

A TREE RING CALENDAR FOR DATING VOLCANIC
EVENTS AT CINDER CONE, LASSEN
NATIONAL PARK, CALIFORNIA.

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ABSTRACT.

Of the several volcanic outbreaks at Cinder Cone, Lassen National Park, Calif., the lava flow of 1851 is the only one that was heretofore dated. It is shown that pine trees can be found near the Cone that are rooted in the old soil under the ash of two explosive eruptions and that another generation of trees are rooted in the ash. The determinable ages of these trees show that the first explosion must have occurred after 1485 and prior to 1680. The ring patterns of some of the older trees indicate that the explosions occurred in 1567 and 1666. Sections from snags of trees killed by hot lava indicate that there were lava flows about 1720 and 1785.

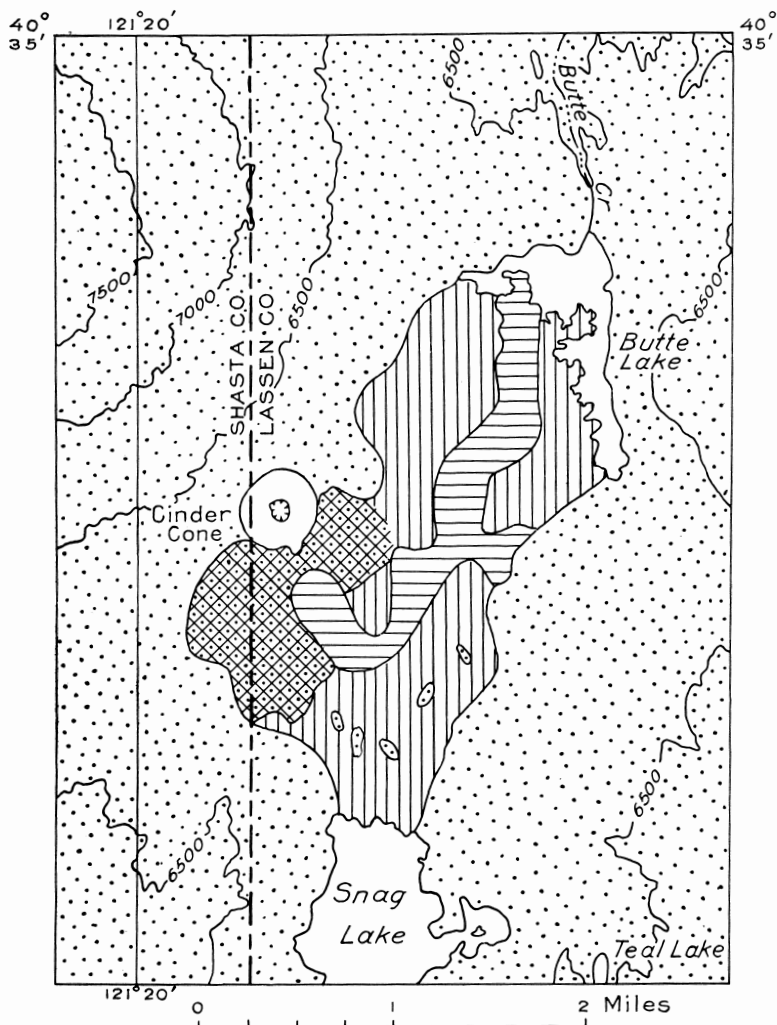
At Cinder Cone in Lassen National Park there have been a series of volcanic eruptions in recent times that produced at least three (probably five) lava flows and two noticeable ash deposits. (See map, Fig. 1.) Historical evidence indicates that the latest of the eruptions occurred during the winter of 1850-51.² Heretofore the dates of the other events were unknown.

While it can be shown that there was a definite interval between some of the outbreaks, field evidence indicates that the earliest explosions may have taken place within the last 500 years. Near the base of Cinder Cone there are many curious depressions in the ash, see Fig. 2, that, as Diller³ explained, mark the location of trees that were killed by the ash fall. Excavation at any of these depressions will reveal stumps of trees rooted in the old soil beneath the ash. As the wood decays the ash rolls in to take its place and the depressions are thus more or less self-perpetuating. At one place a peculiar trench-like depression was found that obviously had not been made by erosion. A little excavation revealed that the depression was over the decaying trunk of a prostrate tree that had been buried by the ash fall. The upright snags in Snag Lake have been diminishing in number during the nine years that this area has been under the observation of the writer and they are distinctly less numerous than at the time of Diller's first

¹ Published by permission of the Director of the U. S. Geological Survey.

² Finch, R. H., and Anderson, C. A.: The Quartz Basalt Eruptions of Cinder Cone, Lassen National Park, Calif. Univ. Calif. Publ. Bull. Dept. Geol. Sci., Vol. 19, 1930.

³ Diller, J. S.: A Late Volcanic Eruption in Northern Calif., Bull. 79, U. S. Geol. Sur., p. 20, 1891.



EXPLANATION

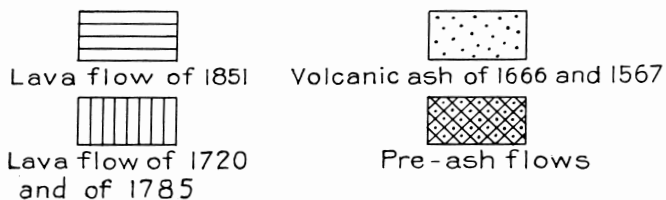


Fig. 1. Sketch Map of Volcanic deposits of Cinder Cone and vicinity.



Fig. 2. Depressions in the ash near western base of Cinder Cone mark the location of trees killed by the ash fall.

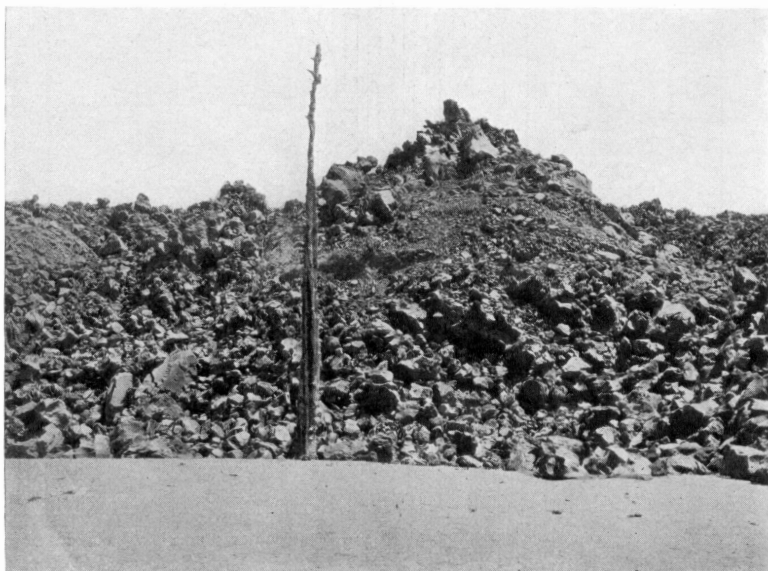


Fig. 3. Snag near edge of lava flow. It was killed by an explosion from Cinder Cone.

visits in the 80's. Many of the snags of pine trees that were killed by the earliest explosion are well preserved. (See Fig. 3.) With these facts in mind it seemed that it should be possible to find trees in the vicinity that had witnessed the eruptions and that their ring patterns might give the dates to some of the events.

During the summer of 1927, A. E. Jones and the writer endeavored to find a live tree near the edge of the lava field that seemed old enough to warrant taking a section for a study of its ring pattern. Only one tree was found near the edge of a lava flow that was also solitary enough to preclude the possibility of an injury from a forest fire and thus to warrant examination. However, the tree proved to be less than 150 years old and nothing definite was found in its ring pattern. During the summer of 1928, A. E. Jones⁴ in a study of the variations in magnetic declinations in the different lava flows found systematic differences. His observations indicated five or more flows.

After Douglas⁵ published his work on the determination of the ages of the pueblos by means of a tree ring calendar, it seemed worthwhile to try to fit the ring pattern of some of the snags killed by an explosion or a lava flow to the pattern obtained from one of the oldest living trees in the vicinity. The tree selected for study was a yellow pine tree (*pinus ponderosa*) 60 inches in diameter, that had died in 1932. It was located one quarter mile west of Cinder Cone where the ash was 20 to 30 inches deep. It was easily seen by counting back that the first ring at a height of 30 inches above ground was formed in 1485. For purposes of comparison with other sections the widths of the rings were plotted as ordinates against a uniform time scale. There was a marked diminution in growth for a few years beginning with 1567 and 1666 as shown in Fig. 4. It would appear that the first explosion occurred in 1567 and the second in 1666. The peculiar patterns indicated by Fig. 4 were uniform in the entire section of the tree. Two fire scars, one in 1752 and the other in 1822, affected the growth in only one quadrant of the tree. For this reason the specimens that were taken from many trees and snags by an increment borer were but little used in this study. A section was taken from a tree five miles west of Cinder Cone where the ash fall was negligible. It proved to be 500

⁴ Jones, A. E.: Bull. Hawaiian Volcano Observatory, Vol. 16, No. 9, Sept. 1928.

⁵ Douglas, A. E.: National Geographic Mag., Dec. 1929.

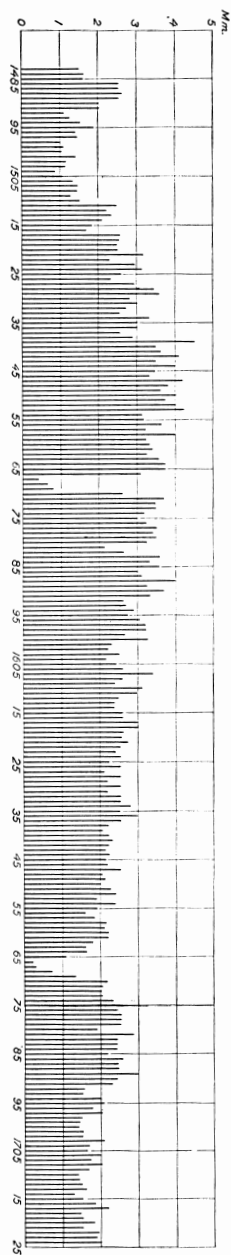


Fig. 4. Portion of "Tree Ring Calendar" showing how explosions from Cinder Cone in 1567 and 1666 affected growth rate of a pine tree. Vertical scale indicates thickness of rings in millimeters.

years old and showed no distinctive change in growth rate in either 1567 or 1666.

Excavation at the stump of the tree one quarter mile west of Cinder Cone and at the base of other trees of comparable age at about the same distance from the Cone showed that they were rooted in the old soil 20 to 30 inches below the present ash surface. Apparently the trees did not survive if the ash deposit amounted to much over 30 inches. The trunks of the trees, with the usual above-ground bark, continue down to the normal butt swell at the old soil layer. These facts show that the trees were alive at the time of the first explosion.

Near at hand and also closer to Cinder Cone there is another generation of trees, with their root systems definitely in the ash layer, some of which are at least 250 years old. Even if the peculiar ring patterns shown in Fig. 4 were not caused by explosions the time of the eruptions can be placed within definite limits. The first explosion must have occurred prior to 1680—250 years ago—and after 1485.

Pine cones and needles in good state of preservation that were found at the bottom of the ash layer attest the general recency of the explosions. The few needles found imbedded in the ash gave no good indication as to the interval between the explosions, but their position in the ash agrees with other field evidence that the first explosion was the larger of the two.

With more or less definite dates fixed for the explosions there still remained the possibility of dating some of the lava flows. One flow lies on the ash of the first explosion and is covered by the ash of the second one. The fact that the ash on this flow is rather highly oxidized and practically unaltered elsewhere furnishes a good clue as to the date of the flow. It occurred just prior to the explosion and was still hot when mantled by the ash. Subsequent precipitation furnished the steam to promote the oxidization. Accepting the tree ring evidence as to the date of the second explosion, this flow can be dated 1666.

It is possible that all the snags along the western side of the lava (nearest Cinder Cone) may be from trees killed by the ash deposit and subsequently surrounded or pushed over by the advancing lava. The ring patterns from sections of snags taken in this area also indicated this possibility. The eastern edge of the lava field, where the ash deposit was not deep enough to kill trees, of moderate size at least, is a more likely place to find remnants of trees that were killed by the lava. A charred snag was found well within the edge of a lava flow

which has been called the next to the youngest flow. It furnished a section from which a ring pattern for 411 years was plotted. However, no definite date could be arrived at for unburned bark was still in place on a small portion of the snag. This indicated that the tree may not have been killed by the lava but only severely burned and that it may have continued a feeble existence for several years. The upper part of the tree was blown off later and may still be seen resting on the lava. The ring pattern when compared with the one with known dates indicated that the tree may have been injured by a lava flow about 1785.

Another section was taken from a snag in Snag Lake. The ring pattern from this section was not very distinctive and showed an age of only 140 years. The best correlation indicated that the tree was killed in the early 1700's. A section from a snag in the edge of another one of the lava flows indicated that it had been injured about 1720. The injury may have been due to the flow that formed the present Snag Lake. The color pattern in the lava field also indicates that there are three post-ash flows.

Topography, in the form of noticeable benches, indicates that there was a small lava flow to the east and southeast of Cinder Cone earlier than 1666. It probably occurred at about the time of the first explosion. More studies might make it possible to date definitely more of the lava flows, but the closing of the Lassen Volcano Observatory on June 30, 1935, precluded further field work.

The events at Cinder Cone with their dates so far worked out are shown in the following table:

TABLE 1.
Schedule of events at Cinder Cone.

Type of activity	Date	Authority
Lava flow	1851	Historical
Lava flow	1785 (ca)	Tree ring (not definite)
Snag Lake formed	1720 (ca)	Tree ring (not definite)
Lava flow	1720 (ca)	Tree ring (not definite)
Explosion	1666	Tree ring
Lava flow	1666	Oxidized ash on lava indicates lava still hot at time of explosion.
Explosion	1567	Tree ring
Lava flow	1567	May have been after explosion. Topography.

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