

Disturbance of Trees by the 1857 Fort Tejon Earthquake, California

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Trees may suffer damage during major earthquakes due to shaking or faulting of their substrate. Damage may result in temporarily asymmetric growth and/or reduction in width of annual growth rings. To determine whether trees contain useful records of prehistoric earthquakes in southern California, we cored eight conifers along the 1857 trace of the San Andreas fault near Wrightwood and Frazier Park, California. Annual ring widths were measured and plotted against the growth year determined by ring counting. We examined significant departures from normal growth trends and interpreted them in light of the 1857 earthquake and other possible environmental factors. Of eight trees sampled, five showed damage or growth anomalies attributable to the 1857 event. One 120-year-old tree straddling the fault is undamaged, suggesting no substantial slip since about 1870. To evaluate asymmetry, ratios of correlative rings widths from opposite sides of three seismically damaged trees were calculated and plotted against growth year. Two types of ratio anomalies can be recognized: (1) short-term, unilateral suppression of growth resulting from damage and (2) long-term, unilateral enhancement of growth attributable to tilt or changes in environmental factors. Further study of ring ratio anomalies may facilitate recognition of seismically damaged trees. Success in recognizing the 1857 event in five out of eight trees suggests that a larger suite of even older trees may contain a valuable 'dendroseismological' record of large prehistoric earthquakes in southern California.

INTRODUCTION

Trees may suffer damage during major earthquakes due to shaking or faulting of the ground beneath them [e.g., *Lawson et al.*, 1908, pp. 64, 106, 182, Plates 69A, B; *Plafker et al.*, 1976, p. 44]. External effects, such as topping, root and limb damage, and scars, may result in temporary reduction in width of annual growth rings. Tilting and changes in environmental factors, such as light, space, and water availability, may initiate asymmetric growth and the formation of reaction wood. Dendrochronologic techniques enable dating of such growth anomalies and hence earthquakes.

Cores extracted in 1968 from damaged trees along the 1958 rupture of the Fairweather fault in Alaska enabled *Page* [1970] to date the earthquake to within a few weeks of its occurrence. In their examination of trees along the San Andreas fault in northern California, *LaMarche and Wallace* [1972] found evidence of the great 1906 earthquake to be ambiguous. They did find that some leaning trees acquired their tilt in 1906, however, and may have identified the effects of a previous prehistoric earthquake.

To determine whether trees contain useful records of prehistoric earthquakes in southern California, we cored eight trees along the 1857 break of the San Andreas fault near Wrightwood and Frazier Park, California, (Figure 1).

The Fort Tejon earthquake of January 9, 1857, was produced by 3–10 m of right-lateral slip along at least 360 km of the San Andreas fault [*Sieh*, 1978b]. Contemporary accounts indicate that the earthquake, lasting 1–3 min, was felt throughout most of California south of Sacramento [*Agnew and Sieh*, 1978]. Intensities within a few kilometers of the fault were high enough to throw down some large oak trees and break limbs for others [*Agnew and Sieh*, 1978, appendix, p. 15].

Several species of trees growing along the 1857 rupture attain sufficient age to have recorded the Fort Tejon earthquake. Various species of oak are abundant along certain

reaches of the fault and some individuals show evidence of uprooting and tilting that may be attributable to the 1857 event (D. Rust, personal communication, 1977). We chose to sample only conifers because their relatively simple geometries and symmetric annual ring patterns allow more certain recognition of anomalies.

Samples

Our sampling was neither systematic nor exhaustive. All sampled trees were recognized during earlier geologic studies along the fault. All occur along two short reaches of the 1857 trace, between 5000 feet (1520 m) and 6000 feet (1830 m) in elevation.

We chose three trees west of Frazier Park and five near Wrightwood (Figure 1, Table 1). Six trees are visibly damaged; two are not. The study trees are either on, or within several meters of, the 1857 rupture. For each tree, Table 1 summarizes location, condition, and other descriptive information.

During April 1976, K. Sieh, E. Helley, and P. Russell took 15-mm-diameter cores, up to 183 cm long, from four of the study trees, using a gasoline-powered coring device. Between September 1978 and February 1979, D. Glover and K. Meisling used a 76-cm-long manual increment borer to extract 20 4-mm-diameter cores, increasing the number of sampled trees to eight. Several cores were taken from some trees for study of azimuthal variations in ring anomalies.

Dating Techniques

The cores were mounted in grooved wooden holders, sawed in half lengthwise, and shaved with a razor to facilitate reading of annual rings [see *Glock*, 1937, p. 5]. One year was assigned to each ring counted under a binocular microscope [*Glock*, 1937, p. 6].

Simple ring counting may lead to incorrect dates if false and/or missing rings are not recognized [*Fritts*, 1976, p. 20; *Glock*, 1937, p. 10; *Schulman*, 1956, p. 19]. Normally the latewood/earlywood boundary, representing winter dormancy, is very sharp. The latewood of a false ring can easily be identi-



Fig. 1. ERTS image showing location of the study trees along the San Andreas fault near Frazier Park and Wrightwood, California.

fied by its diffuse boundary with the following earlywood. Recognition that rings are missing is more difficult [Glock, 1937, p. 8]. Fortunately, rings are often only locally absent around the perimeter of the tree and can be recognized in other cores from the same tree. Schulman [1956, p. 17] showed that rarely are more than 8.7% of a tree's rings missing, even under the most stressful conditions of advanced age and severe climate. This translates to a maximum error of about a decade in the 120 years since the 1857 earthquake. Thus even in trees sampled only once, dates are not likely to be in error by more than 10 years; in the case of multiple cores they are probably not in error at all.

More sophisticated dating techniques, based on variations

in annual ring width due to local climate, permit identification of false and missing rings by cross correlation between many trees [Fritts, 1976, p. 21; Schulman, 1956, p. 20]. For such correlation to be possible, tree growth must be limited by climatic factors such as temperature, or rainfall. Other factors may have limited growth in our study trees, since they (1) were on or near the 1857 break of the San Andreas fault and/or (2) show evidence of damage. Furthermore, some of our study trees occupy poorly drained sites rendering them 'complacent,' or insensitive to yearly rainfall [Fritts, 1976, p. 17]. For these reasons we were not successful in correlating annual growth rings between trees or with published tree ring records for southern California [Schulman, 1947].

Damage Effects

Ring widths, measured under a binocular microscope using a dial caliper, were plotted against growth determined by ring counting. We examined all significant departures from normal growth trends and interpreted them in light of the 1857 earthquake and other possible environmental factors [see *Fritts*, 1976, p. 52].

To determine whether growth had been asymmetric, we calculated ratios of the widths of correlative rings from opposite sides of certain trees and plotted them against growth year. For symmetric growth, ratios fluctuate about 1.0. Departures from 1.0 indicate unilateral enhancement and/or suppression of growth. Ratios made with records from the 4-mm cores are not presented, since they showed a systematic departure from 1.0 resulting from compression of the wood during sampling. We feel confident that compression of wood during sampling was negligible in the 15-mm cores and that the observed ring ratio anomalies are natural.

THE TREES

The trees are discussed in order of increasing complexity. For reference, Table 1 contains detailed descriptive information on each tree.

Young Tree (FRP 3)

The Young Tree is an undamaged Jeffrey pine growing astride a 0.2-m-high scarp delineating the 1857 trace of the San Andreas fault about 3 mi (4.8 km) east of Mill Potrero (Figure 2, Table 1). Its trunk and crown are symmetric and lack external evidence of damage; its trunk is straight and has no measurable tilt.

In a core taken perpendicular to the trend of the scarp an initial trend of erratic increase in ring width peaks after about 30 years (Figure 3). In subsequent years, ring width decreases exponentially. This decrease in average ring width is accompanied by a decrease in ring width variability. Such behavior is typical of healthy growth [see *Fritts*, 1976, p. 25].

The Young Tree straddles the trace of the San Andreas fault and had reached a height of 1.5 m as a very small sapling by 1859(?). Thus it probably experienced the 1857 earthquake. As a young, flexible tree it also might have been able to survive some afterslip undisturbed, but once its roots had become firmly established on both sides of the fault, fault slip of a tenth of a meter or more would probably have resulted in root and trunk damage. Hence the healthy ring record of the Young Tree suggests that no slip has occurred on this strand of the San Andreas fault since at least the late 1870's, by which time the tree had become firmly established. Obvious as this approach might seem, it constrains the timing of the last large earthquake at this locality and has unrealized potential in regions with short periods of historical record.

Whitiner Tree (FRP 2)

A great Ponderosa pine, known as the Whitiner Tree, stands 3 m south of the most recent trace of the San Andreas, 2 mi (3.2 km) east of Mill Potrero (Figure 4, Table 1). It measures 2.0 m in diameter near its base and approximately 0.5 m in diameter where its trunk is topped at a height of about 33 m. The entire trunk tilts about 2.5° northwest. Both trunk and crown are symmetric.

We estimate, by extrapolation from the oldest pierced ring, that the Whitiner Tree reached 1.5 m in height during the

1590's. A nearby stream provides a generous supply of water year-round and is responsible for the tree's complacency. Complacency is evidenced by low ring width variability in each of six core samples.

A sudden, anomalous reduction in growth rate that begins with the 1857 growing season is superimposed on an otherwise healthy pattern of ring width variation in the Whitiner Tree (Figure 5). This 'slowdown' is followed by a 15- to 20-year recovery period during which the ring widths lie consistently below the projected preearthquake trend. On the basis of the comparison with the other five cores we have concluded that the 1857 ring is missing in core FRP 26. This growth anomaly may well represent trauma resulting from topping of the tree during the 1857 Fort Tejon earthquake.

Although pest infestations following the dry years 1857, 1870, 1898, and 1924 may be responsible for similar growth slowdowns that *Schulman* [1947, p. 12] observed in samples taken in the mountains to the north and northeast of Los Angeles, we have observed no slowdown effect for the later years in our trees. Nevertheless, pest infestation, wind, drought, and lightning must also be considered possible damaging agents.

The ring ratio plot S/N, calculated by dividing ring widths on the south side by correlative ring widths on the north side, shows a shift in the sense of asymmetry beginning in 1857 (Figure 6). The sense of this change is consistent with the expected growth of compression wood in response to a northwesterly tilt [*Fritts*, 1976, p. 221].

Leaning Tree (WRW 1) and Leaning Companion (WRW 8)

In Wrightwood, two Jeffrey pines (WRW 1 and 8) were located on a low, linear mound now buried under the engineered levee of Heath Creek (Figure 7, Table 1, and *Sieh* [1978b, Figure 3]). They leaned away from each other and showed a pronounced asymmetry of both trunk and crown. Bends occurred in both trunks. The lower 7.5–12 m of the Leaning Tree tilted 12° northwest; above 12 m the trunk tilted considerably less. The Leaning Companion tilted 13° southeast below an abrupt bend in the trunk at about 3.5 m; above this bend the trunk was nearly vertical. These effects could have been the result of mutual competition for space and light, but because both trees were rooted in the fault zone, we suspected that they might also have been related to the 1857 earthquake. Eight cores were taken from the Leaning Tree and one from the Leaning Companion.

Different core records within the Leaning Tree correlate well with each other (Figure 8), although attempts to correlate with ring records from other trees have been unsuccessful. The oldest ring penetrated by cores of the Leaning Tree formed in 1846; the tree was probably about 1.5 m tall in the late 1830's. One core on the northwest side shows a slowdown and recovery anomaly beginning in 1856 (Figure 8, WRW 18). The ring ratio plot SE/NW shows a 20-year positive anomaly beginning in 1856, followed by a long, sustained negative anomaly (Figure 9).

Morphological features and ring data for both the Leaning Tree and the Leaning Companion are consistent with a single tilting event in 1857. The Leaning Tree was about 20 years old, 10 m high, and about 15 cm in diameter at that time. We propose that the 20-year ring ratio anomaly reflects trauma caused by root or limb damage suffered during fault slippage underfoot in 1857. After recovery, the tree's shifted center of

FRP 2	Whitiner Tree <i>Pinus ponderosa</i>	on Mill Potrero Highway 3 mi (4.8 km) W of junction with Cuddy Valley Road; 30 m N of road, on 5000- foot contour in the creek draining NE from the Sawmill Mountain quad SE¼ of NW¼, SEC 21, R21W T9N	trunk is 3 m S of 0.3-m fault scarp; in perennial drainage tributary to San Emigdio Creek	topped at 33.5 m; diameter 1.99 m (1.87 m without bark); very healthy, very large; tilts 2.5° N30W	21(due S)(4 mm) 22 (S85E)(4 mm) 23(N10E)(4 mm) 24(S70W)(4 mm) 25(due N)(15mm) 26(due S)(15 mm)	1638 1637 1650 1679 1618 1618	1978 1978 1978 1978 1976 1976	(one core)
FRP 3	Young Tree <i>Pinus jeffreyi</i>	on Mill Potrero Highway, 1.5 mi (2.4 km) W of junc- tion with Cuddy Valley Road; 35 m N of road; on fault-related bench S of San Emigdio Creek NE¼ of SE¼, SEC 22, R21W T9N	on 0.2-m fault scarp; on fault-related bench; no developed drainage in stand of trees	very healthy; not damaged in any way; diameter ~1.2 m; 27 m high	31(due N)(4 mm) MP2-3(due E)(4 mm)	1863 1860	1978 1976	1859(?) 1859(?)

* Indicates azimuth of core from bark to oldest ring.
† Indicates estimated date that tree reached 1.5 m in height.

gravity led to increased growth on the northwest side relative to the southeast side. The competitive influence of the Leaning Companion heightened the tendency. The asymmetry of the Leaning Tree actually began in 1856. According to available rain records, 1856 was a moderately dry year, but response to water shortage should not have been asymmetric. Although it is tempting to interpret this early onset of trauma as evidence of root damage caused by creep during the year preceding the earthquake, there are not sufficient data to warrant such a conclusion, since pest and wind damage might have resulted in asymmetric growth. Furthermore, despite repeated counting, we cannot rule out a ring-reading error of 1 year.

The Leaning Companion (Figure 7, Table 1) was rotten in the center and the rings formed before about 1869 were not preserved. It is not clear how many years of early record are missing, but our estimates place the Leaning Companion at a height of 1.5 m during the early 1840's and about 4 m high and 10 cm in diameter in 1857.

The Leaning Companion's outermost rings are extremely thin owing to recent poor health, making our dates uncertain. The ring record is not included as a figure, since it is incomplete and poorly constrained. We simply note that the core from the southeast side of the Leaning Companion shows more erratic growth than the core from the northwest; this could be interpreted as a response to tilting during the 1857 earthquake. Morphological features support this interpretation. The bend in the trunk and rotten center are consistent with a single tilting event in the mid-1800's through which only the outer rings survived intact.

Considered together, the Leaning Tree and the Leaning Companion offer compelling evidence of a single tilting event in 1856-1857.

Sidehill Bench Tree (WRW 3) and Stump Tree (WRW 4)

A healthy Jeffrey pine, the Sidehill Bench Tree, is growing astride the San Andreas fault on a fault-related sidehill bench northwest of Big Pines (Figure 10). A core from the southeast side of the tree reveals a scar involving the growth rings of the years 1855-1857; the 1856 and 1857 rings are missing altogether (Figure 11 WRW 35). In other cores a growth minimum is evident in 1857 (Figure 11, WRW 36).

The ring ratio plot SE/NW displays two conspicuous anomalies (Figure 12). The ring ratios are close to 1.0 except during the 10 years following 1857 and during the 20 years starting in 1960. The first anomaly we attribute to damage to the southeast side of the tree during the 1857 earthquake. The second anomaly is probably due to an increased growth rate on the southeast side of the tree resulting from the removal of a nearby competitor, the Stump Tree.

A few meters southeast of the Sidehill Bench Tree, and 3 m northwest of the fault zone, lies the stump of a White fir dubbed the Stump Tree (Figure 10, Table 1). A part of the tree's trunk, discovered nearby, suggests that the tree had most of its crown and measured a little more than 23 m in height at the time it was felled. The Stump Tree shows a dramatic reduction in ring width beginning 101 years before it was felled (Figure 13). Recovery from the trauma took about 25 years. According to S. R. Carbaugh (personal communication, 1976) the Stump Tree was probably killed during a 'sanitation salvage' logging program in about 1957-1958. If the ring record is plotted so that the last ring dates from 1958, the slowdown begins in 1857. Killing of the Stump Tree in 1958 is



Fig. 2. View to northeast of the Young Tree, a healthy, symmetric, untilted Jeffrey pine, straddling the San Andreas fault east of Mill Potrero. It is 27 m tall and about 120 years old.

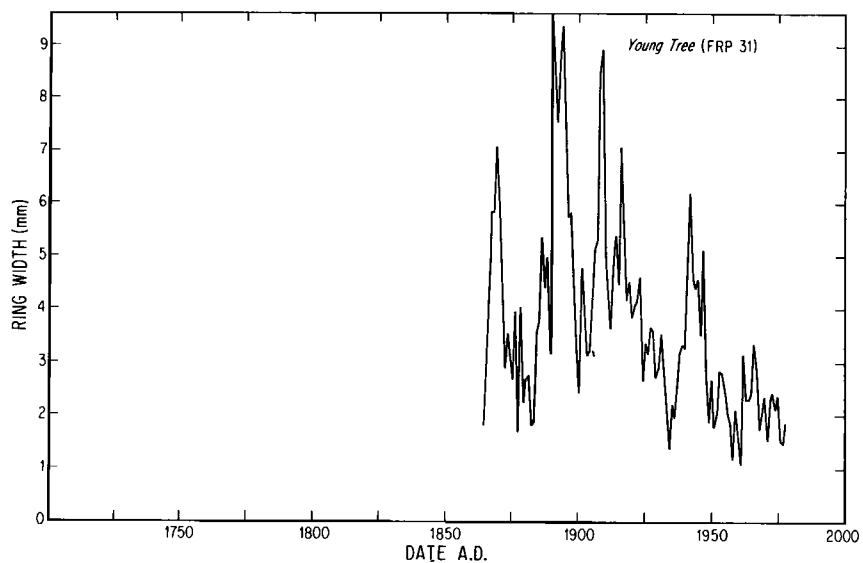


Fig. 3. The width of each annual growth ring in the Young Tree was measured and plotted against its date, determined by simple ring counting. The resulting ring width plot displays the characteristics of a healthy, undisturbed tree: an initial erratic increase in ring width, followed by an exponential decrease. The lack of evidence of trauma in the Young Tree record precludes any significant slip on this strand of the San Andreas fault since at least the late 1870's.

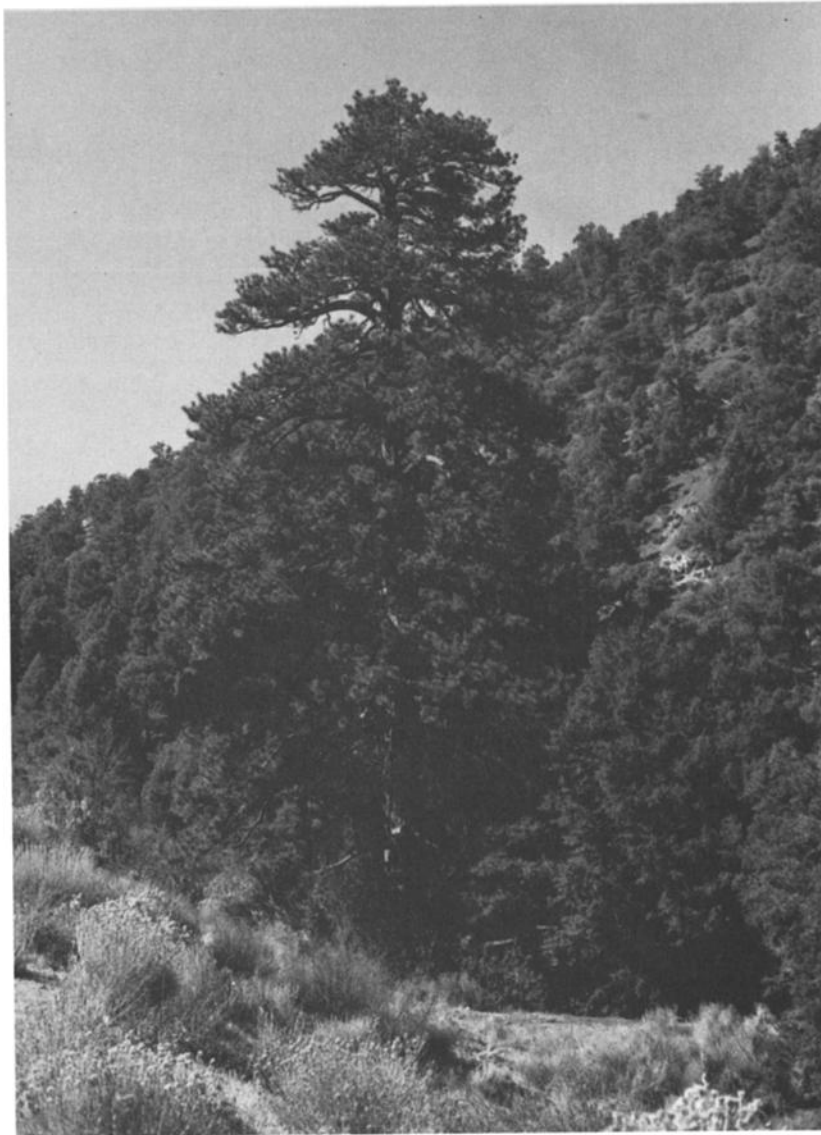


Fig. 4. View to northwest of the 390-year-old Whitiner Tree. It is growing across the San Andreas fault and is topped at about 33 m. Both trunk and symmetric crown tilt 2.5° to the northwest. A nearby stream provides a year-round water supply.

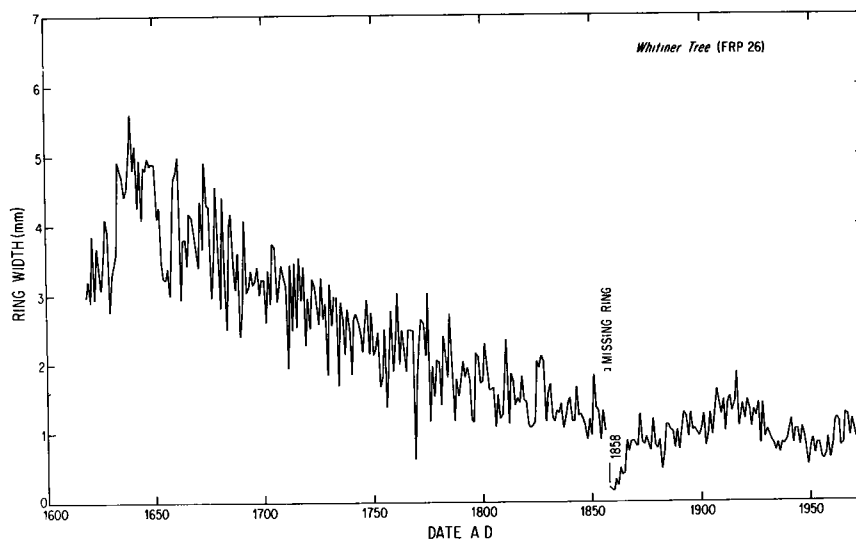


Fig. 5. In the Whitiner Tree a sudden reduction in growth rate beginning in 1857 is superimposed on an otherwise healthy pattern of ring width variation. The 1857 ring is missing altogether in the core shown. We interpret this growth anomaly to be the result of damage suffered during the 1857 earthquake.

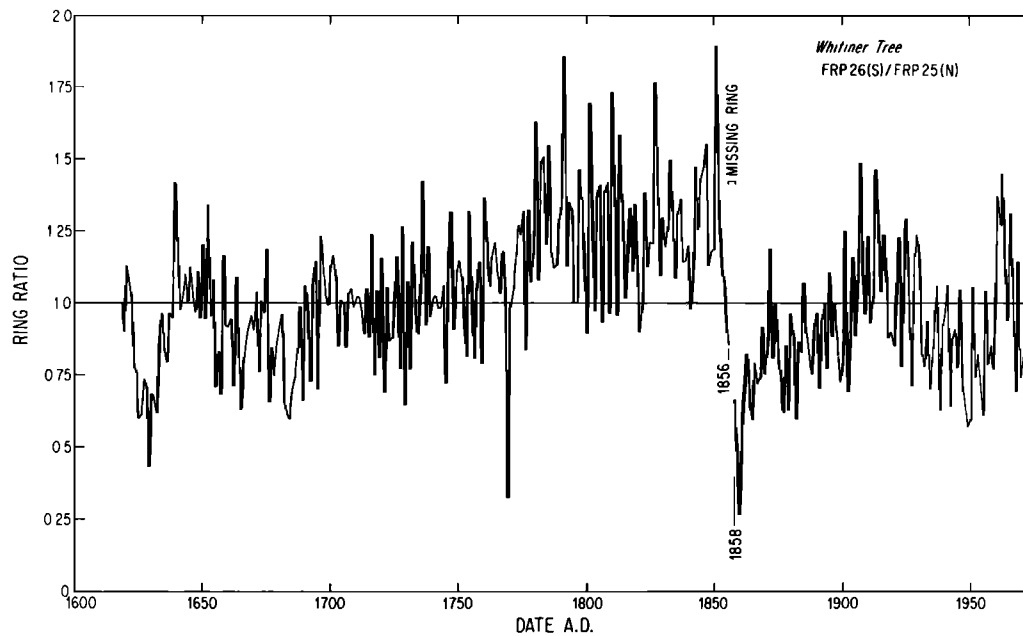


Fig. 6. The Whitiner Tree's ring ratio plot S/N, calculated by dividing the ring widths on the north side by correlative ring widths on the south side, shows a shift in the sense of asymmetry beginning in 1857. The sense of this change is consistent with the expected response to the observed northwesterly tilt.

consistent with the sudden burst in growth on the southeast side of the Sidehill Bench Tree beginning in 1960 (see Figure 12). We were not successful in precisely dating the Stump Tree records by correlation with the Sidehill Bench Tree, but in light of the evidence presented herein it seems likely that the Stump Tree suffered root and/or limb damage during the 1857 earthquake.

*Lone Pine Canyon Road Tree (WRW 2)
and Cuddy Valley Tree (FRP 1)*

Two of the Jeffrey pines studied show no effect of the 1857 earthquake. The Lone Pine Canyon Road Tree lies about 6 m southwest of the main trace of the San Andreas fault, just west of the saddle at the head of Lone Pine Canyon (Figure 14). It was once topped about 15 m from its base, where three large branches have subsequently grown. The tree appears to have lost its entire crown at the time of the topping.

The Lone Pine Canyon Road Tree was about 1.5 m high in 1749. A slight southwestward tilt of the lower 1.5 m of the trunk suggests a tilting event in the mid-1700's. A core taken on the northeast side shows a dramatic slowdown beginning in 1834 (Figure 15) but no obvious effect of the 1857 earthquake. Either the Lone Pine Canyon Road Tree was not seriously damaged during the 1857 earthquake, or the damage sustained in 1834 so limited the tree's growth that the effect of later damage cannot be recognized. We favor the second hypothesis and cite as evidence the anomalously long 55-year recovery period that follows the topping event (see Figure 15). No large or moderate earthquakes are recorded for this region in 1834 [Townley and Allen, 1939], so we must conclude that the tree was probably topped by lightning or wind in 1834.

The Cuddy Valley Tree grows at the foot of a 8.5-m-high fault scarp at the east end of Cuddy Valley (Figure 16, Table 1). It lies 100 m southwest of the main break of the San Andreas fault (T. Davis, personal communication, 1979). It is topped at about 15 m, and a 0.5-m-deep fire scar penetrates its base on the eastern side. The tree's poor health and advanced

age make the rings extremely narrow and difficult to see. Hence considerable uncertainty must be attached to the dates that appear in the following discussion.

We estimate that the Cuddy Valley Tree reached 1.5 m in height in the 1530's (1534?). There is a pronounced slowdown in the record in the early 1700's (1711–1713?, Figure 17). This probably indicates topping in the early 1700's by lightning, wind, or a seismic event. The 1857 earthquake does not appear to have affected the growth of the tree.

A large earthquake produced by slip along the San Andreas fault in 1745 $^{+24}_{-35}$ A.D. has been recognized at Palmett Creek 110 km to the southeast [Sieh, 1978a]. If this seismic event topped the Cuddy Valley Tree, the tree's growth record constrains the date of the event to within the few decades preceding 1712. This correlation must, of course, remain pure speculation until verified or disproved by studies of other old trees along the fault.

CONCLUSIONS

Of eight trees sampled, five show damage effects and/or growth anomalies attributable to the 1857 Fort Tejon earthquake. The Whitiner Tree's trunk is topped and tilted and its ring record shows a sudden slowdown in growth rate and change in sense of asymmetry beginning in 1857 (Figures 5 and 6). Profound asymmetric growth effects in the Leaning Tree also appear to be the result of damage and tilting at the time of the Fort Tejon earthquake (Figures 8 and 9). Bends in the trunks of both the Leaning Tree and the Leaning Companion support this conclusion. Asymmetric growth and rings absent at a scar on the northwest side of the Sidehill Bench Tree appear to indicate damage by earthquake or faulting (Figures 11 and 12). Despite some uncertainty in dating, a dramatic growth slowdown in the Stump Tree appears to have originated in 1857 (Figure 13). The Young Tree's unperturbed ring record rules out any substantial fault movement since the late 1870's (Figure 3). Perhaps because of the severity of ear-

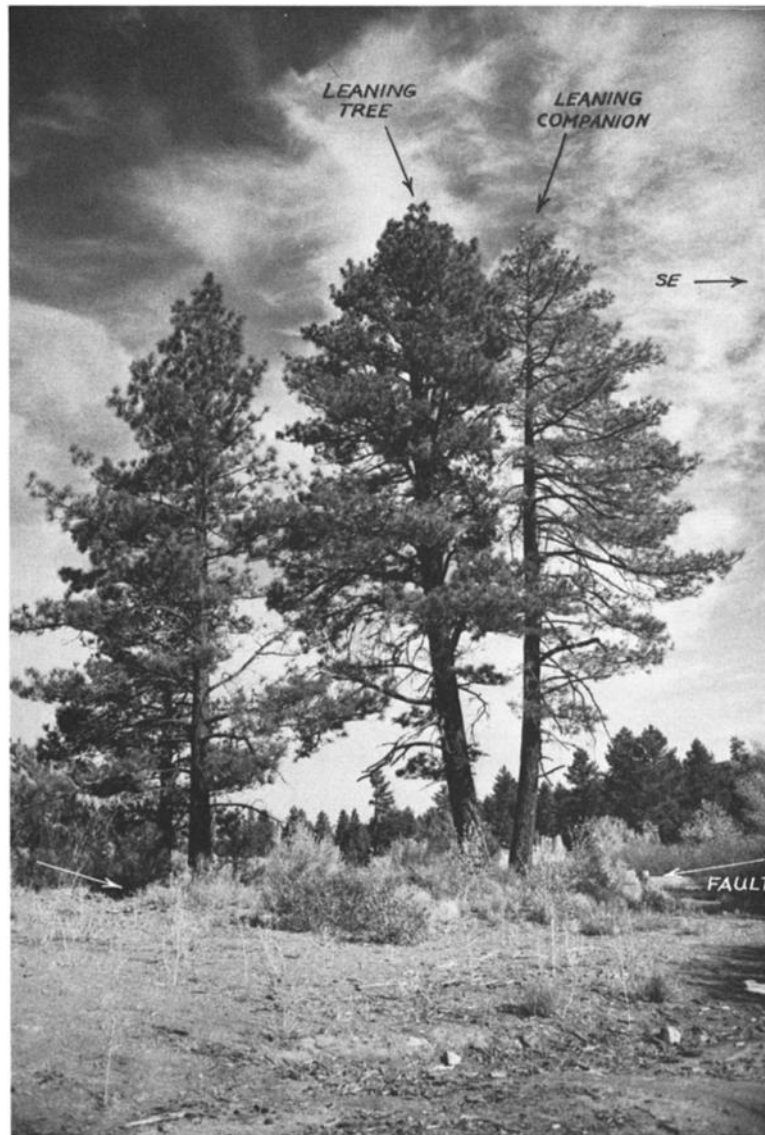


Fig. 7. View to northeast of the Leaning Tree and the Leaning Companion. Both trees are rooted in the San Andreas fault zone and lean away from each other. Pronounced asymmetry and bends occurring in both trunks are consistent with a single tilting event in 1857.

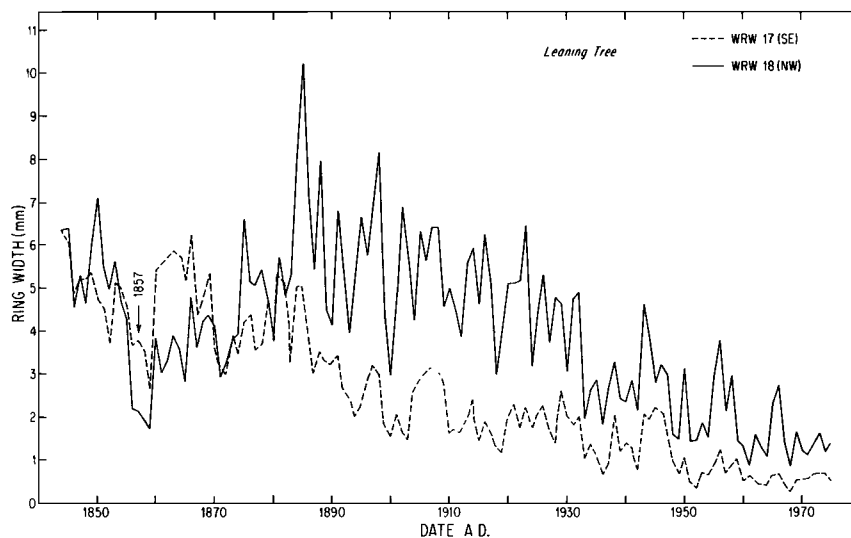


Fig. 8. The northwest side of the Leaning Tree shows a reduction in growth rate beginning in 1856. A marked increase in growth rate on the northwest side follows about 20 years later. By contrast, the southeast side of the tree appears relatively unperturbed.

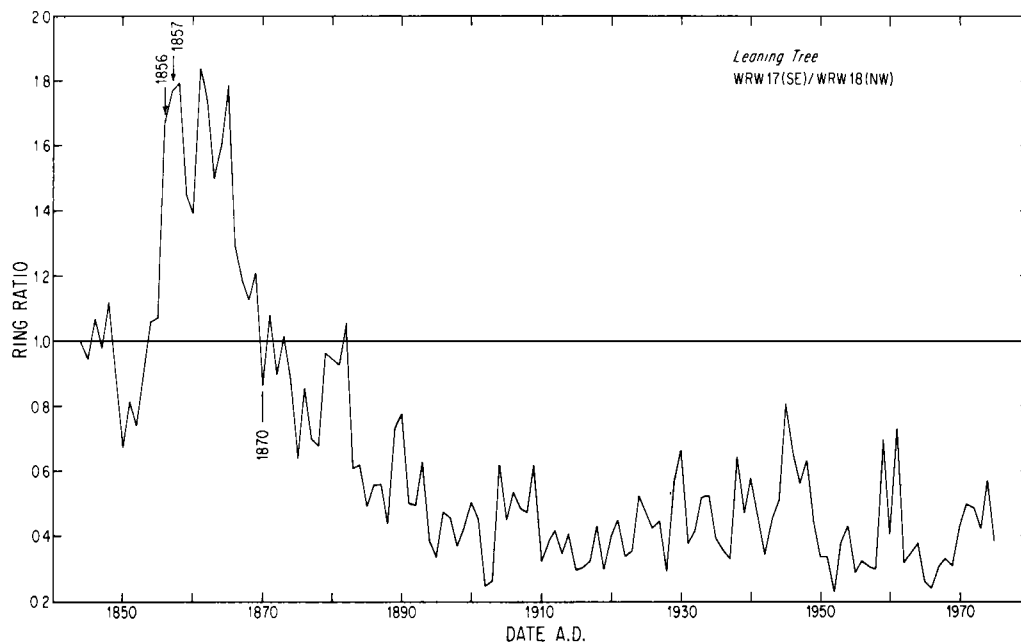


Fig. 9. The Leaning Tree's ring ratio plot SE/NW shows a 20-year positive anomaly beginning in 1856, followed by a sustained negative anomaly. We believe the 20-year anomaly reflects trauma caused by root or limb damage to the northwest side during 1856-1857. After recovery, the tree's shifted center of gravity led to increased growth on the northwest side relative to the southeast side. The competitive influence of the Leaning Companion heightened this tendency.

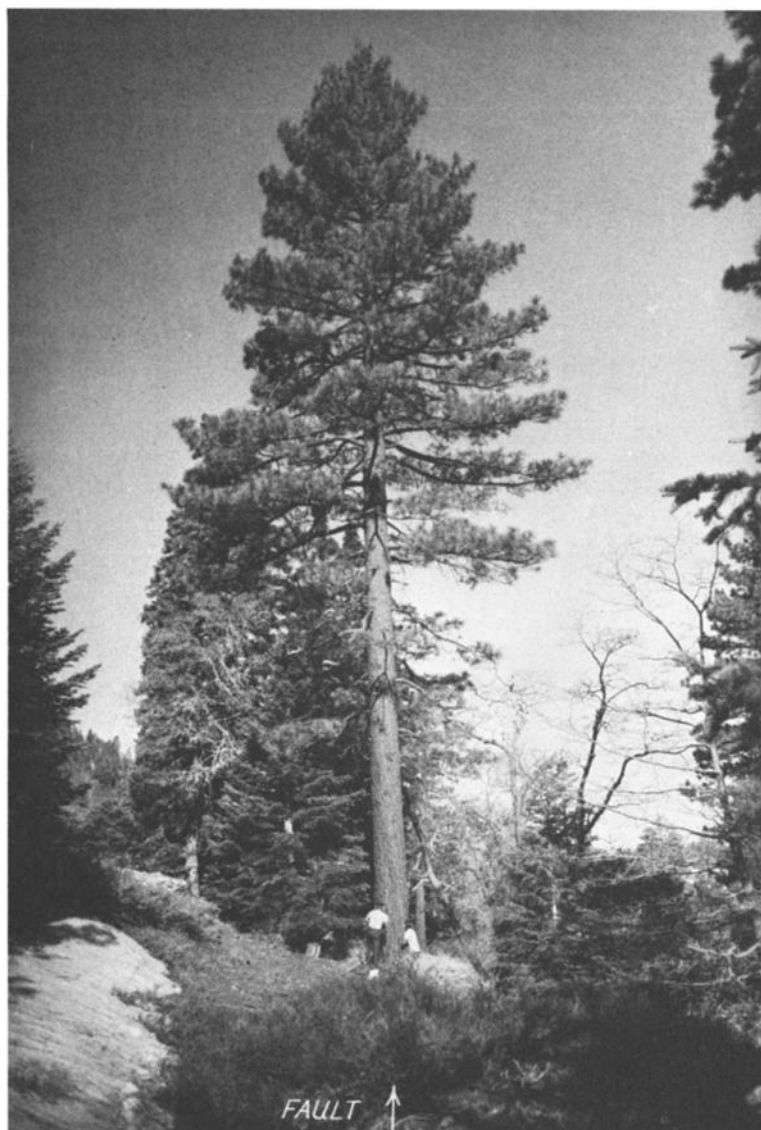


Fig. 10. View to northwest of the Sidehill Bench Tree. Located astride the San Andreas fault, it is healthy and symmetric and tilts 1° to the south. The Stump Tree, in foreground but not visible, stood about 23 m tall, with crown intact before it was felled in 1957-1958.

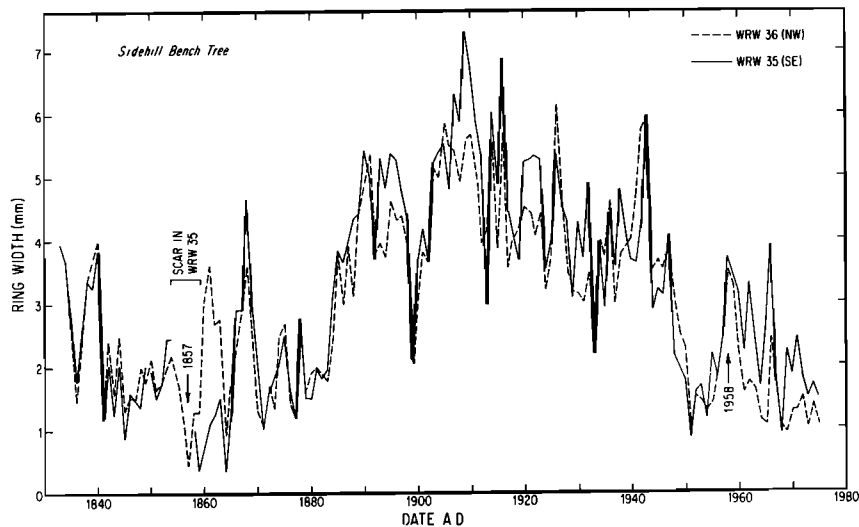


Fig. 11. A core taken from the southeast side of the Sidehill Bench Tree reveals a scar involving the years 1855-1857; the 1856 and 1857 rings are missing altogether. In other cores a growth minimum is evident in 1857.

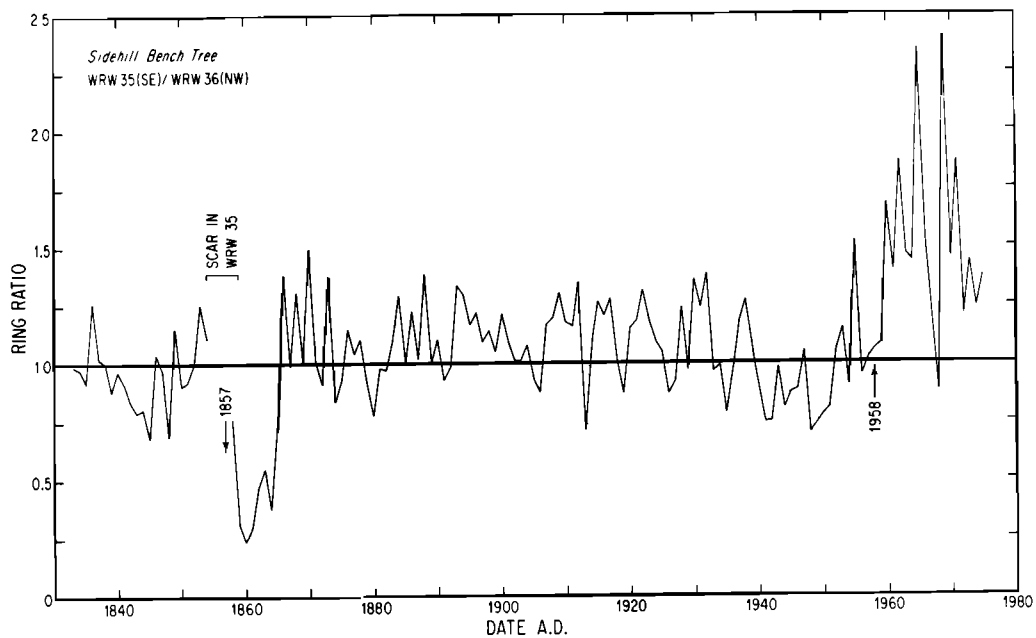


Fig. 12. In the Sidehill Bench Tree's ring ratio plot SE/NW, ring ratios are close to 1.0 except during the 10 years following 1857 and 20 years starting in 1960. The first anomaly we attribute to damage to the southeast side of the tree during the 1857 earthquake. The second anomaly is probably a response to the removal of the nearby Stump Tree.

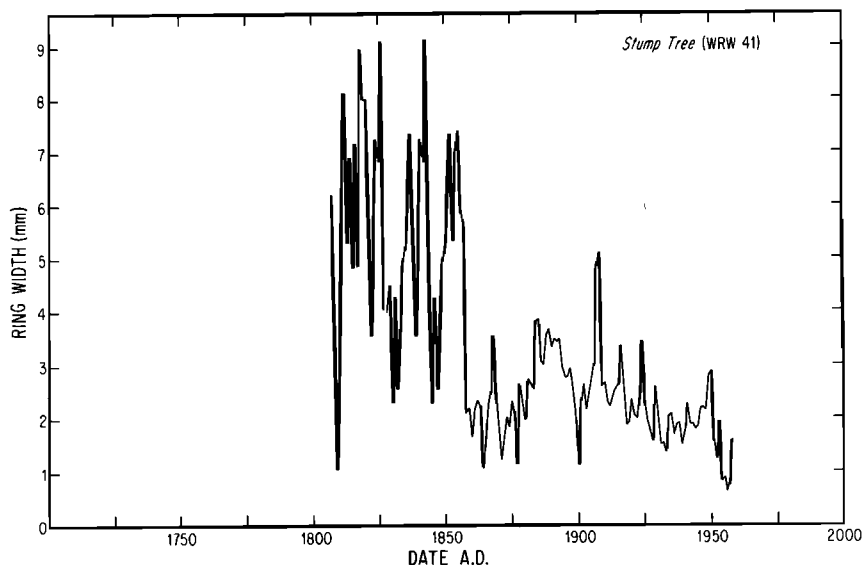


Fig. 13. The Stump Tree shows a dramatic reduction in ring width 101 years before it was felled. Recovery from the trauma took about 25 years. The tree was probably felled during a logging program in 1957-1958. If the last ring grew in 1958, the slowdown began in 1857.



Fig. 14. View to southeast of the Lone Pine Canyon Road Tree. It lies 6 m southwest of the San Andreas fault and is topped at 15 m, where three large branches have subsequently grown. The lower 1.5 m of the trunk tilt to the southwest.

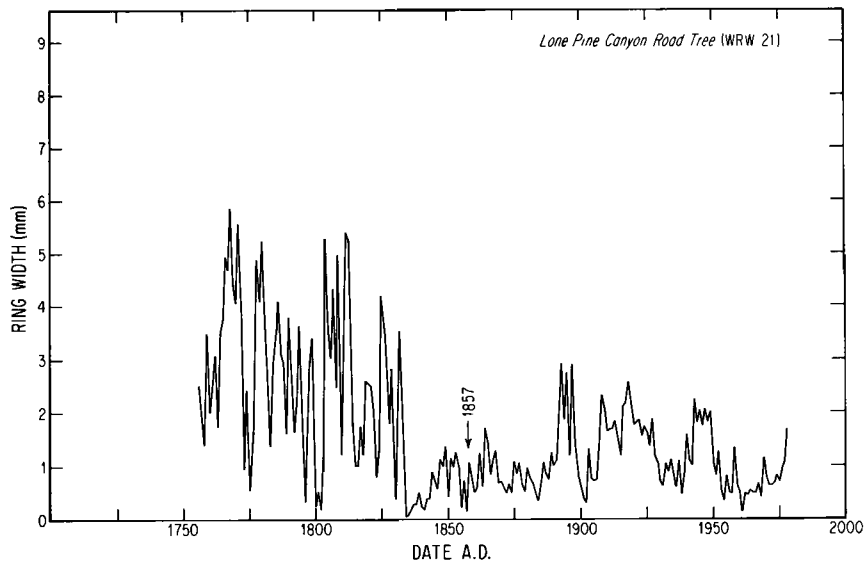


Fig. 15. A core taken on the northeast side of the Lone Pine Canyon Road Tree shows a dramatic reduction in growth rate beginning in 1834. There is no obvious effect of the 1857 earthquake. An anomalously long recovery period of 55 years, however, tends to support our interpretation that damage caused by lightning or wind in 1834 may have rendered the tree insensitive to later trauma.



Fig. 16. View to northwest of the 450-year-old Cuddy Valley Tree. It lies at the foot of a 20-m-high fault scarp, 100 m southwest of the main trace of the San Andreas fault and is topped at 15 m. The tree is in poor health.

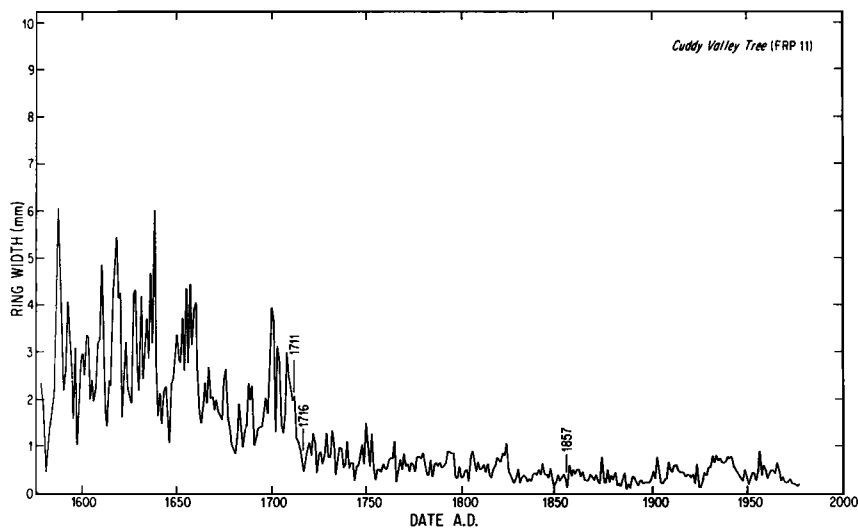


Fig. 17. A core from the southeast side of the Cuddy Valley Tree displays a growth slowdown in the 1700's. This probably indicates topping by wind, lightning, or, possibly, by a seismic event. The 1857 earthquake was not recorded, perhaps due to the tree's poor health.

lier damage, the Lone Pine Canyon Road Tree and Cuddy Valley Tree show no effect of the 1857 Fort Tejon earthquake (Figures 15 and 17).

Our success in recognizing effects of the 1857 Fort Tejon earthquake in these trees, despite casual sampling, suggests that a suite of older trees may contain a valuable 'dendroseismological' record of large prehistoric earthquakes in southern California.

No prehistoric seismic event should be postulated on the evidence of one tree alone, however. It would be an embarrassing mistake to attribute to a great earthquake damage actually produced by a mere lightning strike or strong gust of wind! If an undocumented earthquake is suspected, many trees should be examined and evaluated for consistency before the event is formally proposed.

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