.0	80.9	18.8	0.2
KELUT90B-PLG-r3	main	type 3	traverse	core	48.0	32.5	2.1	16.1	0.04	0.58	NA	99.2	81.3	18.7	81.0	18.7	0.2
KELUT90B-PLG-r5	main	type 2	traverse	rim	51.8	28.9	4.0	13.6	0.08	0.68	NA	99.0	65.5	34.5	65.1	34.5	0.5
KELUT90B-PLG-r5	main	type 2	traverse	rim	52.4	29.0	3.8	13.3	0.09	0.63	NA	99.2	65.7	34.3	65.3	34.2	0.5
KELUT90B-PLG-r5	main	type 2	traverse	rim	51.6	28.7	3.8	13.3	0.09	0.67	NA	98.2	65.9	34.1	65.5	34.0	0.5
KELUT90B-PLG-r5	main	type 2	traverse	rim	52.1	29.0	3.8	13.4	0.08	0.66	NA	99.0	66.2	33.8	66.0	33.5	0.5
KELUT90B-PLG-r5	main	type 2	traverse	rim	52.1	29.2	3.7	13.3	0.09	0.68	NA	99.1	66.4	33.6	66.0	33.5	0.5
KELUT90B-PLG-r5	main	type 2	traverse	rim	51.8	29.0	3.7	13.4	0.09	0.70	NA	98.8	66.6	33.4	66.3	33.2	0.5
KELUT90B-PLG-r5	main	type 2	traverse	rim	51.9	29.3	3.7	13.5	0.08	0.66	NA	99.2	66.8	33.2	66.5	33.0	0.5

SAMPLE	stage	type	analyses	zone	SiO2	Al2O3	Na2O	CaO	K2O	FeO	MgO	Total	An	Ab	An (Ternary)	Ab (Ternary)	Or (Ternary)
KELUT90B-PLG-r5	main	type 2	traverse	rim	52.4	29.4	3.7	13.5	0.08	0.65	NA	99.8	66.9	33.1	66.5	33.0	0.5
KELUT90B-PLG-r5	main	type 2	traverse	rim	51.8	29.2	3.6	13.4	0.08	0.67	NA	98.7	67.1	32.9	66.9	32.6	0.5
KELUT90B-PLG-r5	main	type 2	traverse	rim	51.3	29.1	3.6	13.4	0.09	0.68	NA	98.2	67.6	32.4	67.2	32.2	0.5
KELUT90B-PLG-r5	main	type 2	traverse	rim	52.1	29.3	3.5	13.3	0.08	0.66	NA	99.0	67.7	32.3	67.4	32.2	0.5
KELUT90B-PLG-r5	main	type 2	traverse	rim	51.8	29.7	3.6	13.6	0.09	0.66	NA	99.4	67.9	32.1	67.5	32.0	0.5
KELUT90B-PLG-r5	main	type 2	traverse	rim	51.5	29.3	3.5	13.6	0.08	0.65	NA	98.6	68.2	31.8	67.9	31.6	0.5
KELUT90B-PLG-r5	main	type 2	traverse	rim	51.8	28.6	3.4	13.4	0.12	0.92	NA	98.2	68.4	31.6	68.0	31.3	0.7
KELUT90B-PLG-r5	main	type 2	traverse	rim	50.6	29.9	3.3	14.1	0.07	0.61	NA	98.7	70.0	30.0	69.7	29.9	0.4
KELUT90B-PLG-r5	main	type 2	traverse	rim	51.0	30.3	3.1	14.3	0.06	0.63	NA	99.4	72.0	28.0	71.7	28.0	0.4
KELUT90B-PLG-r5	main	type 2	traverse	rim	50.6	30.1	3.0	14.5	0.06	0.68	NA	98.9	72.6	27.4	72.4	27.3	0.4
KELUT90B-PLG-r5	main	type 2	traverse	rim	50.2	30.5	3.0	14.7	0.06	0.62	NA	99.1	73.2	26.9	72.9	26.7	0.4
KELUT90B-PLG-r5	main	type 2	traverse	core	48.2	32.0	2.1	16.5	0.04	0.60	NA	99.4	81.3	18.7	81.1	18.6	0.2
KELUT90B-PLG-r5	main	type 2	traverse	core	47.4	32.1	2.1	16.6	0.03	0.60	NA	98.7	81.9	18.2	81.6	18.3	0.2
KELUT90B-PLG-r5	main	type 2	traverse	core	47.7	32.1	1.8	16.5	0.03	0.59	NA	98.6	84.0	16.0	83.7	16.1	0.2
KELUT90B-PLG-r5	main	type 2	traverse	core	47.0	32.4	1.7	17.1	0.04	0.57	NA	98.9	84.4	15.6	84.2	15.5	0.2
KELUT90B-PLG-y2	main	type 3	traverse	rim	53.1	28.0	4.3	12.0	0.09	0.60	NA	98.1	60.5	39.5	60.1	39.4	0.5
KELUT90B-PLG-y2	main	type 3	traverse	rim	52.6	28.2	4.3	12.3	0.10	0.53	NA	98.0	61.4	38.6	60.9	38.5	0.6
KELUT90B-PLG-y2	main	type 3	traverse	rim	53.2	28.1	4.1	12.0	0.10	0.61	NA	98.1	61.6	38.4	61.2	38.1	0.6
KELUT90B-PLG-y2	main	type 3	traverse	rim	52.6	28.5	4.3	12.4	0.09	0.55	NA	98.4	61.7	38.3	61.4	38.1	0.5
KELUT90B-PLG-y2	main	type 3	traverse	rim	52.7	28.5	4.2	12.4	0.10	0.55	NA	98.5	61.8	38.2	61.5	37.9	0.6
KELUT90B-PLG-y2	main	type 3	traverse	rim	52.9	28.3	4.2	12.5	0.09	0.59	NA	98.6	62.3	37.7	61.9	37.6	0.5
KELUT90B-PLG-y2	main	type 3	traverse	rim	52.5	28.6	4.1	12.7	0.10	0.59	NA	98.7	63.1	36.9	62.6	36.8	0.6
KELUT90B-PLG-y2	main	type 3	traverse	rim	52.2	28.4	4.1	12.8	0.10	0.62	NA	98.3	63.1	36.9	62.8	36.6	0.6
KELUT90B-PLG-y2	main	type 3	traverse	rim	54.9	26.4	3.8	11.8	0.27	0.88	NA	98.0	63.4	36.6	62.4	36.0	1.7
KELUT90B-PLG-y2	main	type 3	traverse	rim	52.2	28.6	4.0	12.8	0.09	0.55	NA	98.3	63.8	36.2	63.4	36.1	0.5

SAMPLE	stage	type	analyses	zone	SiO2	Al2O3	Na2O	CaO	K2O	FeO	MgO	Total	An	Ab	An (Ternary)	Ab (Ternary)	Or (Ternary)
KELUT90B-PLG-y2	main	type 3	traverse	rim	52.2	28.8	3.9	12.8	0.09	0.60	NA	98.4	64.4	35.6	64.0	35.4	0.5
KELUT90B-PLG-y2	main	type 3	traverse	rim	51.8	28.8	3.9	13.0	0.09	0.56	NA	98.1	64.8	35.2	64.5	35.0	0.5
KELUT90B-PLG-y2	main	type 3	traverse	rim	51.8	29.1	3.9	13.1	0.09	0.60	NA	98.6	65.2	34.8	64.9	34.5	0.5
KELUT90B-PLG-y2	main	type 3	traverse	rim	52.2	28.9	3.8	12.9	0.09	0.63	NA	98.5	65.3	34.7	65.0	34.5	0.5
KELUT90B-PLG-y2	main	type 3	traverse	core	51.2	29.3	3.6	13.5	0.07	0.55	NA	98.1	67.5	32.6	67.2	32.4	0.4
KELUT90B-PLG-y2	main	type 3	traverse	rim	51.2	29.5	3.5	13.8	0.07	0.57	NA	98.6	68.6	31.4	68.2	31.4	0.4
KELUT90B-PLG-y2	main	type 3	traverse	core	50.9	29.4	3.5	13.8	0.07	0.60	NA	98.2	68.8	31.2	68.5	31.1	0.4
KELUT90B-PLG-y2	main	type 3	traverse	core	51.1	29.7	3.4	13.6	0.07	0.59	NA	98.4	68.9	31.1	68.8	30.8	0.4
KELUT90B-PLG-y2	main	type 3	traverse	core	50.8	29.7	3.3	13.8	0.06	0.57	NA	98.2	69.5	30.5	69.2	30.4	0.4
KELUT90B-PLG-y2	main	type 3	traverse	core	50.7	29.7	3.3	13.7	0.08	0.62	NA	98.2	69.6	30.4	69.3	30.2	0.5
KELUT90B-PLG-y2	main	type 3	traverse	core	50.8	29.7	3.4	13.9	0.07	0.58	NA	98.4	69.7	30.3	69.3	30.3	0.4
KELUT90B-PLG-y2	main	type 3	traverse	core	50.6	29.6	3.3	13.9	0.07	0.63	NA	98.1	69.8	30.2	69.5	30.1	0.4
KELUT90B-PLG-y2	main	type 3	traverse	core	50.6	29.7	3.3	14.0	0.07	0.62	NA	98.2	70.3	29.7	69.9	29.7	0.4
KELUT90B-PLG-y2	main	type 3	traverse	core	46.3	32.6	1.4	17.2	0.03	0.58	NA	98.1	86.9	13.1	86.7	13.2	0.2
KELUT90B-PLG-y2	main	type 3	traverse	core	46.4	32.7	1.3	17.3	0.02	0.57	NA	98.3	87.9	12.1	87.9	12.0	0.1
KELUT90B-PLG-y4	main	type 3	traverse	rim	53.2	28.1	4.4	12.0	0.11	0.70	NA	98.5	60.1	39.9	59.8	39.6	0.7
KELUT90B-PLG-y4	main	type 3	traverse	rim	53.0	28.1	4.2	12.2	0.11	0.67	NA	98.4	61.6	38.4	61.1	38.3	0.7
KELUT90B-PLG-y4	main	type 3	traverse	rim	54.8	27.5	3.9	12.0	0.17	0.76	NA	99.2	63.1	36.9	62.5	36.4	1.1
KELUT90B-PLG-y4	main	type 3	traverse	rim	52.4	28.6	4.0	12.7	0.09	0.64	NA	98.5	63.7	36.3	63.4	36.1	0.5
KELUT90B-PLG-y4	main	type 3	traverse	rim	52.2	28.7	3.9	12.8	0.10	0.65	NA	98.3	64.5	35.5	64.2	35.2	0.6
KELUT90B-PLG-y4	main	type 3	traverse	rim	51.6	29.1	3.7	13.1	0.09	0.70	NA	98.2	66.3	33.7	65.9	33.6	0.5
KELUT90B-PLG-y4	main	type 3	traverse	rim	51.8	29.3	3.6	13.2	0.07	0.71	NA	98.6	67.0	33.0	66.9	32.7	0.4
KELUT90B-PLG-y4	main	type 3	traverse	rim	51.3	29.2	3.4	13.4	0.08	0.61	NA	98.0	68.5	31.5	68.2	31.3	0.5
KELUT90B-PLG-y4	main	type 3	traverse	rim	50.7	29.7	3.3	13.9	0.06	0.61	NA	98.3	69.7	30.3	69.5	30.1	0.4
KELUT90B-PLG-y4	main	type 3	traverse	core	49.5	30.6	2.7	14.7	0.05	0.58	NA	98.1	75.1	24.9	74.9	24.8	0.3

SAMPLE	stage	type	analyses	zone	SiO2	Al2O3	Na2O	CaO	K2O	FeO	MgO	Total	An	Ab	An (Ternary)	Ab (Ternary)	Or (Ternary)
KELUT90B-PLG-y4	main	type 3	traverse	core	49.2	30.9	2.5	15.1	0.05	0.60	NA	98.4	76.9	23.1	76.5	23.2	0.3
KELUT90B-PLG-y4	main	type 3	traverse	core	48.8	31.0	2.4	15.2	0.05	0.64	NA	98.1	77.8	22.2	77.7	22.0	0.3
KELUT90B-PLG-y4	main	type 3	traverse	core	48.2	31.3	2.1	15.9	0.04	0.60	NA	98.1	80.7	19.3	80.5	19.2	0.2
KELUT90B-PLG-y5	main	type 1	traverse	rim	53.9	28.3	4.1	12.3	0.13	0.71	NA	99.5	62.3	37.7	61.8	37.5	0.8
KELUT90B-PLG-y5	main	type 1	traverse	rim	51.2	29.4	3.5	13.4	0.08	0.61	NA	98.1	67.7	32.3	67.3	32.2	0.5
KELUT90B-PLG-y5	main	type 1	traverse	rim	50.4	29.8	3.2	14.1	0.07	0.61	NA	98.1	70.7	29.3	70.4	29.2	0.4
KELUT90B-PLG-y5	main	type 1	traverse	rim	50.3	29.9	3.1	14.3	0.07	0.59	NA	98.2	72.0	28.0	71.7	27.9	0.4
KELUT90B-PLG-y5	main	type 1	traverse	rim	49.0	30.7	2.8	15.1	0.06	0.61	NA	98.2	75.1	24.9	74.8	24.8	0.4
KELUT90B-PLG-y5	main	type 1	traverse	core	45.7	33.0	1.1	17.6	0.02	0.63	NA	98.1	89.6	10.4	89.6	10.3	0.1
KELUT90B-PLG-b4	main	type 1	traverse	rim	52.8	28.5	4.0	12.3	0.10	0.56	NA	98.3	63.0	37.0	62.6	36.8	0.6
KELUT90B-PLG-b4	main	type 1	traverse	rim	52.0	29.1	3.8	13.0	0.10	0.57	NA	98.5	65.3	34.7	65.1	34.3	0.6
KELUT90B-PLG-b4	main	type 1	traverse	rim	52.3	28.9	3.7	12.8	0.09	0.63	NA	98.4	65.5	34.5	65.1	34.4	0.5
KELUT90B-PLG-b4	main	type 1	traverse	rim	51.7	29.2	3.6	13.1	0.08	0.57	NA	98.2	66.7	33.3	66.3	33.3	0.5
KELUT90B-PLG-b4	main	type 1	traverse	rim	51.5	29.2	3.7	13.2	0.08	0.60	NA	98.3	66.7	33.3	66.2	33.3	0.5
KELUT90B-PLG-b4	main	type 1	traverse	rim	51.5	29.2	3.7	13.3	0.08	0.57	NA	98.2	66.8	33.2	66.4	33.1	0.5
KELUT90B-PLG-b4	main	type 1	traverse	rim	51.8	29.0	3.6	13.2	0.08	0.56	NA	98.2	67.0	33.0	66.6	32.9	0.5
KELUT90B-PLG-b4	main	type 1	traverse	rim	52.9	28.7	3.5	13.0	0.13	0.68	NA	98.9	67.3	32.8	66.8	32.5	0.8
KELUT90B-PLG-b4	main	type 1	traverse	rim	51.7	29.3	3.5	13.2	0.08	0.59	NA	98.3	67.7	32.3	67.4	32.1	0.5
KELUT90B-PLG-b4	main	type 1	traverse	rim	51.1	29.6	3.5	13.6	0.07	0.58	NA	98.5	68.2	31.8	68.0	31.6	0.4
KELUT90B-PLG-b4	main	type 1	traverse	rim	51.2	29.3	3.3	13.5	0.07	0.55	NA	98.0	69.1	30.9	68.8	30.8	0.4
KELUT90B-PLG-b4	main	type 1	traverse	rim	51.1	29.6	3.4	13.6	0.08	0.60	NA	98.4	69.3	30.7	68.8	30.7	0.5
KELUT90B-PLG-b4	main	type 1	traverse	rim	51.3	29.8	3.3	13.6	0.08	0.63	NA	98.5	69.8	30.2	69.4	30.1	0.5
KELUT90B-PLG-b4	main	type 1	traverse	core	49.9	30.1	3.1	14.3	0.06	0.57	NA	98.1	71.5	28.5	71.3	28.4	0.4
KELUT90B-PLG-b4	main	type 1	traverse	core	50.1	30.0	3.0	14.3	0.06	0.63	NA	98.2	72.3	27.7	72.1	27.6	0.4
KELUT90B-PLG-b4	main	type 1	traverse	core	50.0	30.4	2.9	14.5	0.06	0.57	NA	98.4	73.2	26.8	73.1	26.6	0.4

SAMPLE	stage	type	analyses	zone	SiO2	Al2O3	Na2O	CaO	K2O	FeO	MgO	Total	An	Ab	An (Ternary)	Ab (Ternary)	Or (Ternary)
KELUT90B-PLG-b4	main	type 1	traverse	core	50.2	30.3	2.9	14.5	0.06	0.61	NA	98.5	73.4	26.6	73.2	26.4	0.4
KELUT90B-PLG-b4	main	type 1	traverse	core	49.6	30.4	2.9	14.6	0.05	0.63	NA	98.1	73.4	26.6	73.1	26.6	0.3
KELUT90B-PLG-b4	main	type 1	traverse	core	50.0	30.4	2.9	14.4	0.06	0.59	NA	98.3	73.5	26.5	73.2	26.5	0.4
KELUT90B-PLG-b4	main	type 1	traverse	core	49.1	30.9	2.6	14.9	0.05	0.61	NA	98.2	75.9	24.2	75.7	24.0	0.3
PL1-1-plag4	main	type 1	point	rim	48.3	31.6	3.3	14.9	0.05	0.32	0.04	98.5	71.3	28.8	70.9	28.8	0.3
PL1-1-plag4	main	type 1	point	core	48.9	32.1	3.0	15.4	0.05	0.33	0.03	99.9	73.9	26.1	73.7	26.0	0.3
PL1-1-plag4	main	type 1	point	rim	47.4	32.6	2.6	15.8	0.04	0.33	0.03	98.8	76.9	23.1	76.6	23.1	0.2
PL1-1-plag4	main	type 1	point	rim	45.5	34.2	1.4	18.0	0.02	0.31	0.02	99.4	87.6	12.4	87.6	12.3	0.1
PL1-1-plag3	main	type 1	point	rim	50.5	30.0	4.4	13.4	0.07	0.36	0.07	98.7	63.0	37.0	62.7	36.9	0.4
PL1-1-plag3	main	type 1	point	rim	49.8	30.5	4.0	13.7	0.08	0.36	0.08	98.4	65.4	34.6	65.1	34.5	0.5
PL1-1-plag3	main	type 1	point	core	45.4	33.8	1.5	17.3	0.04	0.41	0.05	98.5	86.4	13.6	86.1	13.7	0.2
PL1-1-plag3	main	type 1	point	core	44.3	34.7	1.1	18.6	0.01	0.32	0.03	99.0	90.6	9.4	90.6	9.3	0.1
PL1-1-plag3	main	type 1	point	core	44.2	35.0	1.0	18.5	0.01	0.31	0.04	99.0	90.9	9.2	90.8	9.2	0.1
PL1-1-plag5	main	type 2	point	core	49.5	31.3	3.6	14.6	0.06	0.36	0.04	99.3	69.5	30.6	69.1	30.5	0.3
PL1-1-plag5	main	type 2	point	core	47.0	33.5	2.0	17.1	0.02	0.37	0.03	100.0	82.7	17.3	82.4	17.5	0.1
PL1-1-plag5	main	type 2	point	core	45.9	33.5	1.9	17.1	0.03	0.34	0.02	98.8	83.1	16.9	83.0	16.9	0.2
PL1-1-plag5	main	type 2	point	core	45.6	34.3	1.3	18.1	0.02	0.36	0.06	99.7	88.2	11.8	88.1	11.8	0.1
PL1-1-plag5	main	type 2	point	core	45.6	33.9	1.3	17.8	0.03	0.36	0.05	98.9	88.4	11.6	88.2	11.7	0.2
PL1-1-plag6	main	type 1	point	rim	49.3	31.7	3.3	14.9	0.05	0.32	0.04	99.5	71.4	28.6	71.2	28.5	0.3
PL1-1-plag6	main	type 1	point	rim	48.5	31.7	3.1	15.1	0.05	0.32	0.04	98.7	72.8	27.2	72.7	27.0	0.3
PL1-1-plag6	main	type 1	point	core	47.3	33.3	2.4	16.6	0.03	0.17	0.02	99.7	79.6	20.4	79.4	20.4	0.2
PL1-1-plag6	main	type 1	point	core	46.9	33.4	2.1	16.8	0.04	0.35	0.04	99.6	81.4	18.6	81.3	18.4	0.2
PL1-1-plag6	main	type 1	point	core	45.9	33.5	2.0	17.2	0.02	0.35	0.03	98.8	82.6	17.4	82.6	17.2	0.1
PL1-1-plag6	main	type 1	point	core	46.2	33.6	1.9	17.1	0.03	0.34	0.02	99.1	83.1	16.9	83.0	16.8	0.2
KELUT90B-PLG-b1	main	type 1	traverse	rim	53.7	28.1	4.7	11.9	0.13	0.62	NA	99.1	58.3	41.7	57.9	41.3	0.8

SAMPLE	stage	type	analyses	zone	SiO2	Al2O3	Na2O	CaO	K2O	FeO	MgO	Total	An	Ab	An (Ternary)	Ab (Ternary)	Or (Ternary)
KELUT90B-PLG-b1	main	type 1	traverse	rim	53.5	28.0	4.6	11.8	0.16	0.57	NA	98.6	58.9	41.1	58.3	40.8	0.9
KELUT90B-PLG-b1	main	type 1	traverse	rim	54.3	27.8	4.3	12.0	0.13	0.66	NA	99.3	60.7	39.3	60.2	39.1	0.8
KELUT90B-PLG-b1	main	type 1	traverse	rim	53.6	28.5	4.2	12.2	0.09	0.56	NA	99.2	61.5	38.5	61.1	38.3	0.5
KELUT90B-PLG-b1	main	type 1	traverse	rim	53.2	28.7	4.2	12.3	0.09	0.54	NA	99.1	61.8	38.2	61.5	38.0	0.5
KELUT90B-PLG-b1	main	type 1	traverse	rim	52.9	28.5	4.1	12.2	0.09	0.56	NA	98.4	62.1	37.9	61.8	37.7	0.5
KELUT90B-PLG-b1	main	type 1	traverse	rim	53.9	29.2	4.2	12.5	0.11	0.59	NA	100.6	62.2	37.8	61.8	37.5	0.6
KELUT90B-PLG-b1	main	type 1	traverse	rim	53.1	28.8	4.2	12.5	0.09	0.56	NA	99.2	62.4	37.6	62.1	37.4	0.5
KELUT90B-PLG-b1	main	type 1	traverse	rim	53.4	28.8	4.2	12.6	0.09	0.56	NA	99.6	62.6	37.4	62.1	37.3	0.5
KELUT90B-PLG-b1	main	type 1	traverse	rim	53.4	28.9	4.1	12.6	0.09	0.56	NA	99.6	62.8	37.2	62.4	37.1	0.5
KELUT90B-PLG-b1	main	type 1	traverse	rim	52.5	28.5	4.0	12.4	0.08	0.55	NA	98.0	63.0	37.0	62.7	36.8	0.5
KELUT90B-PLG-b1	main	type 1	traverse	rim	52.7	28.9	4.0	12.6	0.09	0.56	NA	98.8	63.4	36.6	63.1	36.3	0.5
KELUT90B-PLG-b1	main	type 1	traverse	rim	52.8	29.3	4.0	12.7	0.09	0.60	NA	99.6	63.7	36.3	63.5	36.0	0.5
KELUT90B-PLG-b1	main	type 1	traverse	rim	53.1	29.0	4.1	12.8	0.09	0.63	NA	99.8	63.7	36.3	63.3	36.2	0.5
KELUT90B-PLG-b1	main	type 1	traverse	rim	53.1	29.0	4.0	12.9	0.08	0.59	NA	99.8	64.1	35.9	63.8	35.7	0.5
KELUT90B-PLG-b1	main	type 1	traverse	rim	52.6	29.2	4.0	13.0	0.09	0.56	NA	99.4	64.2	35.8	64.0	35.5	0.5
KELUT90B-PLG-b1	main	type 1	traverse	rim	52.8	29.2	3.9	12.7	0.09	0.59	NA	99.2	64.4	35.6	64.1	35.3	0.5
KELUT90B-PLG-b1	main	type 1	traverse	rim	52.5	29.0	3.9	12.7	0.09	0.58	NA	98.7	64.4	35.6	64.0	35.5	0.5
KELUT90B-PLG-b1	main	type 1	traverse	rim	53.0	29.4	3.9	12.8	0.10	0.56	NA	99.7	64.7	35.3	64.3	35.1	0.6
KELUT90B-PLG-b1	main	type 1	traverse	rim	52.0	28.9	3.8	12.9	0.09	0.56	NA	98.2	65.2	34.8	64.9	34.6	0.5
KELUT90B-PLG-b1	main	type 1	traverse	rim	52.1	29.2	3.8	13.1	0.09	0.56	NA	98.9	65.5	34.5	65.2	34.3	0.5
KELUT90B-PLG-b1	main	type 1	traverse	rim	52.5	29.4	3.8	13.0	0.09	0.57	NA	99.4	65.6	34.4	65.3	34.2	0.5
KELUT90B-PLG-b1	main	type 1	traverse	rim	52.1	28.9	3.7	12.9	0.09	0.55	NA	98.3	65.6	34.4	65.2	34.3	0.5
KELUT90B-PLG-b1	main	type 1	traverse	rim	52.0	29.3	3.8	13.1	0.09	0.57	NA	98.7	65.9	34.1	65.4	34.0	0.5
KELUT90B-PLG-b1	main	type 1	traverse	rim	52.6	29.2	3.7	13.1	0.11	0.62	NA	99.3	66.0	34.0	65.5	33.8	0.7
KELUT90B-PLG-b1	main	type 1	traverse	rim	51.8	29.3	3.7	13.3	0.08	0.60	NA	98.7	66.4	33.6	66.3	33.3	0.5

SAMPLE	stage	type	analyses	zone	SiO2	Al2O3	Na2O	CaO	K2O	FeO	MgO	Total	An	Ab	An (Ternary)	Ab (Ternary)	Or (Ternary)
KELUT90B-PLG-b1	main	type 1	traverse	rim	52.2	29.4	3.7	13.4	0.08	0.59	NA	99.4	66.7	33.3	66.4	33.2	0.5
KELUT90B-PLG-b1	main	type 1	traverse	rim	51.4	29.4	3.6	13.2	0.08	0.53	NA	98.1	66.9	33.1	66.6	32.9	0.5
KELUT90B-PLG-b1	main	type 1	traverse	rim	51.8	29.4	3.6	13.2	0.08	0.58	NA	98.6	67.0	33.0	66.7	32.8	0.5
KELUT90B-PLG-b1	main	type 1	traverse	rim	51.7	29.3	3.6	13.3	0.08	0.58	NA	98.6	67.2	32.8	66.8	32.8	0.5
KELUT90B-PLG-b1	main	type 1	traverse	rim	51.8	29.6	3.6	13.4	0.07	0.53	NA	98.8	67.5	32.5	67.2	32.4	0.4
KELUT90B-PLG-b1	main	type 1	traverse	rim	51.5	29.4	3.6	13.2	0.07	0.56	NA	98.4	67.5	32.5	67.0	32.5	0.4
KELUT90B-PLG-b1	main	type 1	traverse	rim	51.6	29.3	3.6	13.3	0.08	0.57	NA	98.5	67.6	32.4	67.2	32.4	0.5
KELUT90B-PLG-b1	main	type 1	traverse	rim	50.7	29.8	3.5	13.7	0.09	0.59	NA	98.4	68.2	31.8	67.9	31.5	0.5
KELUT90B-PLG-b1	main	type 1	traverse	rim	51.4	29.7	3.5	13.6	0.07	0.61	NA	98.8	68.4	31.6	67.9	31.6	0.4
KELUT90B-PLG-b1	main	type 1	traverse	rim	51.2	29.5	3.4	13.5	0.08	0.58	NA	98.3	68.4	31.6	68.1	31.4	0.5
KELUT90B-PLG-b1	main	type 1	traverse	rim	51.8	29.5	3.5	13.7	0.08	0.59	NA	99.0	68.5	31.5	68.2	31.4	0.5
KELUT90B-PLG-b1	main	type 1	traverse	rim	51.4	30.1	3.5	13.7	0.07	0.58	NA	99.3	68.5	31.5	68.3	31.3	0.4
KELUT90B-PLG-b1	main	type 1	traverse	rim	51.5	30.0	3.4	13.6	0.07	0.56	NA	99.1	68.8	31.2	68.4	31.1	0.4
KELUT90B-PLG-b1	main	type 1	traverse	rim	51.0	29.9	3.4	13.6	0.07	0.54	NA	98.5	68.8	31.2	68.4	31.2	0.4
KELUT90B-PLG-b1	main	type 1	traverse	rim	51.3	29.8	3.4	13.7	0.07	0.59	NA	98.8	68.9	31.1	68.7	30.9	0.4
KELUT90B-PLG-b1	main	type 1	traverse	rim	51.0	30.1	3.4	13.7	0.08	0.56	NA	98.8	69.3	30.7	68.9	30.6	0.5
KELUT90B-PLG-b1	main	type 1	traverse	rim	51.3	29.8	3.3	13.7	0.07	0.55	NA	98.8	69.5	30.5	69.3	30.3	0.4
KELUT90B-PLG-b1	main	type 1	traverse	rim	51.1	30.1	3.3	13.8	0.07	0.57	NA	99.0	69.7	30.3	69.4	30.2	0.4
KELUT90B-PLG-b1	main	type 1	traverse	rim	51.6	30.1	3.3	13.9	0.08	0.54	NA	99.6	69.9	30.1	69.4	30.1	0.5
KELUT90B-PLG-b1	main	type 1	traverse	rim	50.8	29.6	3.3	13.9	0.08	0.60	NA	98.2	70.1	29.9	69.9	29.7	0.5
KELUT90B-PLG-b1	main	type 1	traverse	rim	51.0	30.1	3.3	14.2	0.07	0.56	NA	99.2	70.4	29.6	70.1	29.5	0.4
KELUT90B-PLG-b1	main	type 1	traverse	rim	50.5	29.9	3.1	13.9	0.07	0.57	NA	98.1	71.5	28.5	71.1	28.5	0.4
KELUT90B-PLG-b1	main	type 1	traverse	rim	50.3	30.7	3.1	14.4	0.06	0.60	NA	99.2	71.7	28.3	71.6	28.1	0.4
KELUT90B-PLG-b1	main	type 1	traverse	rim	51.4	30.3	3.1	14.3	0.07	0.58	NA	99.8	71.9	28.1	71.5	28.1	0.4
KELUT90B-PLG-b1	main	type 1	traverse	rim	50.2	30.2	3.0	14.1	0.06	0.57	NA	98.2	71.9	28.1	71.7	27.9	0.4

SAMPLE	stage	type	analyses	zone	SiO2	Al2O3	Na2O	CaO	K2O	FeO	MgO	Total	An	Ab	An (Ternary)	Ab (Ternary)	Or (Ternary)
KELUT90B-PLG-b1	main	type 1	traverse	rim	50.9	30.3	3.0	14.2	0.06	0.56	NA	99.0	72.2	27.8	72.0	27.6	0.4
KELUT90B-PLG-b1	main	type 1	traverse	rim	50.7	30.3	3.0	14.2	0.06	0.59	NA	98.8	72.2	27.8	72.0	27.7	0.4
KELUT90B-PLG-b1	main	type 1	traverse	rim	50.5	30.5	3.1	14.5	0.06	0.54	NA	99.2	72.3	27.7	72.2	27.5	0.4
KELUT90B-PLG-b1	main	type 1	traverse	rim	50.2	30.6	3.0	14.5	0.06	0.63	NA	98.9	72.4	27.6	72.2	27.4	0.4
KELUT90B-PLG-b1	main	type 1	traverse	rim	50.4	29.8	3.0	14.0	0.12	0.67	NA	98.0	72.4	27.6	71.8	27.5	0.7
KELUT90B-PLG-b1	main	type 1	traverse	rim	50.3	30.0	3.0	14.4	0.06	0.57	NA	98.3	72.6	27.4	72.5	27.2	0.4
KELUT90B-PLG-b1	main	type 1	traverse	rim	49.8	30.5	3.0	14.6	0.06	0.60	NA	98.4	73.1	26.9	72.8	26.9	0.4
KELUT90B-PLG-b1	main	type 1	traverse	rim	50.3	30.4	2.9	14.3	0.07	0.57	NA	98.5	73.1	26.9	72.8	26.8	0.4
KELUT90B-PLG-b1	main	type 1	traverse	rim	50.4	30.5	2.9	14.5	0.06	0.60	NA	99.0	73.1	26.9	72.9	26.7	0.4
KELUT90B-PLG-b1	main	type 1	traverse	rim	49.7	30.4	2.9	14.5	0.05	0.57	NA	98.1	73.3	26.7	73.0	26.7	0.3
KELUT90B-PLG-b1	main	type 1	traverse	rim	50.4	30.5	2.9	14.6	0.05	0.60	NA	99.0	73.5	26.5	73.3	26.4	0.3
KELUT90B-PLG-b1	main	type 1	traverse	rim	50.2	30.0	2.8	14.4	0.08	0.64	NA	98.1	73.9	26.1	73.5	26.1	0.5
KELUT90B-PLG-b1	main	type 1	traverse	rim	49.6	30.7	2.8	14.7	0.06	0.58	NA	98.3	74.5	25.5	74.3	25.4	0.4
KELUT90B-PLG-b1	main	type 1	traverse	core	49.1	30.8	2.6	15.0	0.04	0.59	NA	98.1	76.5	23.5	76.3	23.5	0.2
KELUT90B-PLG-b1	main	type 1	traverse	core	48.8	30.8	2.5	15.5	0.05	0.54	NA	98.2	77.1	22.9	77.0	22.7	0.3
KELUT90B-PLG-b1	main	type 1	traverse	core	49.0	30.9	2.4	15.4	0.04	0.56	NA	98.3	77.7	22.3	77.6	22.2	0.2
KELUT90B-PLG-b1	main	type 1	traverse	core	48.7	31.1	2.4	15.4	0.04	0.60	NA	98.2	77.7	22.3	77.5	22.3	0.2
KELUT90B-PLG-b1	main	type 1	traverse	core	48.7	31.1	2.4	15.3	0.05	0.57	NA	98.1	77.9	22.1	77.6	22.1	0.3
KELUT90B-PLG-b1	main	type 1	traverse	core	48.4	31.3	2.4	15.5	0.04	0.58	NA	98.2	78.2	21.8	78.1	21.7	0.2
KELUT90B-PLG-b1	main	type 1	traverse	core	48.3	31.4	2.3	15.5	0.04	0.59	NA	98.1	78.9	21.1	78.7	21.1	0.2
KELUT90B-PLG-b1	main	type 1	traverse	core	48.6	31.4	2.2	15.4	0.05	0.54	NA	98.2	79.0	21.0	78.9	20.8	0.3
KELUT90B-PLG-b1	main	type 1	traverse	core	48.7	31.5	2.2	15.6	0.04	0.59	NA	98.6	79.8	20.2	79.6	20.1	0.2
KELUT90B-PLG-b1	main	type 1	traverse	core	48.2	31.5	2.2	15.6	0.04	0.54	NA	98.0	80.1	19.9	79.9	19.9	0.2
KELUT90B-PLG-b1	main	type 1	traverse	core	47.9	31.6	2.1	15.9	0.03	0.58	NA	98.1	80.5	19.5	80.4	19.4	0.2
KELUT90B-PLG-b1	main	type 1	traverse	core	47.7	31.8	2.1	15.9	0.04	0.56	NA	98.1	81.0	19.0	80.7	19.0	0.2

SAMPLE	stage	type	analyses	zone	SiO2	Al2O3	Na2O	CaO	K2O	FeO	MgO	Total	An	Ab	An (Ternary)	Ab (Ternary)	Or (Ternary)
KELUT90B-PLG-b1	main	type 1	traverse	core	48.0	31.8	2.0	16.2	0.03	0.56	NA	98.5	81.5	18.5	81.4	18.4	0.2
KELUT90B-PLG-b1	main	type 1	traverse	core	47.8	31.8	2.0	16.1	0.03	0.58	NA	98.3	81.7	18.3	81.4	18.4	0.2
KELUT90B-PLG-b1	main	type 1	traverse	core	47.4	31.8	2.0	16.3	0.03	0.59	NA	98.1	82.2	17.8	82.0	17.8	0.2
KELUT90B-PLG-b1	main	type 1	traverse	core	47.7	31.9	1.9	16.2	0.04	0.60	NA	98.4	82.3	17.7	82.0	17.7	0.2
KELUT90B-PLG-b1	main	type 1	traverse	core	47.5	32.1	1.9	16.3	0.03	0.60	NA	98.5	82.4	17.6	82.3	17.5	0.2
KELUT90B-PLG-b1	main	type 1	traverse	core	47.7	32.0	1.9	16.4	0.03	0.61	NA	98.6	82.5	17.5	82.4	17.4	0.2
77PL1-1-plag7	main	type 3	point	rim	51.0	29.8	4.3	13.2	0.11	0.33	0.05	98.7	63.1	36.9	62.6	36.7	0.6
77PL1-1-plag7	main	type 3	point	rim	49.8	30.9	3.8	14.2	0.07	0.32	0.04	99.1	67.1	32.9	66.8	32.8	0.4
77PL1-1-plag7	main	type 3	point	core	50.3	31.3	3.3	14.9	0.05	0.29	0.04	100.1	71.8	28.2	71.5	28.2	0.3
77PL1-1-plag7	main	type 3	point	core	47.6	32.5	2.7	16.0	0.05	0.32	0.03	99.0	76.8	23.2	76.5	23.2	0.3
77PL1-1-plag7	main	type 3	point	core	45.8	33.2	2.1	16.8	0.04	0.30	0.03	98.3	81.4	18.7	81.2	18.6	0.2
77PL1-1-plag7	main	type 3	point	core	45.3	33.8	1.7	17.5	0.02	0.29	0.02	98.5	85.1	14.9	85.0	14.9	0.1
PL2-2-plag1	late	type 2	point	rim	51.3	29.5	4.6	12.6	0.11	0.27	0.05	98.3	60.3	39.7	59.9	39.5	0.6
PL2-2-plag1	late	type 2	point	core	51.1	30.0	4.7	12.9	0.09	0.32	0.04	99.0	60.4	39.6	60.1	39.4	0.5
PL2-2-plag1	late	type 2	point	core	49.9	30.8	4.1	13.7	0.08	0.31	0.03	98.8	65.1	34.9	64.8	34.8	0.5
PL2-2-plag1	late	type 2	point	core	47.9	31.6	3.4	15.0	0.07	0.32	0.04	98.3	71.1	28.9	70.8	28.8	0.4
PL2-2-plag1	late	type 2	point	core	48.0	32.7	2.6	15.9	0.04	0.33	0.03	99.5	77.4	22.6	77.3	22.5	0.2
PL2-2-plag1	late	type 2	point	rim	56.8	25.8	7.3	8.2	0.30	0.28	0.02	98.7	38.1	61.9	37.5	60.9	1.6
PL2-2-plag1	late	type 2	point	rim	55.1	26.4	6.4	9.6	0.24	0.41	0.1	98.1	45.3	54.7	44.7	54.0	1.3
PL2-2-plag2	late	type 1	point	rim	51.9	28.9	5.4	11.6	0.14	0.26	0.02	98.2	54.4	45.6	54.0	45.3	0.8
PL2-2-plag2	late	type 1	point	core	47.7	32.4	2.5	16.1	0.04	0.31	0.02	99.1	78.1	21.9	77.8	21.9	0.2
PL2-2-plag2	late	type 1	point	core	45.0	33.8	1.6	17.5	0.02	0.29	0.01	98.2	85.8	14.2	85.7	14.2	0.1
PL2-2-plag2	late	type 1	point	core	43.7	34.3	1.1	18.0	0.02	0.24	0	97.5	89.9	10.1	89.7	10.2	0.1
PL2-2-plag2	late	type 1	point	core	44.3	34.9	1.1	18.5	0.01	0.23	0.02	99.0	90.2	9.8	90.1	9.9	0.1
PL2-2-plag3	late	type 3	point	core	51.2	30.4	4.4	13.4	0.09	0.30	0.04	99.8	62.6	37.4	62.3	37.2	0.5

SAMPLE	stage	type	analyses	zone	SiO2	Al2O3	Na2O	CaO	K2O	FeO	MgO	Total	An	Ab	An (Ternary)	Ab (Ternary)	Or (Ternary)
PL2-2-plag3	late	type 3	point	core	48.6	31.6	3.6	14.6	0.06	0.31	0.03	98.8	69.2	30.8	68.9	30.8	0.3
PL2-2-plag3	late	type 3	point	rim	56.7	26.3	7.1	8.7	0.26	0.25	0.03	99.2	40.3	59.7	39.7	58.9	1.4
PL2-2-plag3	late	type 3	point	rim	56.4	26.6	7.0	8.8	0.25	0.24	0.02	99.2	41.1	58.9	40.5	58.1	1.4
PL2-2-plag4	late	type 1	point	core	49.4	30.8	4.1	13.7	0.07	0.32	0.04	98.4	65.0	35.0	64.7	34.9	0.4
PL2-2-plag4	late	type 1	point	core	48.0	32.2	2.9	15.4	0.06	0.29	0.02	98.9	74.9	25.1	74.6	25.1	0.3
PL2-2-plag4	late	type 1	point	core	46.9	33.1	2.3	16.5	0.04	0.28	0.02	99.0	80.1	19.9	79.9	19.8	0.2
PL2-2-plag4	late	type 1	point	core	46.0	33.6	2.0	17.0	0.05	0.28	0.01	98.9	82.5	17.5	82.2	17.5	0.3
PL2-2-plag4	late	type 1	point	rim	55.6	25.8	7.5	8.3	0.29	0.29	0.03	97.8	37.9	62.1	37.3	61.1	1.6
PL2-2-plag4	late	type 1	point	rim	55.6	26.3	7.2	8.7	0.26	0.28	0.02	98.3	40.1	59.9	39.6	59.0	1.4
PL2-2-plag5	late	type 3	point	rim	56.3	26.6	7.2	8.8	0.27	0.31	0.03	99.5	40.3	59.7	39.8	58.8	1.5
PL2-2-plag5	late	type 3	point	rim	51.9	29.7	5.0	12.4	0.11	0.34	0.04	99.4	58.1	41.9	57.8	41.6	0.6
PL2-2-plag5	late	type 3	point	rim	51.0	29.6	4.9	12.4	0.13	0.31	0.02	98.3	58.2	41.8	57.7	41.5	0.7
PL2-2-plag5	late	type 3	point	core	48.9	31.3	3.7	14.5	0.06	0.32	0.04	98.8	68.4	31.7	68.1	31.6	0.3
PL2-2-plag5	late	type 3	point	core	49.3	31.5	3.5	14.4	0.08	0.32	0.03	99.1	69.4	30.6	69.1	30.5	0.5
PL2-2-plag5	late	type 3	point	core	48.9	32.1	3.2	15.0	0.05	0.31	0.04	99.6	72.1	27.9	71.8	27.9	0.3
PL2-2-plag5	late	type 3	point	core	47.0	32.9	2.6	16.1	0.04	0.31	0.04	98.9	77.7	22.3	77.6	22.2	0.2
PL2-plag1	late	microlite	point	core	51.7	30.4	4.0	13.0	0.07	0.50	0.05	99.7	64.7	35.3	63.7	35.8	0.4
PL2-plag2-core	late	microlite	point	core	50.0	31.4	3.3	15.0	0.04	0.60	0.06	100.3	71.2	28.8	71.5	28.3	0.2
PL2-plag2-rim	late	microlite	point	rim	61.2	24.5	7.9	6.0	0.39	0.40	0.03	100.4	30.9	69.1	28.9	68.9	2.2
PL2-plag-encl1	late	enclave	point	core	58.2	25.6	7.1	8.0	0.31	0.50	0	99.8	38.2	61.8	37.6	60.7	1.7
PL2-plag-encl1	late	enclave	point	core	58.2	26.5	7.0	9.0	0.27	0.60	0.03	101.6	40.1	60.0	40.8	57.7	1.5
PL2-plag-encl1	late	enclave	point	core	57.8	26.4	6.9	9.0	0.25	0.60	0.04	101.0	40.6	59.4	41.3	57.4	1.4
PL2-plag-encl1	late	enclave	point	core	57.9	25.9	6.9	9.0	0.27	0.60	0.04	100.5	41.2	58.8	41.4	57.1	1.5
PL2-plag-encl1	late	enclave	point	core	51.6	30.8	4.1	14.0	0.09	0.60	0.03	101.2	64.7	35.3	64.9	34.6	0.5
PL2-plag3	late	microlite	point	core	57.5	26.1	6.8	8.0	0.27	0.50	0.01	99.2	40.8	59.2	38.9	59.5	1.6

SAMPLE	stage	type	analyses	zone	SiO2	Al2O3	Na2O	CaO	K2O	FeO	MgO	Total	An	Ab	An (Ternary)	Ab (Ternary)	Or (Ternary)
PL2-plag3	late	microlite	point	core	45.9	34.1	1.5	18.0	0.03	0.60	0.02	100.1	86.9	13.1	86.9	12.9	0.2
PL2-plag4	late	microlite	point	core	57.4	26.3	6.6	9.0	0.26	0.60	0.03	100.1	42.0	58.0	42.4	56.1	1.5
PL2-plag4	late	microlite	point	core	52.0	30.1	4.5	13.0	0.12	0.60	0.02	100.3	61.4	38.6	61.2	38.1	0.7
PL2-plag5	late	microlite	point	core	52.2	29.9	4.6	13.0	0.10	0.80	0.03	100.6	61.0	39.0	60.6	38.8	0.6
PL1-plag1	main	microlite	point	core	50.4	31.0	3.4	14.0	0.07	0.70	0.07	99.6	69.4	30.6	69.1	30.5	0.4
PL1-plag1	main	microlite	point	core	46.6	33.5	2.0	17.0	0.04	0.60	0.03	99.7	82.4	17.6	82.5	17.3	0.2
PL1-site1-plag2	main	microlite	point	core	51.3	30.4	4.0	13.0	0.07	0.70	0.05	99.4	64.7	35.3	64.1	35.5	0.4
PL1-plag2	main	microlite	point	core	53.1	29.3	4.6	12.0	0.12	0.60	0.07	99.7	59.1	40.9	58.6	40.7	0.7
PL1-plag2	main	microlite	point	core	49.2	31.6	2.9	15.0	0.05	0.60	0.05	99.4	73.9	26.1	73.9	25.8	0.3
PL1-plag3-row1-core	main	microlite	point	core	45.9	34.4	1.5	18.0	0.01	0.60	0.02	100.4	86.5	13.5	86.7	13.2	0.1
PL1-plag3-row2-rim	main	microlite	point	rim	53.3	29.5	4.0	13.0	0.12	0.70	0.09	100.7	63.5	36.5	63.6	35.7	0.7
PL1-plag3-row3	main	microlite	point	core	49.9	31.6	3.2	15.0	0.08	0.60	0.04	100.4	71.5	28.5	71.8	27.7	0.5
PL1-plag3-row4-core	main	microlite	point	core	46.2	34.0	1.5	17.0	0.03	0.60	0.02	99.4	86.3	13.7	85.8	14.0	0.2
PL1-plag3-row5-rim	main	microlite	point	rim	51.3	30.7	3.8	14.0	0.06	0.60	0.07	100.5	66.3	33.7	66.8	32.9	0.3

Table S2.2.4: Major element compositions of whole rocks, glasses, and minerals (Mag).

Pair ID	stage	Min	TiO2	Al2O3	Cr2O3	FeO	Fe2O3	MnO	MgO	SiO2	TOTAL	FeOtotal	Xusp	Xilm
Mag-Ilm-01	late	mag	9.5	1.2	0.0	66.4	17.2	0.6	1.0	0.1	96.0	83.6	0.33	0.22
Mag-Ilm-13	late	mag	9.4	1.2	0.1	65.9	16.9	0.6	1.0	0.1	95.2	82.8	0.33	0.22
Mag-Ilm-17	late	mag	9.3	1.2	0.0	66.6	17.3	0.6	1.0	0.1	96.1	83.9	0.32	0.21
Mag-Ilm-20	late	mag	9.7	1.2	0.0	66.7	17.3	0.6	1.0	0.1	96.6	84.0	0.33	0.22
Mag-Ilm-16	late	mag	9.4	1.1	0.0	66.2	17.2	0.6	1.1	0.2	95.8	83.4	0.33	0.22
Mag-Ilm-21	late	mag	9.4	1.2	0.0	66.9	17.5	0.6	1.0	0.1	96.7	84.4	0.32	0.21
Mag-Ilm-22	late	mag	9.3	1.2	0.0	67.0	17.6	0.6	1.0	0.1	96.9	84.6	0.32	0.21
Mag-Ilm-24	late	mag	9.3	1.3	0.1	65.8	17.1	0.6	1.2	0.1	95.4	82.9	0.32	0.22
Mag-Ilm-23	late	mag	9.2	1.2	0.1	67.0	17.6	0.6	1.0	0.1	96.7	84.6	0.31	0.21
Mag-Ilm-12	late	mag	9.5	1.2	0.1	67.1	17.6	0.6	1.0	0.1	97.2	84.7	0.32	0.22
Mag-Ilm-02	late	mag	9.4	1.2	0.0	67.4	17.9	0.6	1.0	0.1	97.7	85.4	0.32	0.21
Mag-Ilm-25	late	mag	9.8	1.2	0.0	66.5	17.1	0.6	1.0	0.2	96.4	83.6	0.34	0.22
Mag-Ilm-26	late	mag	9.3	1.2	0.0	66.9	17.6	0.6	1.0	0.1	96.8	84.5	0.32	0.21
Mag-Ilm-27	late	mag	9.8	1.2	0.1	65.8	16.7	0.6	1.0	0.1	95.4	82.5	0.34	0.23
Mag-Ilm-29	late	mag	9.4	1.2	0.1	67.5	18.0	0.6	1.0	0.1	97.8	85.5	0.32	0.21
Mag-Ilm-04	late	mag	9.5	1.2	0.0	67.6	18.0	0.6	1.0	0.1	98.1	85.6	0.32	0.21
Mag-Ilm-05	late	mag	9.3	1.2	0.0	67.4	17.9	0.6	1.0	0.1	97.5	85.3	0.32	0.21
Mag-Ilm-31	late	mag	9.6	1.2	0.1	67.2	17.8	0.6	1.0	0.1	97.7	85.0	0.33	0.22
Mag-Ilm-07-18	late	mag	9.8	1.2	0.1	67.6	17.9	0.6	1.0	0.1	98.2	85.5	0.33	0.22
Mag-Ilm-08	late	mag	9.5	1.2	0.1	67.9	18.2	0.6	1.0	0.1	98.6	86.2	0.32	0.21
Mag-Ilm-10	late	mag	9.6	1.2	0.0	67.8	18.1	0.6	1.0	0.1	98.4	85.8	0.32	0.21
Mag-Ilm-19	late	mag	9.4	1.3	0.1	67.4	17.8	0.6	0.9	0.1	97.6	85.2	0.32	0.21
Mag-Ilm-17	late	mag	9.4	1.2	0.0	67.3	17.9	0.6	1.0	0.1	97.6	85.1	0.32	0.21

	Pair ID	stage	Min	TiO2	Al2O3	Cr2O3	FeO	Fe2O3	MnO	MgO	SiO2	TOTAL	FeOtotal	Xusp	Xilm
	Mag-Ilm-03	late	mag	9.4	1.2	0.0	67.9	18.2	0.6	1.0	0.1	98.4	86.1	0.31	0.21
	Mag-Ilm-01	late	mag	9.4	1.2	0.0	68.1	18.3	0.6	1.0	0.1	98.6	86.4	0.31	0.21
	Mag-Ilm-02	late	mag	9.4	1.2	0.0	68.0	18.3	0.6	1.0	0.1	98.7	86.3	0.32	0.21
	Mag-Ilm-23-1	late	mag	9.1	1.2	0.1	69.7	19.6	0.6	1.0	0.1	101.3	89.2	0.30	0.20
	Mag-Ilm-25-1	late	mag	9.2	1.2	0.0	69.0	19.0	0.6	1.0	0.3	100.3	88.0	0.30	0.20
	Mag-Ilm-28-1	late	mag	9.3	2.0	0.1	69.4	19.5	0.6	1.0	0.1	102.0	88.9	0.30	0.20
	Mag-Ilm-28-2	late	mag	9.5	1.2	0.1	70.2	19.8	0.6	1.0	0.1	102.4	90.0	0.31	0.20
	Mag-Ilm-05-1	late	mag	9.2	1.2	0.0	70.1	19.8	0.6	1.0	0.1	102.1	89.9	0.30	0.20
	Mag-Ilm-06-1	late	mag	9.6	1.2	0.1	70.3	20.0	0.6	1.0	0.1	102.9	90.3	0.31	0.21
	Mag-Ilm-10-1	late	mag	9.5	1.2	0.0	70.6	20.1	0.6	1.0	0.1	103.2	90.7	0.31	0.20
	Mag-Ilm-19-1	late	mag	9.4	1.2	0.1	70.7	20.2	0.6	1.0	0.1	103.1	90.8	0.30	0.20
	Mag-Ilm-17-1	late	mag	9.8	1.2	0.0	70.2	19.8	0.6	1.0	0.1	102.7	89.9	0.31	0.21
34	90.23-Mag1	main	mag	8.6	2.9	0.0	66.0	18.8	0.5	2.1	0.1	99.0	84.8	0.29	0.20
35	90.23-Mag3	main	mag	8.5	2.9	0.0	65.9	18.8	0.5	2.1	0.1	98.9	84.7	0.29	0.20
36	90.23-Mag4	main	mag	8.5	2.8	0.1	66.3	18.9	0.5	1.9	0.1	99.3	85.3	0.29	0.19
37	90.23-Mag5	main	mag	8.6	2.8	0.0	66.0	18.9	0.5	2.1	0.1	99.2	84.9	0.30	0.20
38	90.23-Mag6	main	mag	8.6	2.8	0.1	66.0	18.8	0.5	2.1	0.1	98.9	84.8	0.29	0.20
39	90.23-Mag7	main	mag	8.5	2.9	0.1	66.3	18.9	0.5	1.9	0.1	99.3	85.3	0.29	0.19
40	90.23-Mag8	main	mag	8.6	2.9	0.0	66.4	19.1	0.5	2.1	0.1	99.8	85.6	0.29	0.20
41	90.23-glom4-1	main	mag	8.6	2.8	0.1	66.2	19.0	0.5	2.1	0.1	99.3	85.2	0.29	0.20
42	90.23-glom4-2	main	mag	8.6	2.8	0.0	66.2	19.0	0.5	2.1	0.1	99.3	85.2	0.29	0.20
43	90.23-glom4-3	main	mag	8.6	2.8	0.0	66.5	19.2	0.5	2.1	0.1	99.9	85.7	0.29	0.19
44	90.23-glom4-4	main	mag	8.5	2.9	0.1	66.4	19.0	0.5	2.0	0.1	99.5	85.4	0.29	0.19
45	90.23-glom1-Mag1	main	mag	8.5	2.9	0.0	66.5	19.2	0.5	2.1	0.1	99.7	85.7	0.29	0.19
46	90.23-glom1-Mag2	main	mag	8.5	2.9	0.0	66.4	19.2	0.5	2.1	0.1	99.8	85.6	0.29	0.19

	Pair ID	stage	Min	TiO2	Al2O3	Cr2O3	FeO	Fe2O3	MnO	MgO	SiO2	TOTAL	FeOtotal	Xusp	Xilm
47	90.23-glom1-Mag3	main	mag	8.6	2.9	0.0	66.4	19.2	0.5	2.1	0.1	99.8	85.6	0.29	0.19
48	90.23-glom1-Mag4	main	mag	8.6	2.9	0.0	66.3	19.1	0.5	2.1	0.1	99.7	85.5	0.29	0.20
	49 PL1-1-Mag1	main	mag	8.3	3.0	0.0	65.8	19.1	0.5	2.3	0.1	99.2	84.9	0.29	0.19
	50 PL1-1-Mag2	main	mag	8.0	3.4	0.0	65.6	19.2	0.5	2.4	0.1	99.2	84.8	0.28	0.18
	51 PL1-1-Mag3	main	mag	8.2	3.0	0.1	65.8	19.1	0.5	2.3	0.1	99.0	84.9	0.28	0.19
	52 PL1-1-Mag4	main	mag	8.1	3.1	0.0	66.1	19.3	0.5	2.3	0.1	99.5	85.3	0.28	0.19
	53 PL1-1-Mag5	main	mag	8.4	2.9	0.1	66.0	19.1	0.5	2.2	0.1	99.3	85.2	0.29	0.19
	54 PL1-1-glom1	main	mag	8.3	2.9	0.1	66.4	19.4	0.5	2.2	0.1	99.9	85.8	0.28	0.19
	55 PL1-1-glom2	main	mag	8.2	3.1	0.0	66.1	19.3	0.5	2.3	0.1	99.7	85.5	0.28	0.19
	56 PL1-1-glom3	main	mag	8.3	3.1	0.0	66.2	19.4	0.5	2.3	0.1	100.0	85.6	0.28	0.19
	57 PL1-1-incl1	main	mag	8.6	3.0	0.1	66.3	19.1	0.5	2.1	0.1	99.7	85.4	0.29	0.20
	58 PL1-1-incl2	main	mag	8.1	3.4	0.0	65.3	18.9	0.4	2.3	0.1	98.6	84.2	0.28	0.19

Table S2.2.5: Major element compositions of whole rocks, glasses, and minerals (Ilm).

Pair ID	stage	Min	TiO2	Al2O3	Cr2O3	FeO	Fe2O3	MnO	MgO	SiO2	TOTAL	FeOtotal	Xusp	Xilm
Mag-Ilm-01	late	ilm	45.1	0.1	0.0	44.2	5.3	1.0	2.0	0.1	97.8	49.5	1.39	0.93
Mag-Ilm-13	late	ilm	44.6	0.1	0.0	43.8	5.3	0.9	2.1	0.2	97.0	49.1	1.39	0.93
Mag-Ilm-17	late	ilm	43.1	0.4	0.0	43.9	5.7	0.9	1.8	0.1	95.9	49.6	1.36	0.91
Mag-Ilm-20	late	ilm	44.4	0.1	0.0	44.4	5.8	0.9	2.0	0.1	97.8	50.2	1.37	0.91
Mag-Ilm-16	late	ilm	44.3	0.1	0.0	44.4	5.7	1.0	2.0	0.1	97.6	50.1	1.37	0.91
Mag-Ilm-21	late	ilm	43.9	0.3	0.0	44.6	5.7	1.0	1.9	0.4	97.8	50.3	1.36	0.91
Mag-Ilm-22	late	ilm	44.6	0.1	0.0	45.0	6.1	1.0	2.0	0.1	98.8	51.1	1.36	0.91
Mag-Ilm-24	late	ilm	44.8	0.1	0.0	45.2	6.1	1.0	2.0	0.1	99.3	51.3	1.36	0.91
Mag-Ilm-23	late	ilm	37.4	9.3	0.0	39.8	4.5	0.8	1.2	0.2	93.1	44.3	1.34	0.89
Mag-Ilm-12	late	ilm	44.0	0.2	0.0	44.6	5.7	1.0	2.0	0.5	98.0	50.3	1.36	0.91
Mag-Ilm-02	late	ilm	43.1	0.2	0.0	45.2	6.3	1.0	2.0	0.6	98.3	51.5	1.34	0.89
Mag-Ilm-25	late	ilm	44.3	0.1	0.0	44.7	5.9	0.9	2.0	0.2	98.1	50.6	1.36	0.91
Mag-Ilm-26	late	ilm	43.4	1.3	0.0	44.1	6.1	0.9	2.2	0.1	98.1	50.2	1.36	0.91
Mag-Ilm-27	late	ilm	44.5	0.3	0.0	44.6	6.0	1.0	2.1	0.1	98.7	50.6	1.37	0.91
Mag-Ilm-29	late	ilm	44.1	0.3	0.0	45.0	5.7	0.9	2.1	0.9	98.9	50.7	1.36	0.91
Mag-Ilm-04	late	ilm	44.9	0.1	0.0	45.1	6.0	1.0	2.0	0.1	99.1	51.1	1.37	0.91
Mag-Ilm-05	late	ilm	44.4	0.1	0.0	44.8	6.1	0.9	2.1	0.1	98.5	50.9	1.36	0.91
Mag-Ilm-31	late	ilm	44.0	0.1	0.0	44.9	6.1	1.0	2.0	0.3	98.4	51.0	1.36	0.90
Mag-Ilm-07-18	late	ilm	43.6	0.1	0.0	44.7	6.1	0.9	1.9	0.1	97.5	50.8	1.35	0.90
Mag-Ilm-08	late	ilm	44.6	0.2	0.0	45.3	6.1	0.9	2.0	0.4	99.5	51.4	1.36	0.91
Mag-Ilm-10	late	ilm	44.5	0.1	0.0	45.5	6.4	0.9	2.0	0.1	99.5	51.9	1.35	0.90
Mag-Ilm-19	late	ilm	42.2	0.8	0.0	45.3	4.2	0.9	1.8	3.7	99.1	49.5	1.33	0.89
Mag-Ilm-17	late	ilm	44.2	0.2	0.0	45.1	6.1	1.0	2.1	0.5	99.1	51.2	1.36	0.90
Mag-Ilm-03	late	ilm	44.6	0.1	0.0	45.1	6.0	1.0	2.0	0.2	99.0	51.1	1.36	0.91

Pair ID	stage	Min	TiO2	Al2O3	Cr2O3	FeO	Fe2O3	MnO	MgO	SiO2	TOTAL	FeOtotal	Xusp	Xilm
Mag-Ilm-01	late	ilm	43.4	0.4	0.0	45.5	5.6	1.0	1.9	1.6	99.4	51.1	1.34	0.89
Mag-Ilm-02	late	ilm	44.3	0.1	0.0	45.2	6.3	0.9	2.0	0.1	98.9	51.5	1.35	0.90
Mag-Ilm-23-1	late	ilm	43.7	0.1	0.0	46.2	7.1	1.0	2.0	0.1	100.2	53.3	1.32	0.88
Mag-Ilm-25-1	late	ilm	44.0	0.1	0.0	46.1	6.9	0.9	2.0	0.1	100.2	53.0	1.33	0.89
Mag-Ilm-28-1	late	ilm	43.9	0.1	0.0	46.2	7.0	0.9	2.0	0.1	100.4	53.2	1.33	0.89
Mag-Ilm-28-2	late	ilm	44.0	0.1	0.0	46.6	7.3	0.9	2.0	0.1	101.1	53.9	1.32	0.88
Mag-Ilm-05-1	late	ilm	44.0	0.1	0.0	46.7	7.4	1.0	2.0	0.1	101.2	54.1	1.32	0.88
Mag-Ilm-06-1	late	ilm	44.2	0.1	0.0	46.5	7.2	0.9	2.0	0.1	101.0	53.7	1.33	0.88
Mag-Ilm-10-1	late	ilm	44.2	0.1	0.0	47.1	7.5	0.9	2.0	0.1	102.0	54.6	1.32	0.88
Mag-Ilm-19-1	late	ilm	44.7	0.1	0.0	46.9	7.2	0.9	2.1	0.2	102.2	54.1	1.33	0.88
Mag-Ilm-17-1	late	ilm	44.4	0.1	0.0	46.8	7.4	1.0	2.0	0.1	101.8	54.2	1.32	0.88

Table S2.2.6: Major element compositions of whole rocks, glasses, and minerals (Amph)

SAMPLE	Sample	Min	Texture	stage	SiO2	TiO2	Al2O3	Cr2O3	FeO	MnO	MgO	CaO	Na2O	K2O	F	Cl	TotalOx	Mg #
KELUD1990PL1_amph1_5	PL1	amph	rxpheno	main	41.16	1.32	15.44	0.09	11.17	0.14	14.03	12.00	2.35	0.33	0.09	0.01	98.1	76.5
KELUD1990PL1_amph1_5	PL1	amph	rxpheno	main	41.27	1.46	14.65	0.02	11.31	0.15	14.13	11.84	2.23	0.33	0.10	0.00	97.5	75.6
KELUD1990PL1_amph1_5	PL1	amph	rxpheno	main	40.84	1.51	15.07	0.01	11.47	0.15	13.57	12.08	2.22	0.31	0.11	0.02	97.4	78.0
KELUD1990PL1_amph1_6	PL1	amph	rxpheno	main	40.89	1.71	15.40	0.00	11.77	0.15	13.43	12.39	2.13	0.30	0.22	0.01	98.4	78.8
KELUD1990PL1_amph1_6	PL1	amph	rxpheno	main	41.36	1.50	15.60	0.09	11.00	0.14	14.07	11.96	2.36	0.33	0.13	0.01	98.5	76.9
KELUD1990PL1_amph1_4	PL1	amph	rxpheno	main	41.65	1.51	15.12	-0.01	11.52	0.15	13.47	12.16	2.16	0.30	0.11	0.02	98.2	79.7
KELUD1990PL1_amph1_4	PL1	amph	rxpheno	main	41.33	1.38	15.37	0.08	11.02	0.15	14.04	11.99	2.26	0.32	0.04	0.00	98.0	76.9
KELUD1990PL1_amph1_4	PL1	amph	rxpheno	main	41.27	1.45	14.80	0.02	11.50	0.16	13.61	12.12	2.08	0.29	0.06	0.01	97.4	78.1
KELUD1990PL1_amph1_3	PL1	amph	rxpheno	main	41.63	1.44	14.50	0.03	10.96	0.16	14.08	11.89	2.27	0.29	-0.02	0.01	97.2	78.1
KELUD1990PL1_amph1_3	PL1	amph	rxpheno	main	42.10	1.42	14.45	0.05	11.17	0.16	14.20	11.73	2.21	0.27	0.10	0.01	97.9	76.1
KELUD1990PL1_amph1_2	PL1	amph	rxpheno	main	41.25	1.31	15.34	0.06	11.07	0.15	13.85	11.83	2.30	0.32	0.09	0.01	97.6	76.7
KELUD1990PL1_amph1_2	PL1	amph	rxpheno	main	41.48	1.54	15.19	0.08	11.04	0.15	13.94	12.09	2.34	0.30	0.14	0.01	98.3	79.0
KELUD1990PL1_amph1_1	PL1	amph	rxpheno	main	41.53	1.53	15.15	0.00	11.62	0.14	13.48	12.22	2.33	0.29	0.12	0.01	98.4	80.4
KELUD1990PL1_amph1_1	PL1	amph	rxpheno	main	41.29	1.47	15.18	0.03	11.32	0.14	13.67	12.23	2.25	0.33	0.04	0.00	98.0	79.8
KELUD1990PL1_amph1_1	PL1	amph	rxpheno	main	43.20	1.74	12.48	-0.01	11.58	0.20	14.23	11.64	2.24	0.29	0.31	0.02	97.9	79.3
KELUD1990PL1_amph1_8	PL1	amph	rxpheno	main	41.44	1.43	15.09	-0.00	10.93	0.14	13.96	12.15	2.21	0.34	-0.03	0.01	97.7	79.2
KELUD1990PL1_amph1_8	PL1	amph	rxpheno	main	42.09	1.45	14.74	0.01	11.22	0.16	14.07	11.79	2.22	0.31	0.02	0.00	98.1	76.7
KELUD1990PL1_amph1_8	PL1	amph	rxpheno	main	42.59	1.55	14.01	0.02	11.20	0.17	14.35	11.68	2.25	0.29	0.17	-0.00	98.3	76.8
KELUD1990-PL1new-1-amph2	PL1	amph	pheno	main	41.08	1.33	14.99	0.00	11.53	0.15	13.16	12.33	2.23	0.38			97.2	82.8
KELUD1990-PL1new-1-amph2	PL1	amph	pheno	main	41.34	1.34	15.15	0.00	12.39	0.18	12.94	12.25	2.04	0.33			98.0	78.5
KELUD1990-PL1new-1-amph2	PL1	amph	pheno	main	41.15	1.38	15.13	0.00	11.59	0.14	13.31	12.46	2.13	0.34			97.6	81.6
KELUD1990-PL1new-1-amph2	PL1	amph	pheno	main	41.46	1.41	14.92	0.00	11.63	0.15	13.28	12.50	2.29	0.31			98.0	83.8
KELUD1990-PL1new-1-amph2	PL1	amph	pheno	main	41.26	1.30	15.40	0.00	11.58	0.14	13.47	12.52	2.12	0.37			98.1	80.5

Table S2.2.7: Major element compositions of whole rocks and glasses

SAMPLE	year	phase	type	Analyses	SiO2	TiO2	Al2O3	FeO	MnO	MgO	CaO	Na2O	K2O	P2O5	SO3	Cl	Total
KELUD-1951-WP	1951	main	Whole Rock	XRF	54.74	0.65	17.98	9.88	0.21	3.78	9.04	2.87	0.68	0.15	NA	NA	100
KELUD-1951-RP	1951	main	Whole Rock	XRF	54.51	0.67	18.55	9.53	0.2	3.81	9.07	2.87	0.67	0.14	NA	NA	100
KELUD-1951-DP	1951	main	Whole Rock	XRF	54.32	0.64	18.34	9.5	0.21	3.87	9.14	2.85	0.67	0.14	NA	NA	99.7
KELUD-1951-2	1951	main	Whole Rock	XRF	53.85	0.64	17.47	10	0.2	3.81	9	2.88	0.68	0.13	NA	NA	98.7
1966-3B	1966	main	Whole Rock	XRF	54.35	0.66	18.83	9.29	0.2	3.56	8.86	2.87	0.68	0.13	NA	NA	99.4
1966-3A	1966	main	Whole Rock	XRF	55.24	0.63	18.35	9.4	0.2	3.6	8.75	2.91	0.7	0.14	NA	NA	99.9
KELUT-90B	1990	main	Whole Rock	XRF	56.15	0.64	18.42	8.74	0.2	3.65	9.1	2.99	0.7	0.13	NA	NA	100.7
KELUD-1990-PL2	1990	late	Whole Rock	XRF	54.42	0.65	17.88	9.26	0.2	3.81	9.08	2.89	0.67	0.13	NA	NA	99
KELUD-1990-PL1	1990	main	Whole Rock	XRF	54.17	0.69	18.95	9.35	0.2	3.66	9.05	2.9	0.69	0.16	NA	NA	99.8
KELUD-1990-BR	1990	main	Whole Rock	XRF	54.6	0.67	18.36	9.65	0.21	3.81	9.2	2.82	0.67	0.14	NA	NA	100.1
KELUT14-ODV	2007	Dome	Whole Rock	XRF	54.81	0.65	18.15	9.33	0.2	3.66	8.98	2.92	0.69	0.13	NA	NA	99.5
KELUT14-OD1	2007	Dome	Whole Rock	XRF	55.32	0.64	18.46	9.37	0.2	3.63	9.08	2.97	0.69	0.13	NA	NA	100.5
KELUT-2007B	2007	Dome	Whole Rock	XRF	55.53	0.65	18.82	9.25	0.2	3.75	9.14	2.93	0.69	0.13	NA	NA	101.1
KELUT-2007A	2007	Dome	Whole Rock	XRF	55.44	0.62	18.05	9.37	0.2	3.75	9.05	2.9	0.68	0.13	NA	NA	100.2
KELUD-XENO-2	2007	Dome	Whole Rock	XRF	54.04	0.64	18.11	9.71	0.2	3.83	9.15	2.85	0.68	0.14	NA	NA	99.4
KELUT14-PUM2	2014	main	Whole Rock	XRF	55.84	0.66	18.74	9.04	0.2	3.64	9.06	3.01	0.7	0.14	NA	NA	101
KELUT14-PUM1	2014	main	Whole Rock	XRF	56.13	0.63	18.93	8.56	0.19	3.46	8.95	3.05	0.72	0.14	NA	NA	100.8
PL2glass14MI1	1990	late	melt inclusion	EPMA	69.93	0.16	14.31	1.2	0.12	0.21	0.99	4.16	3.35	0.04	0.01	0.07	94.5
PL2glass13MI1	1990	late	melt inclusion	EPMA	75.18	0.16	11.54	1.16	0.04	0.11	0.6	3.64	3.3	NA	NA	0.22	95.9
PL2magilm1MI1	1990	late	melt inclusion	EPMA	76.15	0.26	11.41	2.03	0.07	0.09	0.59	3.42	3.26	NA	NA	0.23	97.5
PL2glass9MI2	1990	late	melt inclusion	EPMA	70.19	0.18	14.52	1.36	0.1	0.3	1.97	4.11	1.94	0.03	0.01	0.15	94.9
90BGlassMI18	1990	main	melt inclusion	EPMA	69.63	0.51	15.61	3.34	0.1	1.36	3.94	4.33	1.44	0.36	0.06	0.19	100.87
90BGlassMI17	1990	main	melt inclusion	EPMA	70.42	0.58	15.7	3.77	0.15	1.55	4.13	4.33	2.05	0.35	0.1	0.21	103.34

SAMPLE	year	phase	type	Analyses	SiO2	TiO2	Al2O3	FeO	MnO	MgO	CaO	Na2O	K2O	P2O5	SO3	Cl	Total
90BGlassMI16	1990	main	melt inclusion	EPMA	72.53	0.53	15.53	4.03	0.14	1.64	4.59	4.44	1.69	0.16	0.05	0.19	105.51
90BGlassMI15	1990	main	melt inclusion	EPMA	69.54	0.49	15.52	2.01	0.09	0.84	3.51	4.37	1.55	0.19	0.05	0.19	98.36
90BGlassMI13	1990	main	melt inclusion	EPMA	68.15	0.46	16.19	2.14	0.12	0.89	3.72	4.44	1.54	0.3	0.06	0.18	98.18
90bGLASS7mi1	1990	main	melt inclusion	EPMA	67.74	0.4	15.42	2.44	0.11	1.01	3.91	4.43	1.48	0.22	0.06	0.18	97.4
PL2glass8MI1	1990	late	melt inclusion	EPMA	74.04	0.27	11.82	1.19	0.04	0.24	0.8	3.62	3.51	0.01	0.01	0.26	95.8
PL2glass3MI1	1990	late	melt inclusion	EPMA	75.37	0.51	11.16	1.33	0.03	0.16	0.59	3.91	2.72	NA	0	0.28	96.1
PL2glass2MI4	1990	late	melt inclusion	EPMA	72.48	0.05	13.5	1.34	0.08	0.19	1.57	4.48	2.03	0.05	NA	0.12	95.9
PL2glass2MI2	1990	late	melt inclusion	EPMA	70.2	0.07	13.34	2.01	0.09	1.02	2.96	4.17	1.71	0.08	NA	0.14	95.8
PL1new-MI8	1990	main	melt inclusion	EPMA	69.69	0.44	15.05	2.25	0.1	0.86	3.38	4.6	1.67	0.18	0.04	0.18	98.44
PL1new-MI4-3	1990	main	melt inclusion	EPMA	70.08	0.43	15.23	2.85	0.13	1.08	3.58	4.55	1.78	0.27	0.06	0.19	100.24
PL1new-MI4-1	1990	main	melt inclusion	EPMA	69.75	0.56	15.12	3.04	0.13	1.14	3.68	4.48	1.65	0.2	0.05	0.19	99.99
PL1new-MI1-5	1990	main	melt inclusion	EPMA	68.29	0.57	14.5	4.54	0.2	1.72	4.31	4.22	1.55	0.17	0.04	0.18	100.29
PL1new-MI1-4	1990	main	melt inclusion	EPMA	67.97	0.58	15.96	2.82	0.13	1.05	3.84	4.64	1.62	0.23	0.11	0.18	99.14
PL1new-MI1-2	1990	main	melt inclusion	EPMA	68.56	0.45	15.81	3.33	0.11	1.28	4.11	4.42	1.94	0.25	0.08	0.19	100.53
90BR2-MI3-2	1990	main	melt inclusion	EPMA	69.64	0.32	15.4	4.26	0.16	1.63	5.12	4.37	1.49	0.17	0.07	0.15	102.79
90BR2-MI3-1	1990	main	melt inclusion	EPMA	67.16	0.42	15.44	4.82	0.19	1.85	5.18	4.19	1.52	0.13	0.05	0.16	101.13
90BR2-MI1b-1	1990	main	melt inclusion	EPMA	63.6	0.55	14.47	4.01	0.18	1.78	4.88	4.44	1.39	0.22	0.05	0.18	95.75
9023glass4MI2	1990	main	melt inclusion	EPMA	70.84	0.21	15.08	0.58	0.08	0.21	2.13	3.81	4.05	0.21	0.04	0.18	97.42
PL1new-MI1-1	1990	main	melt inclusion	EPMA	68.36	0.53	15.27	3.94	0.13	1.48	3.96	4.63	1.79	0.29	0.06	0.19	100.63
90BR2-MI4-1	1990	main	melt inclusion	EPMA	69.19	0.54	14.81	4.63	0.17	1.78	4.5	4.34	1.55	0.16	0.05	0.16	101.87
KELUT14PUM2-MI4-1	2014	main	melt inclusion	EPMA	63.07	0.66	15.33	3.42	0.12	0.75	3.01	4.64	1.54	0.29	0.05	0.17	93.1
KELUT14PUM2-MI3	2014	main	melt inclusion	EPMA	64	0.53	14.71	3.73	0.13	0.96	3.38	4.08	1.61	0.25	0.05	0.15	93.6
KELUT14PUM2-MI2	2014	main	melt inclusion	EPMA	64.27	0.57	14.64	3.69	0.1	0.83	3.02	4.09	1.54	0.26	0.05	0.17	93.2
KELUT14PUM2-MI1-2	2014	main	melt inclusion	EPMA	65.37	0.6	14.25	3.69	0.14	0.93	3.2	3.94	1.51	0.19	0.03	0.18	94
KELUT14PUM2-MI1-1	2014	main	melt inclusion	EPMA	64.15	0.7	14.83	4.06	0.23	0.99	3.69	4.24	1.45	0.22	0.07	0.17	94.8

SAMPLE	year	phase	type	Analyses	SiO2	TiO2	Al2O3	FeO	MnO	MgO	CaO	Na2O	K2O	P2O5	SO3	Cl	Total
PL2glass11gm1	1990	late	groundmass	EPMA	77.76	0.16	11.63	1.07	0.04	0.11	0.64	3.89	3.49	0.04	0	0.22	99.1
90BGlassgm1	1990	main	groundmass	EPMA	67.3	0.66	15.51	4.56	0.16	1.17	3.97	4.37	1.62	0.25	0.04	0.14	99.7
PL2pseudo1gm2	1990	late	groundmass	EPMA	78.01	0.16	11.71	1.01	0.03	0.09	0.6	3.73	3.44	NA	0.03	0.24	99.1
PL2pseudo1gm1	1990	late	groundmass	EPMA	78.9	0.14	11.63	0.98	0.04	0.1	0.63	3.84	3.47	NA	0.02	0.23	100
90Bglass6gm2	1990	main	groundmass	EPMA	66.69	0.53	15.28	4.12	0.12	1.18	3.69	4.14	1.6	0.26	NA	0.09	97.7
90Bglass5gm1	1990	main	groundmass	EPMA	66.4	0.55	15.26	3.91	0.14	1.17	3.71	4.26	1.56	0.22	0.01	0.13	97.3
90Bgm2	1990	main	groundmass	EPMA	66.96	0.49	15.14	3.48	0.11	1.24	4.09	4.65	1.57	0.24	0.04	0.12	98.1
90Bglass3gm1	1990	main	groundmass	EPMA	65.68	0.54	15.04	4.07	0.15	1.18	4.01	4.28	1.52	0.18	0.07	0.11	96.8
90Bglass2gm1	1990	main	groundmass	EPMA	66.86	0.52	15.39	4.27	0.12	1.3	3.97	4.27	1.58	0.21	0.02	0.13	98.7
90Bglass2gm1	1990	main	groundmass	EPMA	67.14	0.47	15.47	4.08	0.15	1.21	3.71	4.32	1.58	0.22	0.02	0.1	98.5
90Bgm2	1990	main	groundmass	EPMA	66.71	0.5	15.51	4.37	0.17	1.29	4.1	4.22	1.54	0.27	0.02	0.13	98.8
90Bgm2	1990	main	groundmass	EPMA	66.82	0.58	15.3	4.13	0.15	1.25	3.96	4.25	1.57	0.24	0.01	0.11	98.4
9023glass4gm1	1990	main	groundmass	EPMA	69.67	0.47	14.73	3.88	0.11	1	3.34	4.58	1.8	0.2	NA	0.1	99.9
9023glass4gm1	1990	main	groundmass	EPMA	69.77	0.47	14.96	3.8	0.13	0.97	3.23	4.67	1.8	0.2	0.03	0.07	100.1
9023glass3gm2	1990	main	groundmass	EPMA	69.07	0.41	15.3	3.35	0.11	0.8	4.22	4.67	1.34	0.18	0.01	0.1	99.6
9023glass2gm1	1990	main	groundmass	EPMA	70.44	0.48	14.79	4.05	0.15	1.01	3.5	4.55	1.46	0.18	NA	0.12	100.7
9023glass2gm1	1990	main	groundmass	EPMA	70.14	0.48	14.6	4.07	0.19	1.04	2.8	4.7	1.78	0.22	NA	0.1	100.1
9023glass1gm1	1990	main	groundmass	EPMA	69.26	0.43	14.86	3.87	0.14	0.89	3.85	4.53	1.43	0.21	NA	0.08	99.6
9023glass1gm1	1990	main	groundmass	EPMA	68.84	0.45	14.67	4	0.15	0.98	3.73	4.6	1.47	0.25	NA	0.11	99.3
PL1new-MI7-glass1	1990	main	groundmass	EPMA	68.14	0.53	15.01	4.24	0.16	1.31	3.85	4.59	1.6	0.19	0	0.13	99.7
PL1new-glass2	1990	main	groundmass	EPMA	67.91	0.65	14.98	4.24	0.16	1.07	3.68	4.4	1.69	0.2	0	0.13	99.1
90BR2-MI3-glass-ig2	1990	main	groundmass	EPMA	67.59	0.55	15.06	4.3	0.16	1.14	4.08	4.72	1.63	0.21	0.01	0.15	99.6
90BR2-MI2-glass-minedge	1990	main	groundmass	EPMA	66.97	0.68	14.9	4.41	0.2	1.07	4.06	4.48	1.63	0.2	0.01	0.15	98.8
90BR2-MI2-glass-ig1	1990	main	groundmass	EPMA	66.51	0.53	14.69	4.23	0.12	1.06	3.68	4.29	1.62	0.17	0.01	0.14	97.1
90Bglass4gm1	1990	main	groundmass	EPMA	66.65	0.55	15.54	4.46	0.16	1.28	4.1	4.14	1.52	0.19	0.02	0.12	98.7

SAMPLE	year	phase	type	Analyses	SiO2	TiO2	Al2O3	FeO	MnO	MgO	CaO	Na2O	K2O	P2O5	SO3	Cl	Total
90Bglass2gm1	1990	main	groundmass	EPMA	65.45	0.38	16.5	3.74	0.12	1.02	4.72	4.18	1.35	0.23	NA	0.1	97.8
KELUT14PUM2-textglom-glass4	2014	main	groundmass	EPMA	66.43	0.51	15.55	4.49	0.1	1.27	4.34	4.58	1.59	0.24	0	0.11	99.2
KELUT14PUM2-MI1-IG3	2014	main	groundmass	EPMA	66.85	0.62	15.25	4.48	0.16	1.39	4.34	4.12	1.57	0.25	0	0.13	99.2
KELUT14PUM2-MI1-IG3	2014	main	groundmass	EPMA	65.91	0.69	15.17	4.69	0.16	1.38	4.42	4.16	1.59	0.24	0	0.13	98.5
KELUT14PUM2-MI1-IG1	2014	main	groundmass	EPMA	66.2	0.65	15.49	4.3	0.22	1.33	4.6	4.32	1.39	0.2	0	0.13	98.8
KELUT14PUM2-MI1-IG1	2014	main	groundmass	EPMA	66.71	0.57	15.03	4.66	0.21	1.42	4.34	4.33	1.63	0.28	0	0.14	99.3
kelud2014A_glass2	2014	main	glass	EPMA	65.75	0.52	14.84	4.13	0.15	1.14	3.67	4.04	1.6	0.18	NA	NA	96
kelud2014A_glass4	2014	main	glass	EPMA	66.65	0.48	15.04	4.09	0.19	1.17	3.79	4.3	1.56	0.22	NA	NA	97.5
kelud2014A_glass6	2014	main	glass	EPMA	66.86	0.45	14.99	4.29	0.16	1.18	3.76	4.39	1.5	0.17	NA	NA	97.7
kelud2014A_glass5	2014	main	glass	EPMA	66.48	0.54	15.03	4.21	0.17	1.19	3.62	4.38	1.54	0.2	NA	NA	97.4
kelud2014A_glass1	2014	main	glass	EPMA	67.63	0.49	14.88	3.95	0.16	1.14	3.85	4.33	1.62	0.2	NA	NA	98.3
kelud2014A_glass9	2014	main	glass	EPMA	65.33	0.5	15.86	4.06	0.15	1.07	3.86	4.61	1.49	0.21	NA	NA	97.1
kelud2014A_glass3	2014	main	glass	EPMA	66.35	0.47	15.07	3.91	0.12	1.14	3.71	4.56	1.59	0.19	NA	NA	97.1
270 G	2014	main	groundmass	EPMA	68.1	0.53	14.64	4.05	0.15	0.77	3.6	3.77	1.62	0.15	0.02	0.17	97.6
276 G	2014	main	groundmass	EPMA	68.07	0.51	14.42	3.8	0.12	0.88	3.5	4	1.64	0.21	0.01	0.13	97.3
272 G	2014	main	groundmass	EPMA	67.06	0.47	14.48	4.42	0.15	1	3.85	4.14	1.57	0.23	0.02	0.15	97.5
267 G	2014	main	groundmass	EPMA	67.96	0.52	14.77	4.16	0.15	1.01	3.91	4.38	1.67	0.14	0.01	0.13	98.8
309 G	2014	main	pumice ash	EPMA	65.56	0.56	15.01	4.77	0.14	1.24	3.96	4.05	1.56	0.21	0.01	0.13	97.2
303 G	2014	main	pumice ash	EPMA	66.82	0.49	15.13	3.66	0.15	1.03	4.15	4.26	1.55	0.19	0.01	0.12	97.6
1579 G	2014	main	pumice ash	EPMA	65.9	0.47	14.08	4.31	0.14	0.83	3.16	4.25	1.66	0.26	0.05	0.2	95.3
307 G	2014	main	pumice ash	EPMA	66.92	0.46	14.45	3.68	0.11	0.81	3.36	4.38	1.73	0.21	0.05	0.14	96.3
311 G	2014	main	pumice ash	EPMA	66.37	0.43	16.59	3.31	0.07	0.47	4.59	4.69	1.45	0.19	0.02	0.13	98.3

Table S3.2 Natural glass and mineral compositions analyzed by EPMA and XRF for Kelud, 1990-2014

Table S3.2.1 Natural glass compositions analyzed by EPMA and XRF for Kelud, 1990-2014

SAMPLE	Year	stage	type	texture	SiO2 (wt. %)	TiO2 (wt. %)	Al2O3 (wt. %)	FeO* (wt. %)	MnO (wt. %)	MgO (wt. %)	CaO (wt. %)	Na2O (wt. %)	K2O (wt. %)	P2O5 (wt. %)	SO3 (wt. %)	Cl (wt. %)	F (wt. %)	Total	TAS (wt. %)	H2O (wt. %)
Kelud2014B	2014	main	glass	cpx-hosted MI	65.9	0.5	14.1	4.3	0.1	0.8	3.2	4.3	1.7	0.3	0.05	0.20	0.02	95.3	5.9	
Kelud2014B-1	2014	main	glass	cpx-hosted MI	64.4	0.4	14.4	3.9	0.1	0.7	3.1	3.9	1.4	0.2	0.06	0.14	0.01	92.7	5.3	
Kelud2014B-2	2014	main	glass	cpx-hosted MI	65.0	0.5	13.9	4.0	0.1	0.8	3.4	3.9	1.4	0.1	0.03	0.15	< 0.01	93.3	5.3	
Kelud2014B-3	2014	main	glass	cpx-hosted MI	66.0	0.5	14.0	3.6	0.1	0.7	3.3	3.8	1.5	0.1	0.05	0.15	0.01	93.8	5.4	
Kelud2014B-glass5	2014	main	glass	groundmass	68.1	0.5	14.4	3.8	0.1	0.9	3.5	4.0	1.6	0.2	0.01	0.13	0.01	97.3	5.6	
KELUT14PUM2-MI1-IG3	2014	main	glass	groundmass	67.4	0.6	15.4	4.5	0.2	1.4	4.4	4.2	1.6	0.3		0.13		100.0	5.7	
KELUT14PUM2-MI1-IG3	2014	main	glass	groundmass	66.9	0.7	15.4	4.8	0.2	1.4	4.5	4.2	1.6	0.3		0.13		100.0	5.8	
KELUT14PUM2-MI1-IG1	2014	main	glass	groundmass	67.0	0.7	15.7	4.4	0.2	1.4	4.7	4.4	1.4	0.2		0.13		100.0	5.8	
KELUT14PUM2-MI1-IG1	2014	main	glass	groundmass	67.2	0.6	15.1	4.7	0.2	1.4	4.4	4.4	1.6	0.3		0.14		100.0	6.0	
KELUT14PUM2-textglom-glas	2014	main	glass	groundmass	67.0	0.5	15.7	4.5	0.1	1.3	4.4	4.6	1.6	0.2		0.11		100.0	6.2	
PL1	1990	main	glass	whole rock	52.2	0.7	18.3	9.0	0.2	3.5	8.7	2.8	0.7	0.2				96.1		3.9
PL2	1990	late	glass	whole rock	52.8	0.6	17.4	9.0	0.2	3.7	8.8	2.8	0.7	0.1				96.1		3.9
07B	2007	dome	glass	whole rock	52.8	0.6	17.9	8.8	0.2	3.6	8.7	2.8	0.7	0.1				96.2		3.8
PUMI2	2014	main	glass	whole rock	53.2	0.6	17.8	8.6	0.2	3.5	8.6	2.9	0.7	0.1				96.2		3.8

Cpx = clinopyroxene; MI = melt inclusion

Table S3.2.2: Natural orthopyroxene compositions analyzed by EPMA for Kelud, 1990-2014

SAMPLE	Year	Phase	Type	SiO2 (wt. %)	TiO2 (wt. %)	Al2O3 (wt. %)	FeO* (wt. %)	MnO (wt. %)	MgO (wt. %)	CaO (wt. %)	Na2O (wt. %)	K2O (wt. %)	P2O5 (wt. %)	Cr2O3 (wt. %)	Total (wt. %)
PL1new-px4small-opx	1990	main	opx	54.0	0.1	0.7	18.7	0.8	25.1	1.4	0.070	0.009			101.0
PL1new-px23-opx	1990	main	opx	54.0	0.2	1.1	18.2	0.8	25.1	1.5	0.043	0.003			101.0
PL1new-px22-opx	1990	main	opx	54.1	0.2	1.1	19.2	0.8	24.2	1.4	< 0.01	0.008			101.1
PL1new-px19-opx	1990	main	opx	54.4	0.2	0.8	18.5	0.8	25.1	1.3	0.018	0.003			101.1
90PL2-px7-opx	1990	late	opx	54.1	0.2	1.1	18.8	0.8	24.6	1.4	0.017	< 0.01			101.1
90PL2-px6-opx	1990	late	opx	54.0	0.2	1.1	19.4	0.8	24.1	1.5	0.020	0.001			101.1
90PL2-px4-opx	1990	late	opx	54.7	0.1	0.6	18.5	0.9	25.0	1.5	0.000	0.002			101.1
90PL2-magilm2-apa1-opx	1990	late	opx	53.9	0.2	0.8	19.0	0.8	25.0	1.4	0.059	0.014			101.2
90PL2-px8-opx	1990	late	opx	55.0	0.1	0.8	16.1	0.6	27.0	1.5	0.017	< 0.01			101.2
90PL2-px1-opx-rim2apa	1990	late	opx	54.3	0.2	0.8	19.0	0.9	24.6	1.3	0.025	0.003			101.2
90PL2-px2-r2apa2r	1990	late	opx	54.4	0.2	0.7	18.4	0.8	25.2	1.4	0.035	0.006			101.2
PL1new-amph	1990	main	opx	55.2	0.1	0.8	15.7	0.6	27.5	1.5	0.020	0.003			101.4
Kelud_OLD(dome)- 327 G	2007	dome	opx	52.8	0.2	0.8	19.2	0.9	23.1	1.4	0.013				98.5
Kelud_OLD(dome)- 329 G	2007	dome	opx	52.5	0.2	1.3	19.0	0.9	23.3	1.5	0.015				98.5
Kelud_OLD(dome)- 330 G	2007	dome	opx	52.8	0.2	0.9	19.3	1.0	23.1	1.2	0.021				98.6
Kelud_OLD(dome)- 335 G	2007	dome	opx	52.6	0.4	1.5	16.8	0.7	24.1	2.4	0.024				98.6
Kelud_OLD(dome)- 337 G	2007	dome	opx	52.4	0.2	1.0	19.6	0.9	23.1	1.4	0.014				98.6
Kelud_OLD(dome)- 338 G	2007	dome	opx	52.8	0.2	0.9	19.2	0.9	23.2	1.5	0.012				98.6
Kelud_OLD(dome)- 339 G	2007	dome	opx	52.5	0.2	1.0	19.5	0.9	23.1	1.5	0.014				98.7
Kelud_OLD(dome)- 341 G	2007	dome	opx	53.2	0.2	1.3	16.5	0.7	24.8	1.9	0.021				98.7
Kelud_OLD(dome)- 347 G	2007	dome	opx	52.9	0.2	1.0	19.2	0.8	23.2	1.5	0.014				98.8
Kelud_OLD(dome)- 349 G	2007	dome	opx	52.6	0.2	1.0	19.7	0.9	22.9	1.4	0.018		0.003	0.015	98.8

SAMPLE	Year	Phase	Type	SiO2 (wt. %)	TiO2 (wt. %)	Al2O3 (wt. %)	FeO* (wt. %)	MnO (wt. %)	MgO (wt. %)	CaO (wt. %)	Na2O (wt. %)	K2O (wt. %)	P2O5 (wt. %)	Cr2O3 (wt. %)	Total (wt. %)
Kelud_OLD(dome)- 350 G	2007	dome	opx	52.5	0.2	1.1	19.9	0.9	22.7	1.5	0.079				98.8
zonedpx-9-9	2007	dome	opx	52.8	0.2	2.4	15.9	0.6	26.9	1.6	0.052	< 0.01			100.5
dome-pxzoned-12-1	2007	dome	opx	54.1	0.2	0.8	18.1	0.7	25.1	1.5	0.012	< 0.01	0.001	< 0.01	100.5
dome-pxzoned-12-2	2007	dome	opx	53.1	0.2	1.7	18.1	0.7	25.2	1.4	0.034	0.004			100.5
dome-pxzoned-12-4	2007	dome	opx	53.4	0.2	1.3	19.4	0.8	24.2	1.2	< 0.01	0.001			100.5
dome-pxzoned2-13-1	2007	dome	opx	53.3	0.2	1.0	19.8	0.8	23.9	1.4	0.065	0.000			100.5
dome-pxzoned2-13-2	2007	dome	opx	52.9	0.2	2.1	16.3	0.6	27.0	1.4	< 0.01	< 0.01			100.6
dome-pxzoned2-13-3	2007	dome	opx	54.2	0.2	1.1	17.4	0.8	25.4	1.4	0.029	< 0.01			100.6
dome-pxzoned2-13-4	2007	dome	opx	54.1	0.1	0.6	18.3	0.8	25.1	1.4	0.042	0.013			100.6
dome-pxzoned2-13-5	2007	dome	opx	54.5	0.1	0.6	17.8	0.8	25.3	1.4	0.021	< 0.01			100.6
dome-pxzoned2-13-6	2007	dome	opx	53.3	0.2	2.1	16.8	0.6	26.2	1.4	0.004	0.016			100.6
dome-pxzoned3-14-1	2007	dome	opx	53.9	0.2	0.7	18.5	1.0	25.4	0.9	0.031	0.006			100.6
dome-pxzoned3-14-2	2007	dome	opx	53.6	0.2	1.0	19.6	1.0	24.1	1.2	0.050	< 0.01			100.6
dome-pxzoned3-14-4	2007	dome	opx	53.8	0.2	0.8	19.0	0.8	24.5	1.4	0.022	< 0.01			100.6
dome-pxzoned3-14-5	2007	dome	opx	53.8	0.1	0.7	19.5	0.9	24.2	1.4	0.005	< 0.01			100.6
dome-pxzoned3-14-6	2007	dome	opx	53.4	0.2	0.9	19.3	0.8	24.7	1.4	0.000	0.006	0.011	0.016	100.7
dome-pxzoned3-14-7	2007	dome	opx	53.7	0.2	0.9	19.2	0.7	24.6	1.3	0.004	< 0.01	< 0.01	< 0.01	100.7
dome-pxzoned3-14-8	2007	dome	opx	53.6	0.2	1.1	18.9	0.8	24.8	1.3	0.046	0.007			100.7
dome-pxzoned3-14-9	2007	dome	opx	53.3	0.1	0.9	19.7	0.9	24.3	1.4	0.030	0.005	0.003	0.012	100.7
dome-pxzoned3-14-10	2007	dome	opx	54.8	0.1	0.9	15.3	0.6	27.4	1.6	< 0.01	0.017			100.7
dome-pxzoned3-14-12	2007	dome	opx	54.8	0.1	0.9	15.4	0.6	27.3	1.6	0.034	0.007			100.8
dome-pxzoned3-14-13	2007	dome	opx	53.5	0.2	0.5	22.7	1.1	21.3	1.4	0.068	0.002			100.8
07B-px5-opx-cpx-pair1	2007	dome	opx	53.6	0.2	2.0	15.7	0.6	27.1	1.5	0.033	0.001			100.8

SAMPLE	Year	Phase	Type	SiO2 (wt. %)	TiO2 (wt. %)	Al2O3 (wt. %)	FeO* (wt. %)	MnO (wt. %)	MgO (wt. %)	CaO (wt. %)	Na2O (wt. %)	K2O (wt. %)	P2O5 (wt. %)	Cr2O3 (wt. %)	Total (wt. %)
07B-px3-px8-cpx-opx-pair	2007	dome	opx	54.0	0.2	1.6	16.7	0.7	26.2	1.5	0.019	< 0.01			100.8
KELUD14B-363 G	2014	main	opx	51.9	0.2	0.8	19.8	1.0	22.9	1.4	0.021				98.0
KELUD14B-364 G	2014	main	opx	52.2	0.3	1.0	19.5	0.9	22.4	1.8	0.035				98.2
KELUD14B-366 G	2014	main	opx	53.2	0.1	0.9	15.6	0.6	25.8	1.9	0.005				98.2
KELUD14B-367 G	2014	main	opx	53.3	0.2	0.9	15.6	0.6	25.7	1.9	0.000				98.2
KELUD14B-369 G	2014	main	opx	53.4	0.1	0.8	16.0	0.7	25.4	1.8	0.007				98.2
KELUD14B-373 G	2014	main	opx	52.4	0.2	1.6	17.4	0.8	23.7	2.2	0.024				98.2
KELUD14A-353 G	2014	main	opx	53.6	0.1	0.7	16.7	0.7	24.7	1.6	0.011				98.2
KELUD14A-356 G	2014	main	opx	52.9	0.2	1.1	19.1	0.9	22.9	1.4	0.008				98.4
KELUD14A-358 G	2014	main	opx	52.9	0.2	0.8	19.3	0.9	22.8	1.5	0.028				98.4
opx-smallbright-3-1	2014	main	opx	52.7	0.2	1.0	19.3	0.9	23.3	1.4	0.012				98.8
opx-smallbright-3-2	2014	main	opx	52.9	0.2	0.7	19.8	1.3	22.9	1.0	0.010				98.8
zoned-px-4-1	2014	main	opx	52.7	0.2	1.0	19.6	0.9	22.9	1.5	0.005				98.8
zoned-px-4-2	2014	main	opx	52.3	0.3	1.7	17.7	0.7	24.5	1.7	0.011				98.9
zoned-px-4-3	2014	main	opx	52.9	0.2	1.1	19.5	0.9	23.0	1.5	0.012				99.0
zoned-px-4-4	2014	main	opx	52.7	0.2	0.9	19.9	0.9	23.0	1.4	0.018				99.0
zoned-px-4-5	2014	main	opx	52.7	0.2	1.0	19.5	0.9	23.2	1.5	0.019				99.0
zoned-px-4-6	2014	main	opx	52.7	0.2	1.1	18.8	0.8	24.2	1.4	0.015	< 0.01	0.024	0.008	99.1
zoned-px-4-7	2014	main	opx	52.6	0.1	0.9	19.2	0.8	24.1	1.4	0.041	0.005	0.004	0.029	99.2
zoned-px-4-8	2014	main	opx	52.9	0.2	0.7	19.4	0.9	23.8	1.3	0.026	0.013	0.002	< 0.01	99.2
zoned-px-4-9	2014	main	opx	52.8	0.2	1.1	20.4	0.9	22.3	1.5	0.018				99.2
cpx-opx-clot-thermome-5-1	2014	main	opx	52.7	0.2	1.3	19.3	0.9	23.4	1.4	0.019				99.2
cpx-opx-clot-thermome-5-2	2014	main	opx	53.2	0.2	0.8	19.4	0.9	23.4	1.5	0.018				99.3

SAMPLE	Year	Phase	Type	SiO2 (wt. %)	TiO2 (wt. %)	Al2O3 (wt. %)	FeO* (wt. %)	MnO (wt. %)	MgO (wt. %)	CaO (wt. %)	Na2O (wt. %)	K2O (wt. %)	P2O5 (wt. %)	Cr2O3 (wt. %)	Total (wt. %)
cpx-opx-clot-thermome-5-3	2014	main	opx	52.9	0.2	1.2	19.5	0.9	23.2	1.4	0.021				99.4
cpx-opx-clot-thermome-5-4	2014	main	opx	53.1	0.2	0.7	18.6	0.8	24.5	1.5	< 0.01	< 0.01	< 0.01	< 0.01	99.4
cpx-opx-clot-thermome-5-5	2014	main	opx	53.3	0.2	1.2	18.0	0.8	24.5	1.4	0.018	0.010			99.5
cpx-opx-clot-thermome-5-6	2014	main	opx	52.7	0.2	2.4	16.9	0.6	25.3	1.5	0.022	< 0.01			99.6
cpx-opx-clot-thermome-5-9	2014	main	opx	52.9	0.2	2.1	15.4	0.6	26.4	1.9	0.042	0.014			99.6
cpx-opx-clot-thermome-5-10	2014	main	opx	52.8	0.2	1.2	19.0	0.8	24.2	1.4	< 0.01	< 0.01	0.017	0.012	99.7
cpx-opx-clot-thermome-5-11	2014	main	opx	53.3	0.2	1.0	19.0	0.8	24.0	1.4	0.010	< 0.01			99.7
cpx-opx-clot-thermome-5-13	2014	main	opx	53.3	0.2	1.0	19.0	0.8	24.2	1.4	0.020	< 0.01	< 0.01	0.002	99.8
opx-inplag-6-1	2014	main	opx	53.4	0.2	1.1	18.4	0.8	24.5	1.4	0.044	< 0.01			99.8
opx-inplag-6-2	2014	main	opx	53.3	0.1	1.0	19.1	0.9	24.1	1.4	0.024	0.001			99.9
zonedopx-7-1	2014	main	opx	52.7	0.2	1.4	19.6	0.8	23.9	1.2	0.026	< 0.01			99.9
zonedopx-7-9	2014	main	opx	53.6	0.2	0.8	19.1	0.8	24.2	1.4	0.006	< 0.01	0.015	< 0.01	100.0
zonedopx-7-10	2014	main	opx	53.2	0.3	2.1	15.8	0.6	26.4	1.7	< 0.01	0.004			100.0
zonedopx-7-11	2014	main	opx	53.2	0.2	0.9	19.2	0.8	24.4	1.4	0.021	< 0.01			100.1
zonedopx-7-12	2014	main	opx	53.7	0.2	0.8	19.0	0.9	24.1	1.4	0.054	0.005			100.1
zonedopx-7-13	2014	main	opx	53.8	0.2	0.7	17.6	0.7	25.7	1.4	0.019	0.009	0.006	< 0.01	100.1
zonedglomeropx-8-2	2014	main	opx	52.9	0.2	1.1	19.5	0.9	24.2	1.3	0.018	0.003	0.002	< 0.01	100.1
zonedglomeropx-8-4	2014	main	opx	53.1	0.2	1.1	19.1	0.9	24.5	1.4	0.049	0.005	0.000	0.017	100.1
zonedglomeropx-8-5	2014	main	opx	53.4	0.1	0.8	19.2	0.9	24.4	1.3	0.011	< 0.01	0.010	< 0.01	100.2
zonedglomeropx-8-6	2014	main	opx	53.8	0.2	0.9	18.4	0.8	24.7	1.4	0.017	0.013			100.2
zonedglomeropx-8-7	2014	main	opx	53.5	0.1	0.7	18.8	0.8	24.9	1.4	0.000	0.000			100.2
zonedglomeropx-8-8	2014	main	opx	54.6	0.3	1.3	16.4	0.7	25.5	1.4	0.044				100.2
zonedglomeropx-8-11	2014	main	opx	53.6	0.2	0.7	20.2	0.9	23.2	1.4	< 0.01	< 0.01			100.3

SAMPLE	Year	Phase	Type	SiO2 (wt. %)	TiO2 (wt. %)	Al2O3 (wt. %)	FeO* (wt. %)	MnO (wt. %)	MgO (wt. %)	CaO (wt. %)	Na2O (wt. %)	K2O (wt. %)	P2O5 (wt. %)	Cr2O3 (wt. %)	Total (wt. %)
zonedglomeropx-8-12	2014	main	opx	53.3	0.1	0.9	19.3	0.8	24.5	1.4	0.037	0.000	< 0.01	< 0.01	100.3
zonedglomeropx-8-13	2014	main	opx	53.4	0.2	1.1	18.9	0.8	24.5	1.4	0.031	0.004	< 0.01	0.001	100.3
zonedpx-9-1	2014	main	opx	54.0	0.1	0.6	17.8	0.9	25.5	1.4	0.011	0.001			100.3
zonedpx-9-2	2014	main	opx	53.8	0.2	0.9	18.9	0.8	24.5	1.2	0.013	< 0.01			100.4
zonedpx-9-3	2014	main	opx	54.3	0.1	0.6	17.6	0.8	25.5	1.4	0.009	< 0.01			100.4
zonedpx-9-4	2014	main	opx	53.4	0.3	1.3	18.3	0.9	24.8	1.4	0.012	0.014			100.4
zonedpx-9-5	2014	main	opx	54.6	0.1	0.9	15.3	0.6	27.3	1.6	< 0.01	< 0.01			100.4
zonedpx-9-6	2014	main	opx	53.6	0.2	1.1	18.7	0.8	24.7	1.3	0.034	0.009	0.000	0.003	100.5
zonedpx-9-7	2014	main	opx	54.1	0.1	0.7	18.5	0.9	24.8	1.4	< 0.01	< 0.01			100.5
zonedpx-9-8	2014	main	opx	54.0	0.2	0.9	18.5	0.8	24.8	1.3	0.026	0.003			100.5
14PUM2-2-px3-cpx-opx	2014	main	opx	53.5	0.1	1.1	19.8	0.9	24.2	1.2	0.037	0.000			100.9
14PUM2-2-px3-cpx-opx	2014	main	opx	53.1	0.2	1.4	19.7	0.9	24.2	1.3	0.009	0.005			100.9
14PUM2-1-px7-cpxhost-opx-adj	2014	main	opx	53.8	0.1	0.6	22.2	1.0	21.9	1.3	0.018	0.007			100.9
14PUM2-2-ol2-opx-cpx- plag_opx_plag	2014	main	opx	54.0	0.1	0.8	18.7	0.9	25.5	0.9	0.044	0.001			100.9
14PUM2-2-ol2-opx-cpx- plag_opx_plag	2014	main	opx	53.6	0.3	1.5	18.7	0.8	24.7	1.5	0.016	< 0.01			101.0
14PUM2-2-ol2-opx-cpx- plag_opx_plag	2014	main	opx	53.9	0.1	0.8	19.3	0.9	24.9	1.1	0.015	0.002	0.015	< 0.01	101.0
14PUM2-2-px4-opx	2014	main	opx	53.8	0.1	0.6	20.6	1.2	23.8	1.0	0.048	< 0.01	0.032	< 0.01	101.2
14PUM2-2-px6	2014	main	opx	54.7	0.1	0.6	18.4	0.8	25.2	1.4	0.022	0.003			101.3
14PUM2-1-px4-cpx	2014	main	opx	55.5	0.1	0.9	15.2	0.6	27.5	1.5	0.034	0.009			101.4
14PUM11-amph-apa5-opx	2014	main	opx	54.9	0.1	0.8	16.0	0.7	27.6	1.4	0.040	< 0.01			101.5

Table S3.2.3: Natural clinopyroxene compositions analyzed by EPMA for Kelud, 1990-2014

SAMPLE	Year	Phase	Type	SiO2 (wt. %)	TiO2 (wt. %)	Al2O3 (wt. %)	FeO* (wt. %)	MnO (wt. %)	MgO (wt. %)	CaO (wt. %)	Na2O (wt. %)	K2O (wt. %)	Cr2O3 (wt. %)	Total (wt. %)
90PL2-px5-cpx	1990	late	cpx	51.37	0.36	1.76	9.55	0.49	14.52	20.81	0.28	0.00	0.01	99.15
PL1new-amph-apa3-cpx	1990	main	cpx	50.48	0.96	2.76	8.34	0.36	14.53	21.52	0.28		0.05	99.27
PL1new-px-plag-cpx	1990	main	cpx	51.91	0.32	1.45	9.67	0.57	14.47	20.69	0.26	0.00	0.00	99.34
90PL2-px7-cpx	1990	late	cpx	51.67	0.36	1.80	9.39	0.48	14.49	20.99	0.27		0.00	99.46
PL1new-px4large-cpx	1990	main	cpx	51.91	0.33	1.45	9.40	0.54	14.42	21.21	0.28	0.00	0.00	99.55
90PL2-px7-cpx	1990	late	cpx	51.91	0.33	1.45	9.40	0.54	14.42	21.21	0.28	0.00	0.00	99.55
90PL2-magilm2-apa3-cpx	1990	late	cpx	51.64	0.39	1.92	9.76	0.51	14.32	20.77	0.34	0.00	0.00	99.66
07B-px6-opx-cpx-pair1	2007	dome	cpx	51.42	0.38	1.88	9.67	0.48	14.17	20.55	0.31	0.00	0.00	98.87
07B-px5-opx-cpx-pair1	2007	dome	cpx	51.63	0.36	1.70	9.61	0.52	14.39	20.57	0.27		0.00	99.05
Kelud_OLD(dome)-348G	2007	dome	cpx	51.324	0.384	2.124	9.158	0.425	14.917	20.494	0.334	0.006	0.015	99.186
Kelud_OLD(dome)-351G	2007	dome	cpx	50.30	0.56	3.48	9.69	0.46	14.27	20.17	0.27	0.01	0.01	99.23
Kelud_OLD(dome)-345G	2007	dome	cpx	51.975	0.252	1.37	8.653	0.493	15.602	20.656	0.291	-0.003	0.012	99.309
07B-px8-cpx	2007	dome	cpx	51.77	0.31	1.73	9.42	0.51	14.19	21.22	0.31		0.00	99.48
07B-px7-cpx-pair1	2007	dome	cpx	52.04	0.32	1.65	9.54	0.53	14.62	20.64	0.27		0.01	99.61
Kelud_OLD(dome)-333G	2007	dome	cpx	51.646	0.399	1.963	9.607	0.459	15.089	20.089	0.342	0.005	0.029	99.632
07B-px3-px8-cpx-opx-pair	2007	dome	cpx	52.32	0.30	1.59	9.43	0.53	14.10	21.14	0.30		0.00	99.73
Kelud_OLD(dome)-346G	2007	dome	cpx	51.681	0.434	2.035	9.239	0.465	15.321	20.368	0.215	0.022	-0.005	99.783
Kelud_OLD(dome)-334G	2007	dome	cpx	52.318	0.375	1.69	8.776	0.415	15.216	20.89	0.231	-0.005	-0.012	99.903
Kelud_OLD(dome)-332G	2007	dome	cpx	51.729	0.44	2.134	9.922	0.475	14.822	20.092	0.256	0.02	-0.004	99.921
Kelud_OLD(dome)-340G	2007	dome	cpx	52.006	0.326	1.612	9.59	0.486	15.518	20.148	0.258	0.007	0.007	99.961
Kelud_OLD(dome)-328G	2007	dome	cpx	52.745	0.309	1.633	8.431	0.492	15.336	20.787	0.28	-0.002	0.018	100.035
Kelud_OLD(dome)-331G	2007	dome	cpx	52.218	0.342	1.803	9.475	0.415	15.086	20.542	0.298	0	0.01	100.201

SAMPLE	Year	Phase	Type	SiO2 (wt. %)	TiO2 (wt. %)	Al2O3 (wt. %)	FeO* (wt. %)	MnO (wt. %)	MgO (wt. %)	CaO (wt. %)	Na2O (wt. %)	K2O (wt. %)	Cr2O3 (wt. %)	Total (wt. %)
Kelud_OLD(dome)-336G	2007	dome	cpx	52.15	0.429	1.897	9.417	0.444	15.31	20.417	0.232	-0.005	0.001	100.305
dome-pxzoned-12-3	2007	dome	cpx	52.54	0.43	2.22	9.32	0.47	14.89	20.40	0.30	0.00		100.57
dome-pxzoned3-14-3	2007	dome	cpx	52.41	0.38	2.35	9.36	0.41	15.17	20.24	0.31	0.00		100.63
dome-pxzoned3-14-11	2007	dome	cpx	52.53	0.43	2.32	9.71	0.43	15.28	20.18	0.33	0.01		101.22
KELUD14B-365G	2014	main	cpx	51.186	0.369	1.95	9.201	0.488	14.988	19.971	0.27	0.002	-0.001	98.455
14PUM2-2-px1-cpx	2014	main	cpx	50.53	0.32	3.98	8.77	0.49	13.35	20.62	0.51	0.00	0.00	98.56
14PUM2-2-px2-opxrim-cpx	2014	main	cpx	49.39	0.66	3.84	9.26	0.32	14.33	20.54	0.25		0.00	98.59
14PUM2-2-px1-cpx	2014	main	cpx	51.17	0.34	2.13	9.29	0.51	14.17	20.72	0.28	0.00	0.00	98.59
14PUM2-2-px2-opxcore-cpx	2014	main	cpx	49.88	0.63	3.50	9.46	0.39	14.58	20.00	0.22	0.00	0.02	98.67
14PUM2-2-px3-cpx-opx	2014	main	cpx	50.84	0.37	1.84	9.80	0.48	14.44	20.62	0.29	0.00	0.00	98.68
14PUM1-1-px5-MI-cpx-r2MI2r	2014	main	cpx	51.50	0.35	1.59	8.56	0.49	14.82	21.14	0.28		0.00	98.72
14PUM1-1-amph-apa2_4-amph	2014	main	cpx	49.47	0.88	3.63	8.74	0.39	14.29	20.99	0.32		0.01	98.72
14PUM2-2-px2-opxrim-cpx	2014	main	cpx	51.11	0.43	2.20	9.66	0.45	14.89	19.90	0.22		0.01	98.87
14PUM1-1-px9-cpx	2014	main	cpx	51.26	0.29	1.72	9.94	0.56	14.34	20.51	0.27		0.02	98.91
14PUM2-2-px3-cpx	2014	main	cpx	51.34	0.35	1.78	9.74	0.48	14.37	20.57	0.31		0.01	98.93
14PUM1-1-px3-cpx	2014	main	cpx	50.79	0.45	2.34	10.23	0.52	14.54	19.89	0.25		0.01	99.03
14PUM1-1-px5-cpx	2014	main	cpx	51.43	0.35	1.70	8.91	0.48	14.83	21.06	0.28		0.01	99.05
14PUM1-1-px10-cpx	2014	main	cpx	51.20	0.37	1.91	9.71	0.52	14.42	20.63	0.28		0.01	99.05
14PUM2-2-px1-cpx	2014	main	cpx	51.16	0.35	2.10	9.46	0.50	14.23	20.99	0.28		0.00	99.07
KELUD14B-368G	2014	main	cpx	51.506	0.337	1.968	9.416	0.432	15.178	20.159	0.289	-0.005	-0.011	99.27
14PUM2-1-px7-cpxhost-opx-adj	2014	main	cpx	51.60	0.33	1.73	9.50	0.50	14.62	20.72	0.27	0.00	0.00	99.27
14PUM2-2-px3-cpx-opx	2014	main	cpx	51.65	0.36	1.89	9.59	0.49	14.50	20.63	0.28		0.00	99.39
14PUM1-1-px5-original-cpx	2014	main	cpx	51.58	0.37	1.90	9.53	0.49	14.54	20.74	0.29		0.00	99.44

SAMPLE	Year	Phase	Type	SiO2 (wt. %)	TiO2 (wt. %)	Al2O3 (wt. %)	FeO* (wt. %)	MnO (wt. %)	MgO (wt. %)	CaO (wt. %)	Na2O (wt. %)	K2O (wt. %)	Cr2O3 (wt. %)	Total (wt. %)
14PUM2-1-px5-ox-px	2014	main	cpx	51.86	0.32	1.61	9.30	0.50	14.73	20.87	0.27		0.00	99.47
cpx1-large-1-3	2014	main	cpx	51.53	0.38	1.97	9.21	0.48	15.46	20.17	0.27	0.00		99.47
KELUD14A-354G	2014	main	cpx	52.132	0.312	1.692	9.039	0.433	15.693	19.995	0.309	0.002	0.012	99.634
KELUD14A-359G	2014	main	cpx	51.748	0.389	1.882	9.297	0.378	15.254	20.485	0.244	-0.002	-0.025	99.681
cpx1-large-1-6	2014	main	cpx	51.55	0.36	1.99	9.40	0.43	15.36	20.33	0.34	0.00		99.75
cpx1-large-1-1	2014	main	cpx	52.16	0.34	1.56	9.30	0.48	15.36	20.34	0.30	0.01		99.86
cpx1-large-1-2	2014	main	cpx	52.20	0.37	1.91	9.14	0.46	15.38	20.26	0.26	0.00		99.97
cpx-opx-clot-thermome-5-7	2014	main	cpx	52.17	0.33	1.91	9.65	0.49	14.96	20.14	0.34	0.00		99.99
zonedglomeropx-8-14	2014	main	cpx	52.56	0.36	1.65	8.83	0.46	15.27	20.64	0.27	-0.01		100.03
zonedglomeropx-8-9	2014	main	cpx	52.28	0.35	1.69	9.41	0.48	15.20	20.37	0.30	-0.01		100.06
zonedglomeropx-8-15	2014	main	cpx	52.10	0.41	1.95	9.47	0.47	15.25	20.19	0.26	0.00		100.11
KELUD14B-371G	2014	main	cpx	52.41	0.366	1.665	9.145	0.447	15.37	20.476	0.23	0.004	0	100.129
zonedopx-7-4	2014	main	cpx	51.92	0.35	2.00	9.51	0.43	15.26	20.39	0.31	0.00		100.15
zonedopx-7-8	2014	main	cpx	51.69	0.37	1.98	9.84	0.42	15.35	20.25	0.30	0.00		100.20
zonedopx-7-5	2014	main	cpx	52.65	0.26	1.63	8.79	0.39	16.94	19.45	0.19	0.00		100.31
KELUD14A-357G	2014	main	cpx	52.133	0.37	1.755	9.556	0.471	15.711	20.161	0.227	-0.004	0.016	100.402
cpx1-large-1-7	2014	main	cpx	51.84	0.42	2.22	9.79	0.44	15.37	20.10	0.28	-0.01		100.43
zonedopx-7-6	2014	main	cpx	52.77	0.32	1.65	9.27	0.51	15.36	20.24	0.34	0.00		100.45
cpx2-small-2-1	2014	main	cpx	52.39	0.38	1.84	9.43	0.45	15.28	20.41	0.30	0.00		100.49
KELUD14A-352G	2014	main	cpx	52.31	0.318	1.678	9.514	0.444	15.697	20.209	0.285	-0.002	0.017	100.498
KELUD14A-355G	2014	main	cpx	52.501	0.336	2.035	9.126	0.461	15.402	20.387	0.249	-0.003	0.007	100.508
cpx1-large-1-5	2014	main	cpx	52.38	0.38	1.85	9.33	0.46	15.41	20.42	0.30	0.01		100.53
zonedglomeropx-8-10	2014	main	cpx	53.29	0.27	1.53	9.20	0.49	16.64	19.04	0.22	0.02		100.69

SAMPLE	Year	Phase	Type	SiO2 (wt. %)	TiO2 (wt. %)	Al2O3 (wt. %)	FeO* (wt. %)	MnO (wt. %)	MgO (wt. %)	CaO (wt. %)	Na2O (wt. %)	K2O (wt. %)	Cr2O3 (wt. %)	Total (wt. %)
zonedglomeropx-8-3	2014	main	cpx	53.12	0.33	1.66	9.07	0.45	17.28	18.65	0.17	0.00		100.73
zonedglomeropx-8-1	2014	main	cpx	52.96	0.27	1.59	9.19	0.48	14.98	20.91	0.38	0.00		100.78
opx-inplag-6-4	2014	main	cpx	52.86	0.34	1.57	9.34	0.45	15.82	20.16	0.26	0.00		100.80
KELUD14A-360G	2014	main	cpx	52.468	0.381	2.093	9.216	0.44	15.487	20.444	0.296	-0.005	-0.013	100.815
cpx-opx-clot-thermome-5-12	2014	main	cpx	52.20	0.44	2.05	9.77	0.52	15.30	20.24	0.31	0.01		100.83
zonedopx-7-7	2014	main	cpx	53.25	0.33	1.73	8.82	0.40	16.88	19.36	0.14	0.01		100.90
cpx-opx-clot-thermome-5-8	2014	main	cpx	52.38	0.40	1.87	10.22	0.56	15.42	19.87	0.32	-0.01		101.03
zonedopx-7-2	2014	main	cpx	53.38	0.30	1.44	8.99	0.53	16.17	20.01	0.22	0.00		101.04
cpx1-large-1-4	2014	main	cpx	52.11	0.37	2.66	9.23	0.39	15.60	20.39	0.33	0.01		101.10
zonedopx-7-3	2014	main	cpx	53.20	0.28	1.67	8.84	0.45	16.29	20.36	0.22	0.02		101.32
cpx-opx-clot-thermome-5-14	2014	main	cpx	53.24	0.34	1.62	9.86	0.51	15.77	19.77	0.28	0.01		101.40
opx-inplag-6-3	2014	main	cpx	53.10	0.38	1.81	9.23	0.44	15.71	20.44	0.32	0.00		101.42

Table S3.2.4: Natural plagioclase compositions analyzed by EPMA for Kelud, 1990-2014

SAMPLE	Year	type	SiO2 (wt. %)	TiO2 (wt. %)	Al2O3 (wt. %)	FeO* (wt. %)	MnO (wt. %)	MgO (wt. %)	CaO (wt. %)	Na2O (wt. %)	K2O (wt. %)	P2O5 (wt. %)	Total (wt. %)
kelud2014A_plag_core	2014	plag	47.3	b.d.	34.0	0.5	0.02	0.03	16.6	1.5	0.02	0.01	100.0
kelud2014A_plag_rim	2014	plag	50.2	b.d.	32.1	0.6	0.01	0.04	14.6	2.7	0.05	0.00	100.3
kelud2014A_plag_rim2	2014	plag	51.6	b.d.	30.9	0.6	0.02	0.05	13.7	3.5	0.07	0.04	100.5
kelud2014A_plag_rim2	2014	plag	52.6	b.d.	30.6	0.6	b.d.	0.05	12.8	3.8	0.07	0.01	100.4
kelud2014A_plag2_rim2	2014	plag	52.1	0.003	30.6	0.6	0.02	0.05	12.9	4.3	0.08	0.01	100.6
kelud2014A_plag3_core	2014	plag	51.6	b.d.	30.8	0.6	0.01	0.06	13.0	3.5	0.07	0.01	99.7
14PUM2-2-ol2-opx-cpx-plag_opx_plag	2014	plag	50.9	0.020	29.4	0.7	0.01	0.08	13.5	3.8		0.02	98.4
14PUM2-2-ol2-opx-cpx-plag_opx_plag	2014	plag	51.1	0.030	29.2	0.7	0.01	0.08	13.4	3.9		0.01	98.4
14PUM2-2-ol2-opx-cpx-plag_opx_plag	2014	plag	44.5	0.010	33.6	0.6	0.01	0.04	18.6	1.1		0.02	98.5
14PUM2-2-ol2-opx-cpx-core_plag	2014	plag	44.7	b.d.	33.3	0.5	0.01	0.06	18.2	1.3		0.04	98.2
14PUM2-2-ol2-opx-cpx-core_plag	2014	plag	44.6	0.030	33.4	0.6	0.02	0.09	18.3	1.3		0.01	98.3
Kelut2007B_groundmass_microphenos_plag	2007	plag	49.7	0.079	31.5	0.6	0.01	0.05	14.6	3.2	0.11		99.9
Kelut2007B_groundmass_microphenos_plag	2007	plag	51.1	0.055	29.7	0.6	0.01	0.04	12.5	4.1	0.14		98.4
Kelut2007B_groundmass_microphenos_plag	2007	plag	50.9	b.d.	29.9	0.6	0.01	0.04	12.8	4.0	0.12		98.4
Kelut2007B_groundmass_microphenos_plag	2007	plag	49.2	b.d.	31.0	0.6	0.01	0.04	14.2	3.4	0.06		98.4
Kelut2007B_groundmass_microphenos_plag	2007	plag	49.5	0.020	30.7	0.6	0.02	0.07	14.0	3.4	0.07		98.4
Kelut2007B_groundmass_microphenos_plag	2007	plag	45.4	0.032	34.1	0.6	0.02	0.03	17.5	1.4	0.03		99.1
Kelut2007B_groundmass_microphenos_plag	2007	plag	47.8	0.028	31.8	0.6	0.03	0.06	15.0	2.8	0.07		98.1
Kelut2007B_groundmass_microphenos_plag	2007	plag	48.6	0.024	31.9	0.6	0.01	0.05	14.7	3.0	0.05		99.0
Kelut2007B_groundmass_microphenos_plag	2007	plag	52.4	0.051	29.2	0.7	0.02	0.06	11.9	4.6	0.16		99.0
Kelut2007B_groundmass_microphenos_plag	2007	plag	49.1	b.d.	31.7	0.6	0.02	0.05	14.7	3.0	0.05		99.2

SAMPLE	Year	type	SiO2 (wt. %)	TiO2 (wt. %)	Al2O3 (wt. %)	FeO* (wt. %)	MnO (wt. %)	MgO (wt. %)	CaO (wt. %)	Na2O (wt. %)	K2O (wt. %)	P2O5 (wt. %)	Total (wt. %)
Kelut2007B_groundmass_microphenos_plag	2007	plag	49.7	b.d.	31.5	0.6	0.02	0.03	14.2	3.1	0.08		99.3
Kelut2007B_groundmass_microphenos_plag	2007	plag	48.1	0.075	32.1	0.6	0.02	0.06	15.4	2.5	0.08		98.9
Kelut2007B_groundmass_microphenos_plag	2007	plag	50.8	0.035	30.3	0.6	0.02	0.05	13.2	3.7	0.11		98.9
Kelut2007B_groundmass_microphenos_plag	2007	plag	50.5	b.d.	30.6	0.7	0.00	0.06	13.6	3.7	0.08		99.1
Kelut2007B_groundmass_microphenos_plag	2007	plag	51.2	b.d.	30.1	0.8	0.02	0.05	12.9	3.9	0.16		99.1
Kelut2007B_groundmass_microphenos_plag	2007	plag	53.8	0.075	27.9	0.8	b.d.	0.03	10.7	4.9	0.25		98.4
Kelut2007B_random_cores_of_large_plag_phenos	2007	plag	48.4	0.004	33.0	0.6	0.03	0.05	15.8	2.3	0.04		100.2
Kelut2007B_random_cores_of_large_plag_phenos	2007	plag	51.2	0.000	31.2	0.5	b.d.	0.04	13.7	3.5	0.09		100.3
Kelut2007B_random_cores_of_large_plag_phenos	2007	plag	48.5	b.d.	33.1	0.5	0.03	0.04	15.5	2.3	0.05		100.0
Kelut2007B_random_cores_of_large_plag_phenos	2007	plag	47.2	0.020	33.8	0.6	-0.00	0.02	17.1	1.7	0.05		100.4
Kelut2007B_random_cores_of_large_plag_phenos	2007	plag	47.4	0.008	33.6	0.5	0.04	0.04	16.3	1.8	0.05		99.7
Kelut2007B_random_cores_of_large_plag_phenos	2007	plag	50.0	0.024	32.1	0.6	0.02	0.04	14.9	3.0	0.06		100.6
Kelut2007B_random_cores_of_large_plag_phenos	2007	plag	50.6	0.028	31.8	0.5	0.02	0.05	14.5	3.1	0.06		100.6
Kelut2007B_random_cores_of_large_plag_phenos	2007	plag	45.7	0.012	35.1	0.5	b.d.	0.02	18.0	1.2	0.00		100.6
Kelut2007B_random_cores_of_large_plag_phenos	2007	plag	46.7	0.051	34.6	0.5	0.02	0.02	17.6	1.4	0.02		100.8
Kelut2007B_random_cores_of_large_plag_phenos	2007	plag	48.7	b.d.	32.4	0.5	0.02	0.04	15.3	2.5	0.05		99.4
Kelut2007B_random_cores_of_large_plag_phenos	2007	plag	46.4	0.020	34.2	0.6	0.02	0.02	17.2	1.5	0.01		100.0
Kelut2007B_random_cores_of_large_plag_phenos	2007	plag	48.6	0.075	32.6	0.5	b.d.	0.03	15.3	2.5	0.05		99.7
Kelut2007B_random_cores_of_large_plag_phenos	2007	plag	46.4	0.075	34.1	0.5	0.00	0.01	16.9	1.7	0.03		99.8
Kelut2007B_random_cores_of_large_plag_phenos	2007	plag	46.9	0.028	34.2	0.5	-0.00	0.02	16.8	1.5	0.02		100.0
Kelut2007B_random_cores_of_large_plag_phenos	2007	plag	46.3	0.028	34.3	0.5	-0.00	0.04	17.2	1.4	0.03		99.8
Kelut2007B_random_cores_of_large_plag_phenos	2007	plag	47.5	0.051	33.4	0.5	0.04	0.03	16.2	2.0	0.03		99.8
Kelut2007B_random_cores_of_large_plag_phenos	2007	plag	46.7	b.d.	34.0	0.6	0.02	0.02	17.3	1.6	0.02		100.2
Kelut2007B_random_cores_of_large_plag_phenos	2007	plag	49.2	0.039	32.6	0.6	0.00	0.04	15.2	2.6	0.03		100.3

SAMPLE	Year	type	SiO2 (wt. %)	TiO2 (wt. %)	Al2O3 (wt. %)	FeO* (wt. %)	MnO (wt. %)	MgO (wt. %)	CaO (wt. %)	Na2O (wt. %)	K2O (wt. %)	P2O5 (wt. %)	Total (wt. %)
Kelut2007B_random_cores_of_large_plag_phenos	2007	plag	48.1	0.012	33.1	0.6	b.d.	0.05	16.2	2.2	0.04		100.3
Kelut2007B_random_cores_of_large_plag_phenos	2007	plag	46.7	b.d.	33.2	0.5	0.02	0.04	16.4	2.0	0.03		98.9
Kelut2007B_random_cores_of_large_plag_phenos	2007	plag	46.7	b.d.	33.5	0.5	0.03	0.04	16.6	1.9	0.03		99.4
Kelut2007B_random_cores_of_large_plag_phenos	2007	plag	45.3	0.051	34.1	0.5	0.01	0.04	17.5	1.3	0.03		98.9
Kelut2007B_random_cores_of_large_plag_phenos	2007	plag	47.4	0.043	33.3	0.5	0.03	0.03	16.4	2.0	0.03		99.8
Kelut2007B_random_cores_of_large_plag_phenos	2007	plag	44.6	0.024	34.0	0.5	0.003	0.02	17.5	1.3	0.02		98.0
Kelut2007B_random_cores_of_large_plag_phenos	2007	plag	43.4	b.d.	34.7	0.5	0.01	0.03	18.5	0.9	0.01		98.1
Kelut2007B_random_cores_of_large_plag_phenos	2007	plag	49.0	b.d.	31.3	0.5	0.01	0.04	14.2	3.3	0.08		98.5
Kelut2007B_random_cores_of_large_plag_phenos	2007	plag	48.5	b.d.	31.5	0.6	0.01	0.04	14.6	3.0	0.05		98.1
Kelut2007B_random_cores_of_large_plag_phenos	2007	plag	46.9	0.008	32.3	0.6	-0.00	0.02	15.7	2.5	0.03		98.1
Kelut2007B_random_cores_of_large_plag_phenos	2007	plag	47.1	b.d.	32.2	0.6	0.05	0.06	15.8	2.5	0.05		98.4
Kelut2007B_random_cores_of_large_plag_phenos	2007	plag	49.1	b.d.	32.0	0.5	0.01	0.07	15.0	2.8	0.08		99.6
Kelut2007B_random_cores_of_large_plag_phenos	2007	plag	46.9	b.d.	33.6	0.5	0.01	0.03	16.9	1.9	0.03		99.8
Kelut2007B_random_cores_of_large_plag_phenos	2007	plag	49.4	0.039	31.2	0.5	-0.00	0.04	14.2	3.1	0.05		98.5
Kelut2007B_random_cores_of_large_plag_phenos	2007	plag	47.1	b.d.	32.8	0.6	0.00	0.02	15.9	2.2	0.05		98.7
Kelut2007B_random_cores_of_large_plag_phenos	2007	plag	48.2	b.d.	31.7	0.5	0.00	0.03	14.7	2.8	0.05		98.1
Kelut2007B_random_cores_of_large_plag_phenos	2007	plag	46.2	b.d.	34.4	0.5	0.01	0.02	17.2	1.5	0.01		99.7
Kelut2007B_random_cores_of_large_plag_phenos	2007	plag	44.9	b.d.	34.9	0.5	-0.00	0.02	17.9	1.1	0.02		99.3
Kelut2007B_random_cores_of_large_plag_phenos	2007	plag	48.9	b.d.	31.5	0.6	0.03	0.03	14.5	3.1	0.06		98.5
Kelut2007B_random_cores_of_large_plag_phenos	2007	plag	49.3	0.043	30.6	1.0	0.03	0.09	14.2	2.8	0.19		98.2
Kelut2007B_random_cores_of_large_plag_phenos	2007	plag	46.0	0.047	34.0	0.6	0.02	0.08	17.4	1.6	0.02		99.7
Kelut2007B_random_cores_of_large_plag_phenos	2007	plag	43.4	0.016	35.1	0.3	b.d.	0.01	18.6	0.7	0.01		98.1
Kelut2007B_random_cores_of_large_plag_phenos	2007	plag	43.9	0.032	35.1	0.4	0.00	b.d.	18.7	0.8	0.01		99.0
Kelut2007B_random_cores_of_large_plag_phenos	2007	plag	47.5	b.d.	32.2	0.6	-0.00	0.05	15.6	2.7	0.06		98.7

SAMPLE	Year	type	SiO2 (wt. %)	TiO2 (wt. %)	Al2O3 (wt. %)	FeO* (wt. %)	MnO (wt. %)	MgO (wt. %)	CaO (wt. %)	Na2O (wt. %)	K2O (wt. %)	P2O5 (wt. %)	Total (wt. %)
Kelut2007B_random_cores_of_large_plag_phenos	2007	plag	46.7	0.000	33.2	0.5	0.00	0.06	16.3	2.0	0.03		98.8
Kelut2007B_random_cores_of_large_plag_phenos	2007	plag	45.3	b.d.	34.0	0.6	0.01	0.05	17.5	1.3	0.03		98.9
Kelut2007B_random_cores_of_large_plag_phenos	2007	plag	46.4	0.110	33.3	0.5	b.d.	0.03	16.6	1.9	0.03		98.9
Kelut2007B_random_cores_of_large_plag_phenos	2007	plag	47.6	b.d.	32.7	0.6	0.03	0.02	16.0	2.3	0.04		99.2
Kelut2007B_random_cores_of_large_plag_phenos	2007	plag	44.5	0.043	34.6	0.5	0.02	0.02	18.0	1.1	0.01		98.9
Kelut2007B_random_cores_of_large_plag_phenos	2007	plag	47.4	0.079	32.1	0.6	0.02	0.06	15.1	2.7	0.05		98.1
Kelut2007B_random_cores_of_large_plag_phenos	2007	plag	45.4	b.d.	33.7	0.5	0.00	0.03	16.9	1.7	0.03		98.3
Kelut2007B_random_cores_of_large_plag_phenos	2007	plag	47.9	b.d.	31.9	0.6	0.03	0.04	14.9	2.8	0.04		98.2
Kelut2007B_random_cores_of_large_plag_phenos	2007	plag	44.5	0.024	34.6	0.6	0.02	0.03	17.9	1.3	0.01		98.9
Kelut2007B_random_cores_of_large_plag_phenos	2007	plag	49.4	b.d.	31.4	0.6	0.01	0.02	14.5	3.2	0.06		99.2
Kelut2007B_random_cores_of_large_plag_phenos	2007	plag	48.0	0.063	32.0	0.5	-0.00	0.03	15.2	2.8	0.05		98.8
Kelut2007B_random_cores_of_large_plag_phenos	2007	plag	46.7	0.051	32.7	0.5	0.02	0.03	16.3	2.1	0.03		98.5
Kelut2007B_random_cores_of_large_plag_phenos	2007	plag	44.9	b.d.	33.8	0.6	0.00	0.03	17.5	1.5	0.03		98.3
Kelut2007B_random_cores_of_large_plag_phenos	2007	plag	43.6	0.047	34.7	0.4	0.01	0.01	18.1	1.0	0.02		98.0
Kelut2007B_random_cores_of_large_plag_phenos	2007	plag	44.4	0.024	34.8	0.4	0.03	0.01	18.1	1.0	0.01		98.7
Kelut2007B_random_cores_of_large_plag_phenos	2007	plag	44.9	0.020	34.1	0.5	b.d.	0.03	17.6	1.3	0.02		98.5
Kelut2007B_random_cores_of_large_plag_phenos	2007	plag	48.9	b.d.	31.3	0.5	0.03	0.05	14.6	3.1	0.05		98.5
Kelut2007B_random_cores_of_large_plag_phenos	2007	plag	46.0	0.020	33.8	0.5	b.d.	0.02	16.9	1.6	0.01		99.0
Kelut2007B_random_cores_of_large_plag_phenos	2007	plag	45.1	b.d.	33.9	0.6	0.01	0.02	17.7	1.3	0.02		98.6
Kelut2007B_random_cores_of_large_plag_phenos	2007	plag	48.3	0.035	31.8	0.5	0.03	0.04	14.8	2.9	0.06		98.6
Kelut2007B_random_cores_of_large_plag_phenos	2007	plag	47.4	b.d.	32.2	0.6	b.d.	0.05	15.6	2.5	0.03		98.4
Kelut2007B_random_cores_of_large_plag_phenos	2007	plag	47.7	0.051	32.5	0.5	0.01	0.04	15.6	2.4	0.03		98.8
Kelut2007B_random_cores_of_large_plag_phenos	2007	plag	46.5	0.008	33.4	0.5	0.02	0.02	16.6	1.9	0.02		99.0
Kelut2007B_random_cores_of_large_plag_phenos	2007	plag	44.2	0.020	35.1	0.5	0.04	0.03	18.4	0.9	0.01		99.2

SAMPLE	Year	type	SiO2 (wt. %)	TiO2 (wt. %)	Al2O3 (wt. %)	FeO* (wt. %)	MnO (wt. %)	MgO (wt. %)	CaO (wt. %)	Na2O (wt. %)	K2O (wt. %)	P2O5 (wt. %)	Total (wt. %)
Kelut2007B_random_cores_of_large_plag_phenos	2007	plag	46.2	0.043	32.9	0.6	0.00	0.04	16.4	2.0	0.05		98.3
Kelut2007B_random_cores_of_large_plag_phenos	2007	plag	47.5	0.035	32.0	0.6	0.04	0.06	15.2	2.6	0.07		98.2
Kelut2007B_random_cores_of_large_plag_phenos	2007	plag	45.0	b.d.	33.7	0.5	0.01	0.03	17.3	1.6	0.02		98.1
Kelut2007B_random_cores_of_large_plag_phenos	2007	plag	45.2	0.063	33.6	0.5	0.03	0.03	16.9	1.6	0.03		98.0
Kelut2007B_random_cores_of_large_plag_phenos	2007	plag	44.8	b.d.	33.7	0.6	b.d.	0.05	17.3	1.5	0.01		98.0
Kelut2007B_random_cores_of_large_plag_phenos	2007	plag	47.3	0.004	32.7	0.5	0.03	0.03	15.8	2.4	0.05		98.7
Kelut2007B_random_cores_of_large_plag_phenos	2007	plag	45.2	0.008	34.0	0.7	0.01	0.01	17.3	1.4	0.04		98.6
Kelut2007B_random_cores_of_large_plag_phenos	2007	plag	45.4	b.d.	33.6	0.6	0.01	0.02	17.2	1.7	0.02		98.5
Kelut2007B_random_cores_of_large_plag_phenos	2007	plag	44.9	0.004	34.5	0.5	0.01	0.02	17.8	1.4	0.02		99.2
Kelut2007B_random_cores_of_large_plag_phenos	2007	plag	44.2	0.020	34.8	0.5	0.00	0.01	18.2	1.1	0.02		98.9
Kelut2007B_random_cores_of_large_plag_phenos	2007	plag	47.5	0.043	32.1	0.5	0.03	0.03	15.4	2.5	0.04		98.2
Kelut2007B_random_cores_of_large_plag_phenos	2007	plag	49.8	b.d.	31.3	0.6	0.02	0.03	14.3	3.1	0.05		99.2
Kelut2007B_random_cores_of_large_plag_phenos	2007	plag	48.3	0.027	31.7	0.6	0.04	0.04	14.9	2.7	0.07		98.4
Kelut2007B_random_cores_of_large_plag_phenos	2007	plag	46.2	0.051	34.2	0.6	0.00	0.03	17.1	1.5	0.03		99.6
Kelut2007B_random_cores_of_large_plag_phenos	2007	plag	49.5	b.d.	32.1	0.5	0.03	0.03	14.8	2.8	0.04		100.0
Kelut2007B_random_cores_of_large_plag_phenos	2007	plag	46.7	0.039	33.8	0.7	0.05	0.04	17.0	1.6	0.02		99.9
Kelut2007B_random_plag_rims	2007	plag	48.8	0.008	30.9	0.7	0.01	0.06	14.4	3.1	0.09		98.1
Kelut2007B_random_plag_rims	2007	plag	50.9	0.012	29.9	0.6	0.01	0.08	12.9	4.0	0.08		98.4
Kelut2007B_random_plag_rims	2007	plag	50.9	0.047	30.3	0.6	0.02	0.07	13.3	3.7	0.07		99.0
Kelut2007B_random_plag_rims	2007	plag	51.0	0.070	29.7	0.6	b.d.	0.04	12.6	4.0	0.09		98.2
Kelut2007B_random_plag_rims	2007	plag	50.8	b.d.	30.9	0.6	b.d.	0.05	13.9	3.3	0.08		99.7
Kelut2007B_random_plag_rims	2007	plag	49.7	0.047	31.7	0.5	0.03	0.03	14.4	3.1	0.05		99.5
Kelut2007B_random_plag_rims	2007	plag	51.9	0.031	30.1	0.7	0.02	0.09	13.0	3.9	0.10		99.9
Kelut2007B_random_plag_rims	2007	plag	50.8	0.063	30.3	0.7	0.02	0.08	13.5	3.6	0.09		99.1

SAMPLE	Year	type	SiO2 (wt. %)	TiO2 (wt. %)	Al2O3 (wt. %)	FeO* (wt. %)	MnO (wt. %)	MgO (wt. %)	CaO (wt. %)	Na2O (wt. %)	K2O (wt. %)	P2O5 (wt. %)	Total (wt. %)
Kelut2007B_random_plag_rims	2007	plag	52.7	0.067	29.0	0.7	0.03	0.08	12.1	4.5	0.15		99.3
Kelut2007B_random_plag_rims	2007	plag	51.9	0.035	29.2	0.6	0.02	0.08	12.4	4.2	0.11		98.6
Kelut2007B_random_plag_rims	2007	plag	48.4	b.d.	31.5	0.6	0.003	0.04	14.8	2.9	0.05		98.4
Kelut2007B_random_plag_rims	2007	plag	49.6	0.051	31.1	0.6	b.d.	0.06	14.2	3.1	0.06		98.9

b.d. = below detection limit

Table S3.2.5: Natural olivine compositions analyzed by EPMA for Kelud, 2014

Sample	Year	type	Phase	SiO ₂ (wt. %)	TiO ₂ (wt. %)	Al ₂ O ₃ (wt. %)	FeO* (wt. %)	MnO (wt. %)	MgO (wt. %)	CaO (wt. %)	Na ₂ O (wt. %)	Cr ₂ O ₃ (wt. %)	P ₂ O ₅ (wt. %)	Total
14PUM2-2-ol4	2014	ol	main	37.0	0.0	0.0	25.8	0.6	35.1	0.2	0.0	0.0	0.0	98.8
14PUM2-2-ol3-rim-core-spots	2014	ol	main	36.7	0.0	0.0	27.4	0.7	33.7	0.2	0.0	0.0	0.0	98.7
14PUM2-2-ol3-rim-core-spots	2014	ol	main	37.4	0.0	0.0	24.9	0.6	36.2	0.2	0.0	0.0	0.1	99.4
14PUM2-2-px7-ol1	2014	ol	main	36.6	0.0	0.0	27.2	0.8	33.7	0.2	0.0	0.0	0.1	98.7
14PUM2-2-ol6	2014	ol	main	36.7	0.0	0.0	25.6	0.6	35.3	0.2	0.0	0.0	0.0	98.5
14PUM2-2-ol7	2014	ol	main	37.0	0.0	0.0	25.5	0.7	35.5	0.1	0.0	0.0	0.1	98.9
14PUM2-2-ol8	2014	ol	main	37.2	0.0	0.1	27.6	0.7	33.4	0.2	0.0	0.0	0.0	99.3
14PUM2-2-ol9	2014	ol	main	36.9	0.0	0.0	25.9	0.6	35.4	0.1	0.0	0.0	0.0	99.0
14PUM2-2-ol5-rimspots	2014	ol	main	36.7	0.0	0.0	25.8	0.6	35.1	0.2	0.0	0.0	0.0	98.5

Table S3.2.6: Natural amphibole compositions analyzed by EPMA for Kelud, 1990-2014

SAMPLE	Year	type	Phase	SiO2 (wt. %)	TiO2 (wt. %)	Al2O3 (wt. %)	FeO* (wt. %)	MnO (wt. %)	MgO (wt. %)	CaO (wt. %)	Na2O (wt. %)	K2O (wt. %)	Cr2O3 (wt. %)	Total
amph_3c-b4-mega_10um	2014	amph	main	40.9	1.3	14.9	9.6	0.1	14.7	12.5	2.4	0.5		96.8
amph_3c-b4-mega_10um	2014	amph	main	41.0	1.4	14.8	9.7	0.1	14.6	12.2	2.3	0.5		96.6
14HW-KEL4 cpx1	2014	amph	main	41.2	1.4	14.8	9.5	0.1	14.7	12.3	2.3	0.5		96.7
14HW-KEL4 cpx2	2014	amph	main	46.8	1.2	7.7	13.1	0.2	14.5	11.1	1.5	0.2		96.3
KELUT14-PUM1	2014	amph	main	46.1	2.5	8.1	13.1	0.4	16.6	8.9	1.0	< 0.01	0.02	96.6
14HW-KEL4 cpx1	2014	amph	main	42.3	2.7	11.3	13.3	0.4	13.2	11.1	2.3	1.0	0.01	97.6

Table S3.3: Plagioclase traverse chemistry from 2007 dome rock.

SAMPLE	Year	type	mineral	traverse d (μm)	SiO ₂ (wt. %)	Al ₂ O ₃ (wt. %)	CaO (wt. %)	Na ₂ O (wt. %)	FeO (wt. %)	K ₂ O (wt. %)	Total (wt. %)	An content
Un 17 Kelut2007B_plag_trav1	2007	dome	plag	0	50.9	30.0	12.8	3.8	0.7	0.1	98.3	64.4
Un 17 Kelut2007B_plag_trav1	2007	dome	plag	5	50.1	31.0	14.0	3.3	0.6	0.1	99.0	60.3
Un 17 Kelut2007B_plag_trav1	2007	dome	plag	10	50.0	31.2	14.2	3.3	0.6	0.1	99.2	64.2
Un 17 Kelut2007B_plag_trav1	2007	dome	plag	15	49.9	30.9	14.0	3.3	0.5	0.1	98.8	56.5
Un 17 Kelut2007B_plag_trav1	2007	dome	plag	20	49.5	31.3	14.5	3.1	0.6	0.1	99.1	70.0
Un 17 Kelut2007B_plag_trav1	2007	dome	plag	25	49.4	31.5	14.5	3.0	0.6	0.1	99.1	66.2
Un 17 Kelut2007B_plag_trav1	2007	dome	plag	30	50.3	30.7	13.9	3.4	0.6	0.1	99.1	69.5
Un 17 Kelut2007B_plag_trav1	2007	dome	plag	35	49.8	31.5	14.4	3.1	0.6	0.1	99.4	74.3
Un 17 Kelut2007B_plag_trav1	2007	dome	plag	40	47.1	33.0	16.3	2.0	0.6	0.0	99.0	68.7
Un 17 Kelut2007B_plag_trav1	2007	dome	plag	45	46.6	33.1	16.0	2.2	0.6	0.0	98.4	77.9
Un 17 Kelut2007B_plag_trav1	2007	dome	plag	50	47.8	31.4	14.1	2.9	0.6	0.1	96.8	72.0
Un 17 Kelut2007B_plag_trav1	2007	dome	plag	55	48.7	32.2	15.2	2.6	0.6	0.0	99.3	70.1
Un 17 Kelut2007B_plag_trav1	2007	dome	plag	60	49.2	31.7	14.8	2.9	0.6	0.0	99.2	76.7
Un 17 Kelut2007B_plag_trav1	2007	dome	plag	65	49.2	31.7	14.7	2.8	0.6	0.0	99.0	69.9
Un 17 Kelut2007B_plag_trav1	2007	dome	plag	70	49.3	31.5	14.7	3.1	0.6	0.1	99.1	70.9
Un 17 Kelut2007B_plag_trav1	2007	dome	plag	75	47.8	32.5	15.6	2.4	0.5	0.0	98.8	74.5
Un 17 Kelut2007B_plag_trav1	2007	dome	plag	80	45.5	34.0	17.7	1.3	0.5	0.0	98.9	71.6
Un 17 Kelut2007B_plag_trav1	2007	dome	plag	85	43.9	35.2	18.7	0.7	0.5	0.0	99.0	79.1
Un 17 Kelut2007B_plag_trav1	2007	dome	plag	90	43.4	34.8	18.5	0.8	0.4	0.0	97.9	71.8
Un 17 Kelut2007B_plag_trav1	2007	dome	plag	95	44.4	35.4	18.6	0.8	0.5	0.0	99.7	72.8
Un 17 Kelut2007B_plag_trav1	2007	dome	plag	100	44.8	34.9	18.2	0.9	0.5	0.0	99.3	77.3
Un 17 Kelut2007B_plag_trav1	2007	dome	plag	105	44.3	34.5	18.0	0.9	0.5	0.0	98.3	69.3
Un 17 Kelut2007B_plag_trav1	2007	dome	plag	110	44.6	34.9	18.3	0.9	0.5	0.0	99.3	80.6

SAMPLE	Year	type	mineral	traverse d (μm)	SiO2 (wt. %)	Al2O3 (wt. %)	CaO (wt. %)	Na2O (wt. %)	FeO (wt. %)	K2O (wt. %)	Total (wt. %)	An content
Un 17 Kelut2007B_plag_trav1	2007	dome	plag	115	44.6	35.0	18.3	0.9	0.5	0.0	99.4	72.1
Un 17 Kelut2007B_plag_trav1	2007	dome	plag	120	44.7	35.1	18.2	0.9	0.5	0.0	99.5	73.1
Un 17 Kelut2007B_plag_trav1	2007	dome	plag	125	45.0	34.9	18.6	1.0	0.5	-0.0	100.0	69.1
Un 17 Kelut2007B_plag_trav1	2007	dome	plag	130	45.0	34.7	18.0	1.0	0.5	0.0	99.3	84.1
Un 17 Kelut2007B_plag_trav1	2007	dome	plag	135	44.8	34.9	18.1	1.0	0.6	0.0	99.3	71.3
Un 17 Kelut2007B_plag_trav1	2007	dome	plag	140	44.8	34.5	18.2	1.0	0.6	0.0	99.0	71.8
Un 17 Kelut2007B_plag_trav1	2007	dome	plag	145	44.9	34.6	18.0	1.1	0.6	0.0	99.1	72.9
Un 17 Kelut2007B_plag_trav1	2007	dome	plag	150	45.0	34.7	18.2	1.0	0.6	0.0	99.5	71.6
Un 17 Kelut2007B_plag_trav1	2007	dome	plag	155	44.2	35.2	18.2	1.0	0.5	0.0	99.2	85.7
Un 17 Kelut2007B_plag_trav1	2007	dome	plag	160	44.9	35.0	18.3	0.9	0.5	0.0	99.7	74.9
Un 17 Kelut2007B_plag_trav1	2007	dome	plag	165	44.9	34.9	18.3	0.9	0.5	0.0	99.6	67.2
Un 17 Kelut2007B_plag_trav1	2007	dome	plag	170	44.8	35.0	18.4	1.0	0.5	0.0	99.7	86.6
Un 17 Kelut2007B_plag_trav1	2007	dome	plag	175	45.1	35.0	18.4	0.9	0.5	0.0	99.9	81.4
Un 17 Kelut2007B_plag_trav1	2007	dome	plag	180	44.9	34.9	18.5	1.0	0.5	0.0	99.7	70.9
Un 17 Kelut2007B_plag_trav1	2007	dome	plag	185	45.2	34.9	18.3	1.1	0.5	0.0	99.9	89.5
Un 17 Kelut2007B_plag_trav1	2007	dome	plag	190	45.3	34.9	18.4	1.1	0.4	0.0	100.1	81.9
Un 17 Kelut2007B_plag_trav1	2007	dome	plag	195	45.1	34.9	18.4	0.9	0.5	0.0	99.8	80.2
Un 17 Kelut2007B_plag_trav1	2007	dome	plag	200	44.2	34.8	18.0	1.0	0.5	0.0	98.6	85.5
Un 17 Kelut2007B_plag_trav1	2007	dome	plag	205	45.0	34.7	18.0	1.1	0.5	0.0	99.4	72.7
Un 17 Kelut2007B_plag_trav1	2007	dome	plag	210	45.4	34.9	18.2	1.2	0.5	0.0	100.2	71.8
Un 17 Kelut2007B_plag_trav1	2007	dome	plag	215	45.1	34.6	18.1	1.1	0.5	0.0	99.4	90.9
Un 17 Kelut2007B_plag_trav1	2007	dome	plag	220	44.9	34.5	17.6	1.2	0.5	0.0	98.7	91.4
Un 17 Kelut2007B_plag_trav1	2007	dome	plag	225	39.6	30.6	15.9	0.9	0.5	0.0	87.5	76.4
Un 17 Kelut2007B_plag_trav1	2007	dome	plag	230	40.6	32.5	16.9	0.7	0.4	0.0	91.0	90.4

SAMPLE	Year	type	mineral	traverse d (μm)	SiO2 (wt. %)	Al2O3 (wt. %)	CaO (wt. %)	Na2O (wt. %)	FeO (wt. %)	K2O (wt. %)	Total (wt. %)	An content
Un 17 Kelut2007B_plag_trav1	2007	dome	plag	235	44.7	35.2	18.7	0.8	0.5	0.0	99.9	71.1
Un 17 Kelut2007B_plag_trav1	2007	dome	plag	240	45.0	35.2	18.3	1.0	0.5	0.0	100.0	71.3
Un 17 Kelut2007B_plag_trav1	2007	dome	plag	245	45.0	34.9	18.5	0.9	0.4	0.0	99.7	92.5
Un 17 Kelut2007B_plag_trav1	2007	dome	plag	250	45.0	34.8	18.2	1.0	0.4	0.0	99.4	92.5
Un 17 Kelut2007B_plag_trav1	2007	dome	plag	255	45.1	35.0	18.2	0.9	0.4	0.0	99.7	73.4
Un 17 Kelut2007B_plag_trav1	2007	dome	plag	260	45.2	34.9	18.4	1.0	0.5	0.0	99.9	91.2
Un 17 Kelut2007B_plag_trav1	2007	dome	plag	265	46.7	34.1	17.2	1.7	0.5	0.0	100.3	91.4
Un 17 Kelut2007B_plag_trav1	2007	dome	plag	270	46.1	34.3	17.4	1.6	0.5	0.0	99.9	75.3
Un 17 Kelut2007B_plag_trav1	2007	dome	plag	275	45.1	35.0	18.0	1.0	0.5	0.0	99.7	73.9
Un 17 Kelut2007B_plag_trav1	2007	dome	plag	280	45.6	34.8	18.1	1.3	0.5	0.0	100.3	72.3
Un 17 Kelut2007B_plag_trav1	2007	dome	plag	285	46.5	33.9	17.3	1.6	0.5	0.0	99.8	90.7
Un 17 Kelut2007B_plag_trav1	2007	dome	plag	290	46.6	33.9	17.0	1.6	0.5	0.0	99.6	77.5
Un 17 Kelut2007B_plag_trav1	2007	dome	plag	295	46.0	34.2	17.6	1.4	0.5	0.0	99.8	91.2
Un 17 Kelut2007B_plag_trav1	2007	dome	plag	300	45.6	34.7	17.8	1.3	0.5	0.0	99.8	91.8
Un 17 Kelut2007B_plag_trav1	2007	dome	plag	305	45.2	35.0	18.4	0.9	0.5	0.0	99.9	91.2
Un 17 Kelut2007B_plag_trav1	2007	dome	plag	310	45.0	35.3	18.6	0.9	0.4	0.0	100.2	78.0
Un 17 Kelut2007B_plag_trav1	2007	dome	plag	315	45.0	35.2	18.5	0.9	0.4	0.0	100.0	79.4
Un 17 Kelut2007B_plag_trav1	2007	dome	plag	320	44.5	35.4	18.4	0.8	0.4	-0.0	99.5	88.3
Un 17 Kelut2007B_plag_trav1	2007	dome	plag	325	45.0	35.3	18.6	0.8	0.5	0.0	100.3	77.4
Un 17 Kelut2007B_plag_trav1	2007	dome	plag	330	45.0	35.2	18.5	0.9	0.5	0.0	100.1	91.6
Un 17 Kelut2007B_plag_trav1	2007	dome	plag	335	45.1	34.7	18.1	1.0	0.5	0.0	99.5	87.0
Un 17 Kelut2007B_plag_trav1	2007	dome	plag	340	45.1	35.1	18.4	1.1	0.5	0.0	100.1	93.3
Un 17 Kelut2007B_plag_trav1	2007	dome	plag	345	45.0	35.1	18.5	0.8	0.5	0.0	99.9	79.4
Un 17 Kelut2007B_plag_trav1	2007	dome	plag	350	44.8	35.1	18.5	0.9	0.5	0.0	99.7	92.2

SAMPLE	Year	type	mineral	traverse d (μm)	SiO2 (wt. %)	Al2O3 (wt. %)	CaO (wt. %)	Na2O (wt. %)	FeO (wt. %)	K2O (wt. %)	Total (wt. %)	An content
Un 17 Kelut2007B_plag_trav1	2007	dome	plag	355	45.0	35.0	18.3	0.9	0.5	-0.0	99.7	85.0
Un 17 Kelut2007B_plag_trav1	2007	dome	plag	360	44.5	35.3	18.9	0.8	0.5	0.0	99.9	90.4
Un 17 Kelut2007B_plag_trav1	2007	dome	plag	365	44.9	35.5	18.5	0.8	0.5	0.0	100.1	78.4
Un 17 Kelut2007B_plag_trav1	2007	dome	plag	370	44.7	35.3	18.8	0.8	0.5	0.0	100.1	92.9
Un 17 Kelut2007B_plag_trav1	2007	dome	plag	375	44.8	35.4	18.5	0.9	0.4	0.0	100.0	82.6
Un 17 Kelut2007B_plag_trav1	2007	dome	plag	380	44.9	35.0	18.2	1.0	0.5	0.0	99.6	92.8
Un 17 Kelut2007B_plag_trav1	2007	dome	plag	385	45.1	35.0	18.5	0.9	0.5	0.0	100.0	90.1
Un 17 Kelut2007B_plag_trav1	2007	dome	plag	390	45.1	35.1	18.3	1.0	0.5	0.0	100.0	79.0
Un 17 Kelut2007B_plag_trav1	2007	dome	plag	395	45.7	34.7	18.1	1.1	0.5	0.0	100.1	77.6
Un 17 Kelut2007B_plag_trav1	2007	dome	plag	400	45.6	34.8	18.1	1.1	0.5	0.0	100.2	79.6
Un 17 Kelut2007B_plag_trav1	2007	dome	plag	405	45.5	34.6	17.7	1.2	0.5	0.0	99.6	73.4
Un 17 Kelut2007B_plag_trav1	2007	dome	plag	410	45.3	34.7	18.1	1.1	0.5	0.0	99.6	91.7
Un 17 Kelut2007B_plag_trav1	2007	dome	plag	415	44.9	35.2	18.3	0.9	0.4	-0.0	99.8	89.1
Un 17 Kelut2007B_plag_trav1	2007	dome	plag	420	45.1	35.0	18.3	1.1	0.5	0.0	100.0	89.2
Un 17 Kelut2007B_plag_trav1	2007	dome	plag	425	45.4	34.9	18.4	1.0	0.5	0.0	100.2	75.9
Un 17 Kelut2007B_plag_trav1	2007	dome	plag	430	45.2	35.0	18.3	1.0	0.5	0.0	100.0	91.5
Un 17 Kelut2007B_plag_trav1	2007	dome	plag	435	45.4	35.0	18.3	1.0	0.5	0.0	100.1	71.2
Un 17 Kelut2007B_plag_trav1	2007	dome	plag	440	45.1	35.0	18.5	1.0	0.5	0.0	100.0	92.0
Un 17 Kelut2007B_plag_trav1	2007	dome	plag	445	45.1	34.9	18.4	1.0	0.5	0.0	99.9	90.2
Un 17 Kelut2007B_plag_trav1	2007	dome	plag	450	45.7	34.6	17.8	1.2	0.5	0.0	99.9	74.6
Un 17 Kelut2007B_plag_trav1	2007	dome	plag	455	45.3	34.4	17.9	1.1	0.5	0.0	99.3	75.4
Un 17 Kelut2007B_plag_trav1	2007	dome	plag	460	45.7	34.6	18.3	1.1	0.5	0.0	100.2	90.5
Un 17 Kelut2007B_plag_trav1	2007	dome	plag	465	38.3	29.7	15.7	1.0	0.4	0.0	85.1	91.8
Un 17 Kelut2007B_plag_trav1	2007	dome	plag	470	45.3	34.8	18.0	1.1	0.5	0.0	99.7	67.2

SAMPLE	Year	type	mineral	traverse d (μm)	SiO2 (wt. %)	Al2O3 (wt. %)	CaO (wt. %)	Na2O (wt. %)	FeO (wt. %)	K2O (wt. %)	Total (wt. %)	An content
Un 17 Kelut2007B_plag_trav1	2007	dome	plag	475	45.3	34.9	18.2	1.1	0.5	0.0	99.9	75.8
Un 17 Kelut2007B_plag_trav1	2007	dome	plag	480	45.2	34.8	18.2	1.1	0.5	0.0	99.9	89.2
Un 17 Kelut2007B_plag_trav1	2007	dome	plag	485	45.7	34.8	18.1	1.2	0.5	0.0	100.3	91.8
Un 17 Kelut2007B_plag_trav1	2007	dome	plag	490	46.3	34.2	17.5	1.5	0.5	0.0	100.1	76.6
Un 17 Kelut2007B_plag_trav1	2007	dome	plag	495	47.1	33.8	16.9	1.7	0.6	0.0	100.0	74.8
Un 17 Kelut2007B_plag_trav1	2007	dome	plag	500	47.2	33.3	16.5	2.0	0.5	0.0	99.6	91.5
Un 17 Kelut2007B_plag_trav1	2007	dome	plag	505	47.6	33.2	16.5	2.1	0.6	0.0	99.8	88.3
Un 17 Kelut2007B_plag_trav1	2007	dome	plag	510	49.3	31.6	15.2	2.8	0.5	0.1	99.4	87.7
Un 17 Kelut2007B_plag_trav1	2007	dome	plag	515	50.6	31.2	14.1	3.4	0.5	0.1	100.0	90.7
Un 17 Kelut2007B_plag_trav1	2007	dome	plag	520	51.0	30.8	13.5	3.7	0.6	0.1	99.7	77.4
Un 17 Kelut2007B_plag_trav1	2007	dome	plag	525	51.5	30.3	13.3	3.9	0.5	0.1	99.6	83.6
Un 17 Kelut2007B_plag_trav1	2007	dome	plag	530	50.3	31.1	14.1	3.3	0.6	0.1	99.5	74.5
Un 17 Kelut2007B_plag_trav1	2007	dome	plag	535	49.2	31.6	14.6	2.9	0.6	0.1	99.0	91.2
Un 17 Kelut2007B_plag_trav1	2007	dome	plag	540	49.8	31.5	14.5	3.1	0.6	0.1	99.4	91.0
Un 17 Kelut2007B_plag_trav1	2007	dome	plag	545	49.2	31.6	15.0	2.9	0.6	0.1	99.3	85.7
Un 17 Kelut2007B_plag_trav1	2007	dome	plag	550	48.3	32.5	15.9	2.4	0.6	0.0	99.7	68.9
Un 17 Kelut2007B_plag_trav1	2007	dome	plag	555	49.1	31.9	15.1	2.9	0.6	0.1	99.6	89.7
Un 17 Kelut2007B_plag_trav1	2007	dome	plag	560	49.6	31.5	14.6	3.1	0.5	0.1	99.4	89.9
Un 17 Kelut2007B_plag_trav1	2007	dome	plag	565	49.8	31.2	14.5	3.2	0.6	0.1	99.2	65.6
Un 17 Kelut2007B_plag_trav1	2007	dome	plag	570	49.9	31.2	14.5	3.1	0.6	0.0	99.3	65.8
Un 17 Kelut2007B_plag_trav1	2007	dome	plag	575	49.9	31.1	14.5	3.2	0.5	0.1	99.4	91.0
Un 17 Kelut2007B_plag_trav1	2007	dome	plag	580	50.4	31.1	14.2	3.3	0.6	0.1	99.7	90.6
Un 17 Kelut2007B_plag_trav1	2007	dome	plag	585	49.6	31.3	14.6	3.0	0.6	0.1	99.1	67.4
Un 17 Kelut2007B_plag_trav1	2007	dome	plag	590	49.7	31.8	14.7	3.0	0.6	0.0	100.0	91.2

SAMPLE	Year	type	mineral	traverse d (μm)	SiO2 (wt. %)	Al2O3 (wt. %)	CaO (wt. %)	Na2O (wt. %)	FeO (wt. %)	K2O (wt. %)	Total (wt. %)	An content
Un 17 Kelut2007B_plag_trav1	2007	dome	plag	595	50.1	30.9	14.2	3.5	0.6	0.1	99.4	90.3
Un 17 Kelut2007B_plag_trav1	2007	dome	plag	600	50.0	31.1	14.5	3.2	0.6	0.1	99.4	93.2
Un 17 Kelut2007B_plag_trav1	2007	dome	plag	605	50.3	30.9	14.5	3.2	0.6	0.1	99.6	91.5
Un 17 Kelut2007B_plag_trav1	2007	dome	plag	610	51.3	30.6	13.5	3.7	0.6	0.1	99.8	69.9
Un 17 Kelut2007B_plag_trav1	2007	dome	plag	615	51.9	28.5	12.2	3.9	1.3	0.1	97.9	95.1
Un 17 Kelut2007B_plag_trav1	2007	dome	plag	620	53.3	28.6	11.6	4.8	0.7	0.2	99.3	91.6
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	0	52.1	29.2	12.3	4.4	0.8	0.2	98.8	75.2
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	5	49.5	29.0	12.7	3.5	0.7	0.2	95.6	95.2
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	10	48.7	30.0	13.6	3.4	0.6	0.1	96.3	79.9
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	15	49.7	31.0	14.2	3.2	0.6	0.1	98.7	91.4
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	20	49.2	31.6	14.8	3.0	0.6	0.0	99.3	95.1
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	25	48.0	31.9	15.4	2.5	0.6	0.0	98.3	91.6
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	30	48.6	31.5	14.9	3.0	0.5	0.1	98.6	81.8
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	35	49.0	31.6	14.4	3.1	0.5	0.1	98.6	79.9
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	40	48.5	32.2	15.1	2.8	0.5	0.0	99.1	95.0
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	45	47.1	33.1	16.2	2.0	0.5	0.0	98.8	91.3
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	50	46.0	33.8	17.0	1.6	0.5	0.0	98.9	95.4
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	55	44.6	34.7	18.1	1.1	0.4	0.0	99.0	90.4
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	60	44.1	34.8	18.3	0.8	0.4	0.0	98.5	81.7
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	65	44.1	34.9	18.2	1.0	0.4	0.0	98.7	84.7
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	70	44.2	34.7	18.2	1.0	0.4	0.0	98.6	95.1
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	75	44.1	34.9	18.3	0.9	0.4	-0.0	98.7	90.3
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	80	43.9	34.9	18.4	0.9	0.4	0.0	98.5	89.1
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	85	44.2	34.6	18.4	0.8	0.4	0.0	98.5	95.4

SAMPLE	Year	type	mineral	traverse d (μm)	SiO2 (wt. %)	Al2O3 (wt. %)	CaO (wt. %)	Na2O (wt. %)	FeO (wt. %)	K2O (wt. %)	Total (wt. %)	An content
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	90	44.5	34.7	18.3	1.1	0.4	0.0	99.1	91.5
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	95	44.5	34.9	18.1	1.1	0.4	0.0	99.0	95.1
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	100	45.1	34.2	17.8	1.2	0.5	0.0	98.8	91.2
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	105	45.0	34.3	17.7	1.2	0.4	0.0	98.6	90.7
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	110	45.0	34.5	18.0	1.1	0.4	0.0	99.0	95.0
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	115	45.0	34.6	18.0	1.0	0.4	0.0	99.0	92.0
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	120	44.8	34.3	17.7	1.2	0.5	0.0	98.5	89.8
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	125	45.0	34.1	17.6	1.3	0.5	0.0	98.6	95.2
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	130	45.0	34.1	17.6	1.3	0.5	0.0	98.6	93.8
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	135	46.1	33.2	16.9	1.8	0.5	0.0	98.5	89.5
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	140	45.4	33.8	17.5	1.6	0.5	0.0	98.7	93.1
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	145	44.8	34.3	17.9	1.1	0.5	0.0	98.6	95.1
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	150	44.4	34.5	18.5	1.0	0.4	0.0	98.9	89.9
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	155	44.8	34.6	18.0	1.1	0.4	0.0	98.8	94.9
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	160	44.0	35.1	18.6	0.7	0.4	0.0	98.8	94.1
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	165	43.8	35.6	19.1	0.5	0.4	-0.0	99.4	88.8
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	170	43.4	35.5	19.3	0.5	0.4	0.0	99.2	95.2
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	175	43.4	35.7	18.9	0.5	0.4	0.0	99.0	93.9
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	180	43.4	35.4	19.0	0.6	0.4	0.0	98.8	90.2
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	185	43.5	35.6	19.2	0.5	0.4	0.0	99.1	95.2
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	190	43.5	35.5	19.1	0.5	0.4	0.0	99.0	93.9
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	195	43.5	35.5	18.9	0.5	0.4	0.0	98.9	93.1
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	200	43.1	35.5	19.2	0.5	0.4	-0.0	98.8	94.2
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	205	43.1	35.4	19.1	0.6	0.4	-0.0	98.6	92.6

SAMPLE	Year	type	mineral	traverse d (μm)	SiO2 (wt. %)	Al2O3 (wt. %)	CaO (wt. %)	Na2O (wt. %)	FeO (wt. %)	K2O (wt. %)	Total (wt. %)	An content
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	210	43.3	35.6	19.2	0.5	0.5	0.0	99.0	94.7
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	215	43.3	35.4	19.1	0.5	0.4	0.0	98.8	94.1
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	220	43.3	35.5	19.1	0.6	0.4	0.0	98.9	92.5
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	225	43.6	35.6	19.0	0.5	0.5	0.0	99.2	90.9
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	230	43.6	35.3	19.3	0.5	0.4	0.0	99.1	91.9
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	235	43.5	35.5	19.2	0.6	0.5	0.0	99.2	94.8
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	240	43.2	35.4	19.0	0.6	0.5	0.0	98.7	91.8
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	245	43.5	35.5	19.0	0.6	0.5	0.0	99.0	91.3
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	250	43.3	35.5	19.0	0.5	0.5	-0.0	98.7	92.0
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	255	43.2	35.3	19.0	0.6	0.4	-0.0	98.6	95.2
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	260	43.3	35.4	19.2	0.5	0.5	0.0	99.0	94.7
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	265	43.4	35.3	19.2	0.6	0.5	-0.0	99.0	91.4
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	270	43.4	35.3	19.0	0.6	0.4	0.0	98.7	92.4
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	275	43.2	35.5	19.0	0.6	0.5	0.0	98.8	91.8
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	280	43.6	35.4	18.8	0.6	0.5	0.0	98.9	91.1
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	285	43.3	35.4	18.9	0.6	0.4	0.0	98.7	95.2
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	290	43.1	35.3	18.9	0.5	0.5	0.0	98.2	94.6
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	295	43.4	35.3	19.0	0.6	0.5	0.0	98.7	85.1
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	300	43.4	35.4	18.9	0.6	0.4	0.0	98.7	92.5
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	305	43.2	35.3	19.1	0.5	0.5	0.0	98.7	94.5
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	310	43.3	35.2	19.3	0.5	0.4	-0.0	98.7	93.2
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	315	43.3	35.4	18.9	0.5	0.5	-0.0	98.7	85.7
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	320	43.2	35.3	18.9	0.6	0.5	0.0	98.5	90.4
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	325	43.2	35.6	19.0	0.5	0.5	0.0	98.8	95.0

SAMPLE	Year	type	mineral	traverse d (μm)	SiO2 (wt. %)	Al2O3 (wt. %)	CaO (wt. %)	Na2O (wt. %)	FeO (wt. %)	K2O (wt. %)	Total (wt. %)	An content
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	330	43.3	35.0	18.9	0.6	0.4	0.0	98.2	92.4
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	335	43.3	35.5	19.0	0.5	0.4	0.0	98.7	94.4
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	340	43.4	35.5	18.9	0.6	0.5	0.0	98.8	88.7
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	345	43.6	35.5	19.1	0.5	0.4	0.0	99.1	91.3
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	350	43.6	35.3	18.9	0.6	0.5	0.0	98.8	91.0
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	355	43.5	35.2	19.0	0.6	0.5	0.0	98.7	94.7
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	360	43.4	35.1	18.9	0.5	0.4	0.0	98.4	85.1
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	365	43.4	35.3	18.8	0.5	0.4	0.0	98.4	95.1
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	370	43.8	35.3	18.9	0.6	0.4	0.0	99.0	85.0
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	375	43.5	35.2	19.3	0.6	0.4	-0.0	99.0	92.3
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	380	43.4	35.2	18.9	0.7	0.4	0.0	98.7	94.9
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	385	43.6	35.3	18.9	0.7	0.4	0.0	98.9	87.1
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	390	43.8	35.2	18.7	0.8	0.4	0.0	98.9	92.1
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	395	45.8	33.8	17.1	1.6	0.5	0.0	98.8	94.7
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	400	44.6	34.0	17.7	1.3	0.5	0.0	98.1	93.4
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	405	44.4	34.3	18.1	1.1	0.4	0.0	98.4	88.3
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	410	44.5	34.4	17.8	1.2	0.5	0.0	98.4	95.3
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	415	44.3	34.3	18.0	1.2	0.4	0.0	98.3	93.9
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	420	44.9	34.5	17.8	1.2	0.4	0.0	98.8	92.1
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	425	44.8	34.4	17.8	1.2	0.4	0.0	98.7	95.2
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	430	45.0	34.2	17.8	1.3	0.4	0.0	98.8	92.9
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	435	44.9	34.3	18.1	1.3	0.4	0.0	99.0	92.1
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	440	44.8	34.5	17.7	1.3	0.5	0.0	98.7	92.6
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	445	45.0	34.2	17.7	1.4	0.5	0.0	98.7	95.5

SAMPLE	Year	type	mineral	traverse d (μm)	SiO2 (wt. %)	Al2O3 (wt. %)	CaO (wt. %)	Na2O (wt. %)	FeO (wt. %)	K2O (wt. %)	Total (wt. %)	An content
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	450	45.3	34.0	17.5	1.4	0.5	0.0	98.7	92.0
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	455	45.6	33.5	16.9	1.6	0.6	0.0	98.2	94.4
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	460	45.4	33.7	17.1	1.6	0.6	0.0	98.5	92.6
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	465	46.0	32.4	16.3	2.2	0.6	0.1	97.6	92.7
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	470	48.2	31.3	14.7	3.0	0.7	0.1	97.9	95.1
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	475	45.8	33.3	16.8	1.7	0.6	0.0	98.3	92.3
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	480	46.7	32.8	16.2	2.2	0.6	0.0	98.5	92.4
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	485	47.1	32.7	16.2	2.2	0.6	0.0	98.8	94.7
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	490	44.4	34.5	17.9	1.1	0.5	0.0	98.3	92.9
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	495	44.5	34.6	17.9	1.1	0.4	0.0	98.6	91.6
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	500	43.8	34.9	18.4	0.9	0.5	0.0	98.4	95.3
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	505	44.1	34.7	18.5	0.9	0.4	0.0	98.6	92.8
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	510	44.0	35.1	18.6	0.9	0.4	0.0	99.0	90.5
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	515	44.3	34.7	18.2	1.0	0.4	0.0	98.6	94.7
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	520	44.1	34.6	18.2	1.1	0.5	0.0	98.5	94.2
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	525	44.0	34.7	18.3	1.0	0.5	0.0	98.4	90.1
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	530	44.2	34.5	18.2	1.1	0.5	0.0	98.5	95.2
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	535	44.6	34.3	17.9	1.2	0.5	0.0	98.5	93.3
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	540	44.8	34.0	17.4	1.4	0.5	0.0	98.0	92.4
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	545	45.5	33.6	17.4	1.5	0.5	0.0	98.6	93.2
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	550	44.5	34.2	17.8	1.1	0.5	0.0	98.1	94.4
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	555	44.4	34.3	18.2	1.2	0.4	0.0	98.6	91.9
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	560	44.9	34.5	18.0	1.1	0.5	0.0	99.0	91.6
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	565	44.5	34.7	18.1	1.1	0.4	0.0	98.9	94.9

SAMPLE	Year	type	mineral	traverse d (μm)	SiO2 (wt. %)	Al2O3 (wt. %)	CaO (wt. %)	Na2O (wt. %)	FeO (wt. %)	K2O (wt. %)	Total (wt. %)	An content
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	570	44.8	34.4	18.0	1.2	0.5	0.0	98.8	92.2
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	575	44.2	34.7	18.2	1.2	0.5	0.0	98.8	95.1
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	580	45.1	34.2	17.5	1.2	0.4	0.0	98.5	91.2
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	585	44.7	34.0	17.6	1.3	0.5	0.0	98.1	93.1
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	590	43.7	34.4	18.1	1.0	0.4	0.0	97.7	95.3
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	595	43.7	34.9	18.2	0.8	0.4	0.0	98.1	89.4
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	600	43.9	34.7	18.4	1.0	0.4	0.0	98.5	92.6
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	605	44.4	34.5	18.1	1.2	0.4	0.0	98.6	90.2
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	610	44.1	34.5	18.1	1.1	0.4	0.0	98.2	94.8
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	615	43.5	34.8	18.5	0.8	0.4	0.0	98.0	93.0
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	620	43.9	34.8	18.5	0.9	0.4	0.0	98.5	92.2
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	625	46.1	33.3	16.8	1.7	0.5	0.0	98.5	94.8
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	630	45.0	30.6	15.0	2.4	0.5	0.1	93.5	90.3
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	635	48.1	31.7	15.2	2.7	0.6	0.0	98.3	93.6
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	640	48.0	31.5	15.1	2.7	0.6	0.1	97.9	91.0
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	645	50.4	30.2	13.2	3.7	0.6	0.1	98.1	90.7
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	650	50.1	29.9	13.2	3.8	0.6	0.1	97.6	94.1
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	655	49.3	30.7	14.1	3.4	0.6	0.1	98.2	91.8
Un 18 Kelut2007B_plag_trav2	2007	dome	plag	660	51.2	29.2	12.2	3.9	0.7	0.1	97.4	91.9
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	0	52.0	30.2	13.1	4.0	0.6	0.1	100.0	90.8
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	5	51.0	31.1	14.3	3.4	0.6	0.1	100.4	93.0
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	10	49.9	31.2	14.6	3.1	0.6	0.1	99.5	92.1
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	15	48.9	32.2	15.5	2.6	0.6	0.0	99.8	85.4
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	20	49.8	31.6	14.7	3.2	0.6	0.1	99.9	89.6

SAMPLE	Year	type	mineral	traverse d (μm)	SiO2 (wt. %)	Al2O3 (wt. %)	CaO (wt. %)	Na2O (wt. %)	FeO (wt. %)	K2O (wt. %)	Total (wt. %)	An content
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	25	51.1	31.2	14.1	3.4	0.6	0.1	100.4	91.8
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	30	50.3	31.4	14.3	3.1	0.6	0.1	99.8	88.2
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	35	50.2	31.7	14.8	3.0	0.6	0.0	100.3	89.6
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	40	51.4	30.7	13.6	3.6	0.6	0.1	99.9	92.1
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	45	50.4	31.0	14.4	3.2	0.6	0.1	99.6	89.2
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	50	50.1	31.3	14.7	3.1	0.5	0.1	99.9	89.6
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	55	49.9	31.3	14.3	3.2	0.6	0.1	99.2	92.2
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	60	50.3	31.5	14.5	3.2	0.5	0.1	100.0	89.3
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	65	49.4	31.9	15.3	2.7	0.6	0.0	100.0	90.3
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	70	48.4	32.2	16.0	2.5	0.6	0.0	99.7	92.0
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	75	47.6	32.7	15.9	2.2	0.6	0.0	99.1	89.2
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	80	48.8	32.3	15.7	2.5	0.6	0.0	100.0	91.9
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	85	48.2	32.7	15.9	2.2	0.6	0.0	99.7	92.6
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	90	48.3	32.7	16.1	2.4	0.6	0.1	100.2	89.2
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	95	48.6	32.5	15.5	2.4	0.6	0.1	99.7	91.8
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	100	48.1	32.9	16.1	2.2	0.6	0.0	100.0	90.3
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	105	49.2	32.2	15.3	2.7	0.6	0.0	100.0	88.9
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	110	49.4	32.0	15.2	2.8	0.6	0.0	100.0	90.6
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	115	49.4	32.0	15.4	2.7	0.6	0.0	100.0	92.3
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	120	49.3	32.4	15.6	2.6	0.6	0.0	100.4	88.1
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	125	49.5	31.9	15.3	2.8	0.6	0.1	100.1	91.1
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	130	48.8	32.5	15.9	2.6	0.6	0.0	100.5	92.5
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	135	49.4	31.9	15.2	2.8	0.6	0.0	100.0	88.5
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	140	51.0	31.1	13.9	3.4	0.6	0.1	100.1	90.8

SAMPLE	Year	type	mineral	traverse d (μm)	SiO2 (wt. %)	Al2O3 (wt. %)	CaO (wt. %)	Na2O (wt. %)	FeO (wt. %)	K2O (wt. %)	Total (wt. %)	An content
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	145	51.5	30.4	13.3	3.8	0.5	0.1	99.7	92.5
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	150	51.7	30.5	13.3	3.8	0.5	0.1	99.9	88.3
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	155	51.2	30.7	13.6	3.6	0.6	0.1	99.8	92.4
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	160	51.0	31.2	14.0	3.3	0.5	0.1	100.1	91.1
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	165	48.9	32.0	15.2	2.7	0.6	0.0	99.6	87.2
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	170	48.4	33.0	16.0	2.2	0.5	0.0	100.2	92.4
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	175	47.8	33.1	16.2	2.0	0.5	0.0	99.6	91.1
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	180	47.8	33.3	16.2	2.2	0.5	0.0	100.2	87.0
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	185	47.3	33.4	16.8	2.1	0.5	0.0	100.2	89.0
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	190	46.8	33.6	17.3	1.7	0.5	0.0	100.0	93.1
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	195	45.9	34.4	17.8	1.2	0.4	0.0	99.7	85.4
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	200	45.2	34.9	18.2	1.0	0.5	0.0	99.7	93.4
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	205	44.9	35.0	18.5	0.9	0.4	0.0	99.8	89.6
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	210	44.8	35.5	18.7	0.7	0.4	0.0	100.1	85.3
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	215	44.7	35.4	19.0	0.8	0.4	0.0	100.3	92.5
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	220	44.5	35.3	19.0	0.7	0.4	0.0	99.8	90.2
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	225	44.7	35.5	18.9	0.7	0.4	0.0	100.2	90.9
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	230	44.8	35.7	18.8	0.7	0.4	0.0	100.4	79.9
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	235	45.0	35.3	19.0	0.6	0.4	-0.0	100.3	89.9
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	240	45.2	35.3	18.4	0.8	0.4	0.0	100.1	72.9
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	245	45.1	35.2	18.4	0.9	0.5	0.0	100.1	90.8
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	250	45.1	35.4	18.7	0.9	0.4	0.0	100.5	90.3
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	255	44.8	35.4	18.8	0.8	0.4	0.0	100.2	84.5
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	260	43.8	35.5	18.4	0.9	0.4	0.0	99.0	90.1

SAMPLE	Year	type	mineral	traverse d (μm)	SiO2 (wt. %)	Al2O3 (wt. %)	CaO (wt. %)	Na2O (wt. %)	FeO (wt. %)	K2O (wt. %)	Total (wt. %)	An content
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	265	44.8	35.2	18.7	0.8	0.4	0.0	100.0	92.9
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	270	44.9	35.3	18.6	0.7	0.4	0.0	100.0	80.2
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	275	44.9	35.3	18.8	0.8	0.4	0.0	100.2	89.8
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	280	45.1	35.1	18.6	1.0	0.4	0.0	100.3	92.6
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	285	45.1	34.9	18.4	1.0	0.4	0.0	99.8	80.5
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	290	45.3	35.2	18.6	0.8	0.4	0.0	100.4	91.5
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	295	44.9	35.1	18.7	0.9	0.4	0.0	100.0	89.5
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	300	44.6	35.3	18.8	0.7	0.4	0.0	99.9	90.2
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	305	44.9	35.4	19.0	0.7	0.4	0.0	100.4	92.9
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	310	45.2	35.4	18.6	0.8	0.5	0.0	100.5	86.2
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	315	44.7	35.4	18.6	0.8	0.4	0.0	100.0	89.9
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	320	45.0	35.2	18.8	0.8	0.5	0.0	100.3	84.4
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	325	45.0	35.2	18.6	0.9	0.5	0.0	100.1	91.8
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	330	44.9	35.3	19.0	0.8	0.4	0.0	100.4	92.1
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	335	44.6	35.6	18.8	0.8	0.4	0.0	100.2	91.5
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	340	44.7	35.5	18.8	0.6	0.5	0.0	100.1	81.7
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	345	44.7	35.4	18.8	0.7	0.4	0.0	100.1	91.9
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	350	44.6	35.3	18.9	0.8	0.5	0.0	100.0	92.5
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	355	44.9	35.2	18.7	0.9	0.5	0.0	100.2	81.4
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	360	45.5	35.0	18.5	1.0	0.5	0.0	100.5	92.2
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	365	45.6	34.7	17.9	1.2	0.5	0.0	99.9	93.3
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	370	45.5	34.6	18.2	1.1	0.5	0.0	99.9	74.5
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	375	45.7	35.0	18.3	1.1	0.5	0.0	100.6	90.7
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	380	45.4	35.1	18.4	1.0	0.4	0.0	100.4	93.8

SAMPLE	Year	type	mineral	traverse d (μm)	SiO2 (wt. %)	Al2O3 (wt. %)	CaO (wt. %)	Na2O (wt. %)	FeO (wt. %)	K2O (wt. %)	Total (wt. %)	An content
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	385	45.3	35.0	18.3	0.9	0.4	0.0	99.9	69.1
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	390	44.8	35.1	18.4	0.9	0.4	0.0	99.7	90.1
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	395	45.0	35.3	18.5	0.9	0.5	0.0	100.2	66.7
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	400	45.1	35.2	18.7	0.9	0.4	0.0	100.3	93.4
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	405	45.1	35.3	18.3	0.9	0.4	0.0	99.9	91.3
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	410	45.0	35.5	18.8	0.9	0.5	0.0	100.7	64.7
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	415	45.2	35.1	18.7	0.8	0.4	0.0	100.3	94.2
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	420	45.3	35.2	18.6	0.9	0.5	0.0	100.4	90.4
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	425	45.2	35.1	18.4	0.8	0.4	0.0	100.0	69.7
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	430	44.9	35.3	18.7	0.8	0.4	0.0	100.1	93.9
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	435	45.0	35.4	18.4	0.8	0.5	0.0	100.0	88.8
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	440	44.9	35.4	18.8	0.8	0.5	0.0	100.4	94.3
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	445	45.2	35.3	18.5	0.8	0.5	0.0	100.3	73.2
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	450	45.0	35.4	18.6	0.8	0.4	0.0	100.2	87.4
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	455	44.8	35.2	18.9	0.7	0.4	0.0	100.0	71.9
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	460	45.1	35.3	18.6	0.8	0.4	0.0	100.3	94.1
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	465	45.1	34.9	18.3	1.0	0.5	0.0	99.8	86.6
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	470	44.3	34.6	18.2	1.0	0.4	0.0	98.5	73.7
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	475	44.6	35.2	18.5	0.8	0.5	0.0	99.6	94.3
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	480	45.2	35.3	18.8	0.8	0.4	0.0	100.5	89.9
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	485	45.1	34.9	18.5	0.9	0.4	0.0	99.8	93.6
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	490	45.0	35.3	18.7	0.8	0.4	0.0	100.2	78.3
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	495	45.3	35.2	18.3	0.9	0.4	0.0	100.2	89.1
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	500	45.2	35.2	18.3	0.9	0.4	0.0	100.1	74.1

SAMPLE	Year	type	mineral	traverse d (μm)	SiO2 (wt. %)	Al2O3 (wt. %)	CaO (wt. %)	Na2O (wt. %)	FeO (wt. %)	K2O (wt. %)	Total (wt. %)	An content
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	505	44.7	35.2	18.9	0.8	0.4	0.0	100.1	93.8
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	510	44.7	35.3	19.1	0.7	0.4	0.0	100.2	89.6
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	515	44.4	35.5	18.8	0.7	0.4	0.0	99.8	71.8
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	520	44.6	35.5	18.8	0.7	0.4	0.0	100.1	93.3
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	525	44.4	35.4	18.7	0.6	0.4	0.0	99.6	90.1
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	530	44.0	34.9	19.0	0.7	0.4	0.0	99.0	71.1
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	535	44.2	35.6	19.1	0.6	0.4	-0.0	100.0	94.1
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	540	44.3	35.6	19.0	0.7	0.4	-0.0	99.9	89.0
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	545	44.5	35.6	19.1	0.6	0.4	0.0	100.2	93.8
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	550	44.5	35.4	19.1	0.7	0.4	0.0	100.1	71.8
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	555	44.4	35.7	19.1	0.7	0.4	0.0	100.2	89.6
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	560	43.8	35.8	18.4	0.7	0.4	0.0	99.1	93.9
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	565	44.6	35.5	18.8	0.7	0.5	0.0	100.1	71.1
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	570	44.3	35.5	18.8	0.7	0.4	0.0	99.7	88.6
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	575	44.3	35.5	18.9	0.7	0.4	0.0	99.7	93.9
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	580	44.2	35.5	19.1	0.7	0.4	0.0	99.9	69.9
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	585	44.5	35.6	19.2	0.7	0.4	0.0	100.4	88.1
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	590	44.3	35.5	19.0	0.6	0.4	0.0	99.8	72.5
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	595	44.4	35.6	18.9	0.6	0.4	0.0	99.9	93.8
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	600	44.5	35.6	18.9	0.7	0.4	0.0	100.1	90.6
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	605	44.4	35.6	18.9	0.6	0.4	-0.0	99.9	94.7
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	610	44.7	35.4	18.8	0.8	0.4	0.0	100.0	72.6
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	615	44.7	34.8	18.8	0.9	0.4	0.0	99.6	92.3
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	620	44.6	35.3	18.5	0.8	0.4	0.0	99.6	94.7

SAMPLE	Year	type	mineral	traverse d (μm)	SiO2 (wt. %)	Al2O3 (wt. %)	CaO (wt. %)	Na2O (wt. %)	FeO (wt. %)	K2O (wt. %)	Total (wt. %)	An content
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	625	44.4	35.2	18.7	0.8	0.4	0.0	99.6	69.2
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	630	43.5	34.3	18.2	1.0	0.4	0.0	97.4	93.6
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	635	44.4	34.8	18.6	0.7	0.4	0.0	99.0	91.4
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	640	44.4	35.3	18.9	0.7	0.4	0.0	99.7	71.4
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	645	44.4	35.7	19.1	0.6	0.4	0.0	100.2	89.6
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	650	43.9	35.6	18.8	0.7	0.4	0.0	99.4	94.4
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	655	43.8	35.6	19.1	0.5	0.4	0.0	99.4	71.1
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	660	43.7	35.5	19.2	0.5	0.4	0.0	99.4	89.9
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	665	43.9	35.5	18.8	0.5	0.4	0.0	99.1	66.5
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	670	43.8	35.7	19.2	0.5	0.4	0.0	99.6	93.1
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	675	43.9	35.6	19.4	0.5	0.4	0.0	99.8	93.1
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	680	43.9	35.5	19.3	0.6	0.4	0.0	99.7	62.8
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	685	44.2	35.7	19.2	0.6	0.4	0.0	100.1	92.2
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	690	42.4	34.4	18.3	0.6	0.4	0.0	96.1	91.9
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	695	41.5	34.0	18.0	0.6	0.4	-0.0	94.5	92.4
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	700	41.9	34.0	18.2	0.6	0.4	0.0	95.2	56.8
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	705	42.5	34.1	18.4	0.6	0.4	0.0	95.9	84.2
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	710	42.9	34.2	17.7	0.8	0.5	0.0	96.1	92.6
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	715	46.3	33.5	16.8	1.6	0.5	0.0	98.7	77.4
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	720	47.8	32.6	15.9	2.1	0.5	0.0	99.0	91.0
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	725	47.6	32.7	16.4	2.1	0.5	0.0	99.4	75.2
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	730	48.2	32.3	15.7	2.5	0.6	0.0	99.3	93.3
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	735	50.1	31.2	14.3	3.4	0.5	0.1	99.5	75.6
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	740	51.7	30.0	13.2	3.9	0.5	0.1	99.4	93.6

SAMPLE	Year	type	mineral	traverse d (μm)	SiO2 (wt. %)	Al2O3 (wt. %)	CaO (wt. %)	Na2O (wt. %)	FeO (wt. %)	K2O (wt. %)	Total (wt. %)	An content
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	745	50.0	30.7	14.1	3.3	0.6	0.1	98.9	66.0
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	750	49.5	31.3	14.4	3.0	0.5	0.1	98.8	94.4
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	755	50.4	30.9	14.1	3.3	0.6	0.1	99.4	65.7
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	760	49.6	31.3	14.6	3.1	0.6	0.1	99.1	93.6
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	765	48.8	31.7	15.2	2.8	0.6	0.1	99.2	69.5
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	770	49.1	31.7	14.8	2.8	0.6	0.0	99.1	95.1
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	775	49.2	31.7	14.9	2.8	0.6	0.0	99.3	62.7
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	780	48.1	32.2	15.4	2.3	0.6	0.1	98.6	95.1
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	785	59.6	21.5	9.0	4.0	2.9	0.9	98.0	95.1
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	790	64.6	18.1	4.6	6.7	2.6	1.0	97.6	95.5
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	795	52.3	28.9	12.2	4.3	0.8	0.2	98.6	95.2
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	800	48.2	32.3	15.5	2.5	0.6	0.0	99.1	94.6
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	805	48.4	32.2	15.5	2.5	0.6	0.0	99.2	94.8
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	810	48.1	32.3	15.6	2.3	0.6	0.1	99.0	94.0
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	815	50.6	30.2	14.1	3.4	0.9	0.2	99.4	93.9
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	820	48.3	32.2	15.7	2.5	0.6	0.0	99.4	94.2
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	825	48.1	32.3	15.6	2.4	0.6	0.0	99.0	94.6
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	830	47.6	32.9	16.2	2.2	0.6	0.0	99.5	92.4
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	835	47.5	32.5	15.9	2.4	0.6	0.0	99.0	85.4
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	840	43.7	30.0	15.1	2.1	0.6	0.0	91.6	80.3
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	845	47.3	32.5	15.8	2.2	0.6	0.0	98.4	80.7
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	850	46.8	32.6	16.2	2.0	0.6	0.0	98.4	77.5
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	855	46.8	32.7	16.2	2.1	0.6	0.0	98.5	69.9
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	860	49.2	31.8	14.9	3.0	0.6	0.0	99.5	64.8

SAMPLE	Year	type	mineral	traverse d (μm)	SiO2 (wt. %)	Al2O3 (wt. %)	CaO (wt. %)	Na2O (wt. %)	FeO (wt. %)	K2O (wt. %)	Total (wt. %)	An content
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	865	49.4	30.2	13.6	3.5	0.6	0.1	97.3	70.1
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	870	51.2	29.8	13.2	3.8	0.5	0.1	98.4	72.2
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	875	51.6	29.5	12.6	4.1	0.5	0.1	98.4	69.7
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	880	50.5	30.0	13.1	3.8	0.5	0.1	98.0	72.1
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	885	50.5	30.5	13.7	3.7	0.6	0.1	99.0	74.6
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	890	48.9	31.4	14.7	3.0	0.6	0.0	98.6	74.1
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	895	49.4	31.3	14.5	3.1	0.6	0.1	98.9	74.3
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	900	47.6	28.3	12.6	3.5	0.6	0.1	92.7	78.4
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	905	45.7	28.7	13.4	3.0	0.5	0.1	91.4	51.7
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	910	48.7	30.8	14.5	3.1	0.5	0.1	97.6	25.5
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	915	48.6	31.2	14.5	3.1	0.5	0.1	97.9	60.5
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	920	47.5	31.7	15.2	2.6	0.5	0.1	97.7	77.0
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	925	48.4	31.2	14.7	2.9	0.6	0.1	98.0	77.3
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	930	49.3	30.1	13.8	3.5	0.6	0.1	97.2	78.6
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	935	49.1	30.6	14.2	3.1	0.6	0.1	97.6	68.8
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	940	49.8	30.3	13.4	3.6	0.6	0.1	97.7	77.2
Un 19 Kelut2007B_plag_trav3	2007	dome	plag	945	50.4	29.7	13.1	3.7	0.6	0.1	97.6	78.2
Un 20 Kelut2007B_plag_trav4	2007	dome	plag	0	52.5	28.0	11.4	4.7	0.7	0.2	97.4	80.3
Un 20 Kelut2007B_plag_trav4	2007	dome	plag	5	46.6	30.2	14.1	2.6	0.6	0.1	94.2	78.3
Un 20 Kelut2007B_plag_trav4	2007	dome	plag	10	47.3	32.0	15.7	2.4	0.6	0.1	98.1	79.8
Un 20 Kelut2007B_plag_trav4	2007	dome	plag	15	48.1	31.5	15.0	2.8	0.6	0.1	98.1	80.0
Un 20 Kelut2007B_plag_trav4	2007	dome	plag	20	47.1	32.1	15.6	2.3	0.6	0.0	97.7	81.4
Un 20 Kelut2007B_plag_trav4	2007	dome	plag	25	46.2	32.7	16.3	2.1	0.5	0.0	97.9	81.0
Un 20 Kelut2007B_plag_trav4	2007	dome	plag	30	45.8	33.1	17.0	1.8	0.6	0.0	98.2	73.3

SAMPLE	Year	type	mineral	traverse d (μm)	SiO2 (wt. %)	Al2O3 (wt. %)	CaO (wt. %)	Na2O (wt. %)	FeO (wt. %)	K2O (wt. %)	Total (wt. %)	An content
Un 20 Kelut2007B_plag_trav4	2007	dome	plag	35	45.0	33.6	17.3	1.6	0.6	0.0	98.1	67.9
Un 20 Kelut2007B_plag_trav4	2007	dome	plag	40	44.8	33.5	17.3	1.5	0.6	0.0	97.8	65.6
Un 20 Kelut2007B_plag_trav4	2007	dome	plag	45	44.4	34.0	17.4	1.1	0.5	0.0	97.5	62.6
Un 20 Kelut2007B_plag_trav4	2007	dome	plag	50	44.2	34.1	17.7	1.0	0.5	0.0	97.5	65.3
Un 20 Kelut2007B_plag_trav4	2007	dome	plag	55	43.8	34.2	18.0	0.9	0.5	0.0	97.5	67.0
Un 20 Kelut2007B_plag_trav4	2007	dome	plag	60	43.6	34.4	18.3	0.8	0.5	0.0	97.7	72.7
Un 20 Kelut2007B_plag_trav4	2007	dome	plag	65	44.0	34.4	17.9	0.9	0.5	0.0	97.7	71.6
Un 20 Kelut2007B_plag_trav4	2007	dome	plag	70	43.6	34.2	17.8	0.9	0.5	0.0	97.1	66.2
Un 20 Kelut2007B_plag_trav4	2007	dome	plag	75	43.8	34.6	18.3	1.0	0.6	0.0	98.2	70.8
Un 20 Kelut2007B_plag_trav4	2007	dome	plag	80	44.8	33.7	17.3	1.4	0.6	0.0	97.7	71.9
Un 20 Kelut2007B_plag_trav4	2007	dome	plag	85	45.3	33.1	16.7	1.6	0.6	0.0	97.5	72.0
Un 20 Kelut2007B_plag_trav4	2007	dome	plag	90	45.8	32.6	16.2	1.9	0.6	0.0	97.1	76.3
Un 20 Kelut2007B_plag_trav4	2007	dome	plag	95	46.8	32.0	15.7	2.3	0.6	0.0	97.5	73.3
Un 20 Kelut2007B_plag_trav4	2007	dome	plag	100	48.4	31.2	14.7	2.9	0.6	0.1	97.9	68.6
Un 20 Kelut2007B_plag_trav4	2007	dome	plag	105	48.7	30.4	14.1	3.1	0.6	0.1	96.9	71.7
Un 20 Kelut2007B_plag_trav4	2007	dome	plag	110	47.7	31.8	14.9	2.7	0.6	0.1	97.8	67.2
Un 20 Kelut2007B_plag_trav4	2007	dome	plag	115	49.7	30.0	13.3	3.5	0.6	0.1	97.2	65.7

An content = Ca / [Ca + Na + K] in mol.

Table S3.4: whole rock trace element composition of 2007 and 2014 samples

Table S3.4.1: Transition metals, semi-metals, immobile elements, alkaline (earth) elements

Sample ID		Sc	Be	V	Cr	Co	Ni	Cu	Zn	Ga	Ge	As	Rb	Sr	Y	Zr	Nb	Mo	Ag	In	Sn	Sb	Cs	Ba
	<i>wt. ppm</i>																							
KELUT-2007A	2007	20	< 1	182	40	19	< 20	60	70	16	1.5	< 5	13	557	15.3	46	1.1	2	< 0.5	< 0.1	3	0.8	1	468
KELUT-2007B	2007	20	< 1	184	30	19	< 20	60	60	16	1.3	< 5	13	573	15.7	46	0.9	< 2	< 0.5	< 0.1	1	0.8	1	475
KELUT14-ODV	2007	20	< 1	189	40	20	< 20	60	70	16	1.5	< 5	14	564	15.9	45	1.2	< 2	< 0.5	< 0.1	1	1.1	1.1	470
KELUT14-OD1	2007	20	< 1	186	40	20	< 20	60	80	16	1.6	< 5	13	580	15.9	46	1.2	3	< 0.5	< 0.1	1	0.9	1	480
KELUT14-PUM1	2014	19	< 1	178	30	18	< 20	60	60	16	1.6	< 5	14	587	16.3	46	1	< 2	< 0.5	< 0.1	2	1	1.1	497
KELUT14-PUM2	2014	20	< 1	182	40	19	< 20	90	70	16	1.2	< 5	13	600	16.1	45	1.1	< 2	< 0.5	< 0.1	7	0.9	1	489

Table S3.4.2: REE, HFSE, Th, U, Pb, (semi-) metal elements

Sample ID		La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	Hf	Ta	W	Ti	Pb	Bi	Th	U
<i>wt. ppm</i>																							
KELUT-2007A	2007	5.71	12.6	1.69	7.94	2.32	0.902	2.72	0.47	2.81	0.57	1.66	0.245	1.58	0.252	1.4	0.09	2	0.11	8	< 0.1	0.93	0.39
KELUT-2007B	2007	5.65	12.3	1.66	7.92	2.29	0.885	2.66	0.44	2.65	0.54	1.69	0.259	1.74	0.285	1.4	0.13	2	0.11	8	< 0.1	0.9	0.39
KELUT14-ODV	2007	5.86	13.1	1.76	8.49	2.4	0.906	2.73	0.45	2.72	0.55	1.78	0.259	1.65	0.298	1.4	0.07	2.4	0.14	8	< 0.1	0.97	0.39
KELUT14-OD1	2007	5.71	12.9	1.76	8.46	2.51	0.868	2.59	0.44	2.78	0.56	1.65	0.251	1.63	0.262	1.3	0.09	2.3	0.22	9	< 0.1	0.88	0.39
KELUT14-PUM1	2014	6.03	13.2	1.75	8.4	2.4	0.902	2.68	0.46	2.85	0.57	1.76	0.27	1.8	0.274	1.5	0.08	2.3	0.18	9	< 0.1	0.95	0.4
KELUT14-PUM2	2014	6	13.2	1.82	8.3	2.46	0.905	2.75	0.46	2.85	0.59	1.82	0.274	1.75	0.291	1.5	0.1	2.2	0.22	11	< 0.1	0.97	0.4

Fig. S3.4: Compilation of BSE images of plagioclase textures, plagioclase traverse analyses, and elemental maps of plagioclase and cristobalite from the 2007 dome

Figure S2: Miscellaneous
mineral textures and chemistry
for Kelud, 1990-2014

Selected 2007 dome plagioclase textures

Selected 2007 dome plagioclase compositional traverses

2007 dome plagioclase and cristobalite element maps