by Author

A COMPARISON OF CINDER CONES IN THE CRATER LAKE NATIONAL PARK AREA WITH THOSE IN THE LASSEN NATIONAL PARK AREA

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Introduction

General Setting & Geology - Both Crater Lake and Lassen Volcano are part of the massive volcanic complex known as the Cascade Range. This volcanic mountain range extends from the Sierra-Nevada Province in California northward into Canada. It is approximately 500 miles long (8, Williams, p 42)* and varies in width. Lassen occurs in California near the southern limit of the Cascades while Crater Lake is some 160 miles north in Oregon (see diagram 1).

The Cascade range obtained its height from both the piling up of volcanic material and regional uplift. These mountains are not composed only of flows but consist also of explosive material from central vents (7, Thornbury, p 517). The Cretaceous rocks that undoubtedly lie beneath the Cascades were later uplifted and by Miocene time volcanoes were active. Many of the volcanoes remained active into the Pleistocene (2, Diller, p 20-21) and even into historical times.

Both Lassen and Crater Lake have a similar background; that of a shattered volcano. Lassen rests in the crater of former volcano Mt. Brokeoff (7, Thornbury, p 517) and is some 2500 ft. above the floor of the original crater. Crater Lake actually occupies the caldera of the former volcano Mt. Mazama. There is no massive build-up in Mt. Mazama's caldera similar to Lassen peak in Mt. Brokeoff.

*Reference[illegible] by number & page

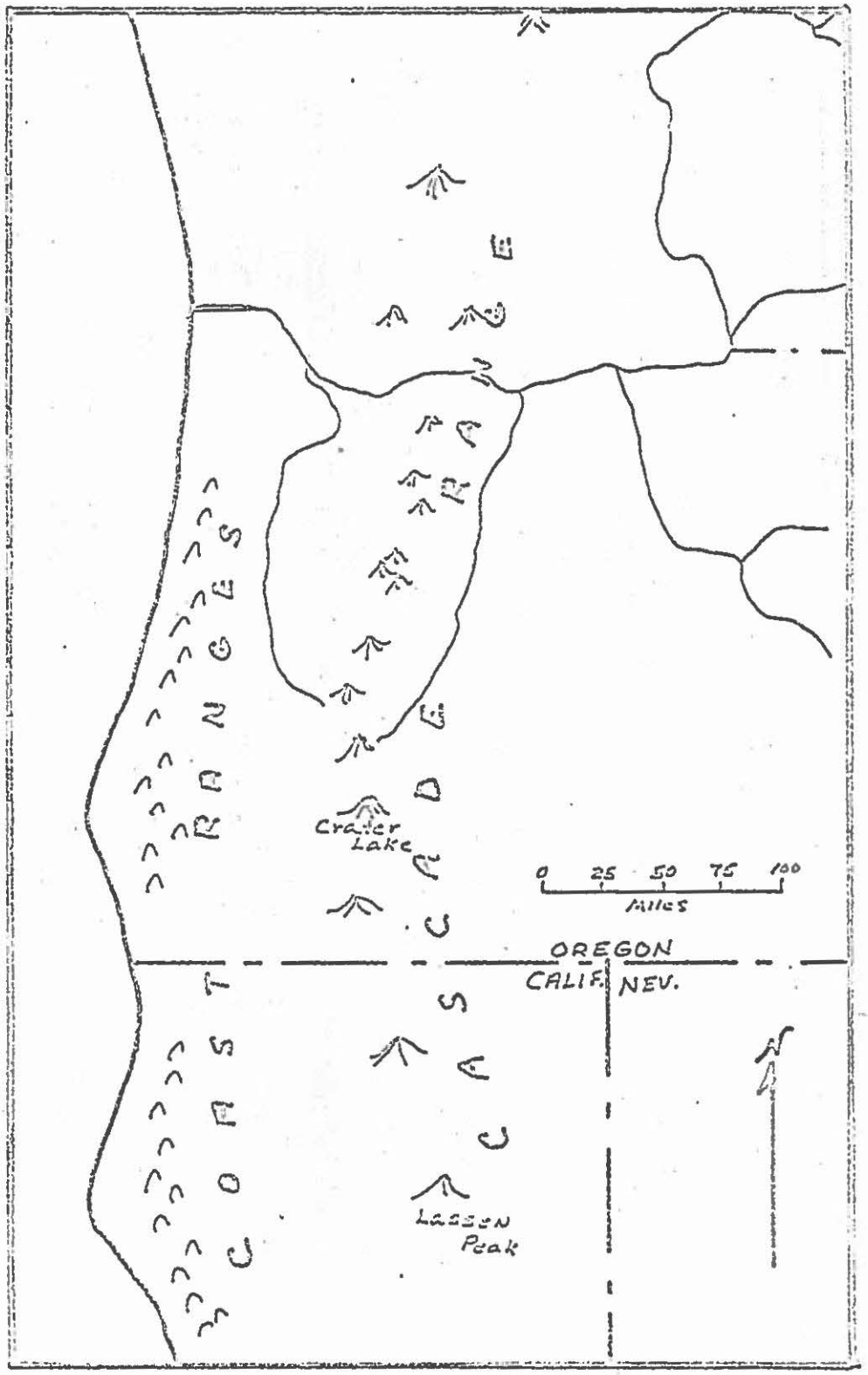
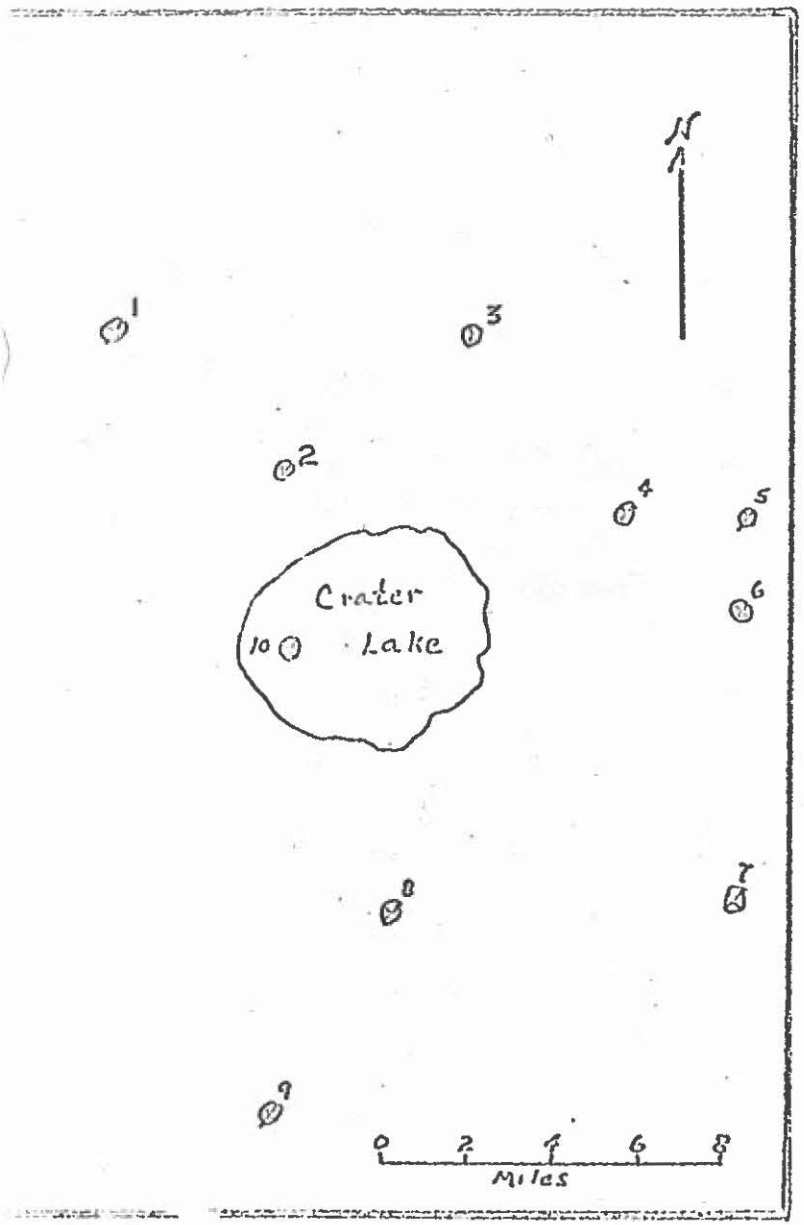


Figure 1 Location of Crater Lake and Lassen Peak in the Cascade Ranges.

Cinder Cones - Rittmann (4, p 140-142) discusses cinder cones under the heading of pyroclastic volcanoes. He suggests that they are monogenetic resulting from explosive erruptions and never attain the dimensions of the much larger strato-volcanoes. They often form during the last phases of a mixed eruption and may cover the previously erupted flows. Thornbury (6, p 494-495) describes the cone of a volcano by stating "the shape and profile of the accumulated debris around the central vent are to a large degree influenced by the type of eruption. The angle of repose of the fluid or solid material which are emitted from the central vent largely determine the steepness of a volcanoes slopes." He also points out that cinder cones result from explosive type eruptions, are predominantly composed of pyroclastics and seldom attain heights in excess of a few thousand feet.

From an inspection of Williams (8, p 6) geologic map of Crater Lake National Park one can pick out several cinder cones. Correlating this map with the U.S.G.S. topo sheet of the Crater Lake area these cinder cones appear as conical mounds. As one studies the Lassen Volcano topographic map, many of the small features noted have the same appearance as the cinder cones of Crater Lake. The following discussion comparing the conical features of the Crater Lake area with those of the Lassen Volcano area is

based on the above argument that these features are in fact cinder cones. Ten such features were selected randomly from the Crater Lake vicinity while eight were chosen the same way in the Lassen area (see diagram 2).



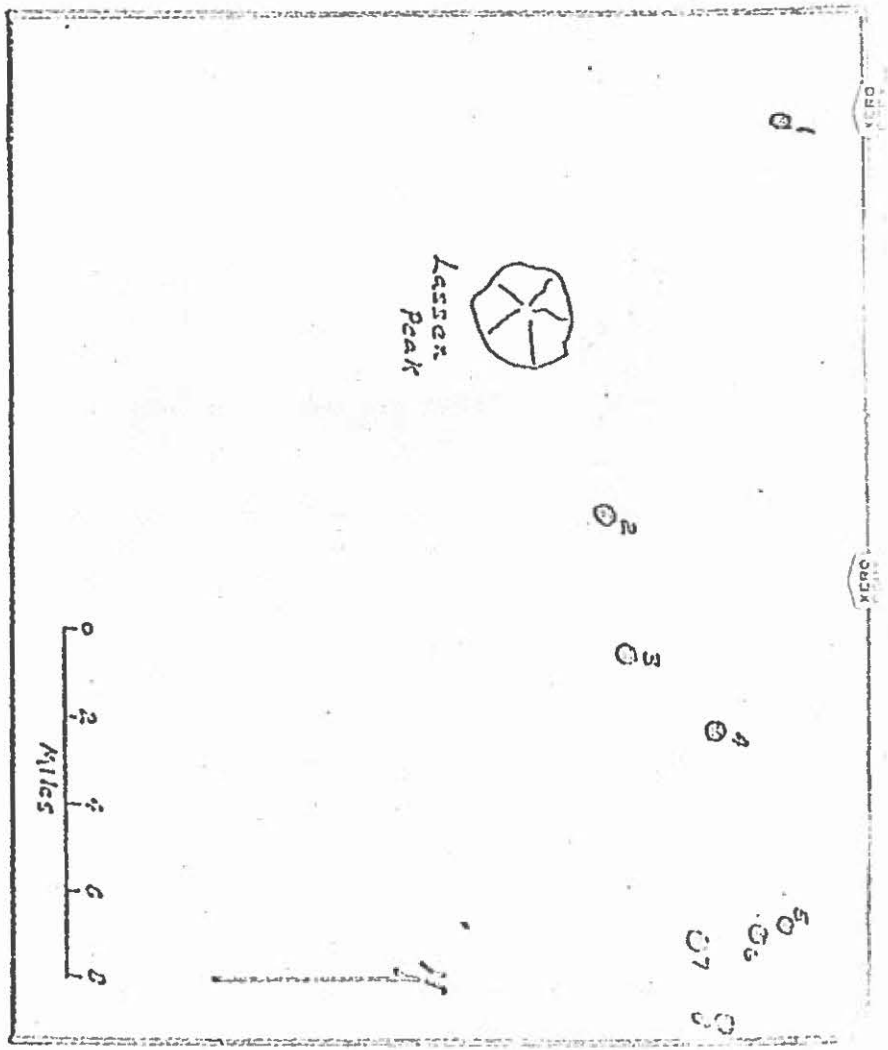


Figure 2 Location of Cinder Cones in the vicinity of Crater Lake National Park and Lassen Volcano

Methods and Measurements

General - Although the cinder cones being considered are generally symetrical in shape, certain criteria must be established prior to making any analytical measurements. These criteria will be outlined in this section along with brief discussion of the method of measurement used for the various parameter being considered. Only the following parameters will be studied in this paper:

Lower limit of the cone
Height of the cone
Length of maximum axis
Length of minimum axis
Symetry ratio
Angle between maximum & minimum axis
Strike of maximum axis
Strike of minimum axis

All measurements were made from photographs of the individual cones enlarged four times. An example of this technique is shown on the inside of the front cover.

Lower Limit of the Cone - The lower limit of each cone was selected as the lowest contour line above the contour line that "breaks". This definition is best illustrated by Bald Crater in figure 3. Notice that the ~~6,040~~ 5,850 foot contour line is the lowest contour above the ~~6,920~~ 5,800 foot line that departs greatly from those above it. There is a significant change in slope at this point. Thus the lower limit of Bald Crater is defined as ~~6,040~~ 5,850 feet.

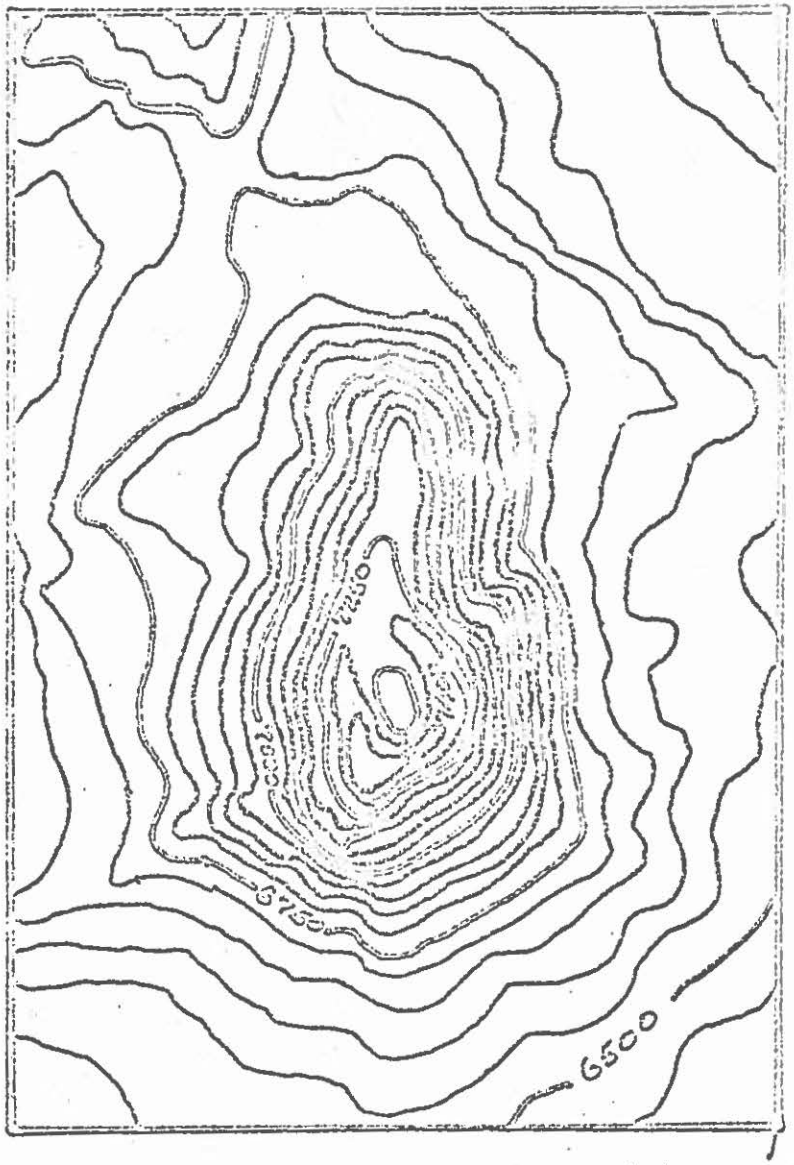


Figure 5 Timber Crater near Crater Lake.

Angle Between Maximum & Minimum Axis - This measurement is straight foreward and easily made from the intersection of the maximum and minimum axis lines at the point of symetry. The acute angle shall represent this measurement. For Fairfield Peak in figure 4 this angle amounts to 59.0 degrees.

Strike of Maximum and Minimum Axis - If we observe Timber Crater in figure 5, the maximum and minimum axis will be noted in addition to a true North line. The acute angle between a given axis and this north index will be considered the strike of that axis. Preference will be given to the northern two gradients in naming these as illustrated by a north 05.0 degrees west (N05.0^{o}) for the maximum axis and a N 72.5^{o} W for the minimum axis of Timber Crater.

All measurements made are presented in tables 1 and 2 which follow on the next two pages.

TABLE 1

Measurements from Cinder Cones in Vicinity of Crater Lake National Park

Cone	Lower Limit	Max. Elevation	Height of Cone	Length of Max. Axis	Length of Min. Axis	Angle Between Max. & Min.		Strike of Max. Axis	Strike of Min. Axis
ter Peak	6600	7265	665	4,685 ft. (3.55)	3,010 (2.38)	1.56	68.5	N 10.5E	N 79.0E
ber Crater	6800	7403	653	4,990 (3.78)*	2,783 ft. (2.11)*	1.79	67.5	N 05.0W	N 72.5W
rd Island	6300	6940	640	3,300 (2.50)	2,745 (2.08)	1.20	62.0	N 60.0W	N 58.0E
d Crater	5850	6478	628	4,302 (3.26)	2,930 (2.22)	1.47	74.0	N 74.5W	N 00.5W
hole Butte	5600	6158	558	4,248 (3.22)	2,942 (2.23)	1.44	77.0	N 86.5E	N 09.5E
se Next	6750	7259	509	2,495 (1.89)	2,045 (1.55)	1.28	49.5	N 21.5E	N 28.0W
kout Butte	5650	6118	468	3,285 (2.49)	2,665 (2.02)	1.26	50.5	N 42.5E	N 87.0W
r Butte	5900	6338	438	3,932 (2.98)	2,930 (2.22)	1.34	78.5	N 81.0W	N 02.5W
Cone	6800	7372	428	4,428 (3.39)	2,270 (1.72)	1.97	63.5	N 65.5W	N 51.0E
Butte	5450	5705	255	3,945 (2.99)	2,112 (1.60)	1.87	72.0	N 53.0W	N 19.0E

* Numbers in Parenthesis is the length of axis in inches based on the scale of 4 in. = 1 mile used in the photographs

TABLE 2

Measurements from Cinder Cones in vicinity of Lassen Volcano National Park

Cone	Lower Limit	Max. Elevation	Height of Cone	Length of Max Axis	Length of Min. Axis	Angle Between Max. & Min.		Strike of Max. Axis	Strike of Min. Axis
h Twin Cone	7080	7796	716	4,158 (3.15)*	3,165 (2.40)*	1.31	83.5	N 40.5E	N 56.0W
Lake Mtn.	6040	6680	640	6,860 (5.20)	3,960 (3.00)	1.73	75.5	N 71.0W	N 33.5E
ld Peak	6680	7272	592	4,989 (3.77)	3,578 (2.71)	1.39	59.0	N 35.0E	N 86.0W
Cone	6420	6907	487	2,495 (1.89)	2,163 (1.64)	1.15	63.5	N 32.0E	N 84.5W
Twin Cone	7000	7414	414	3,697 (2.80)	2,572 (1.95)	1.44	75.5	N 10.5E	N 86.0E
tn.	7320	7695	375	2,972 (2.25)	2,203 (1.67)	1.35	85.5	N 75.0W	N 10.5E
tte	7520	7884	364	2,362 (1.79)	1,914 (1.45)	1.23	79.5	N 24.0W	N 76.5E
Lake Rd.	6800	7130	330	2,322 (1.76)	2,059 (1.56)	1.13	52.5	N 20.5W	N 73.0W

*Numbers in parenthesis is the length of axis in inches based on the scale of 4 in = 1 mile used in the photographs.

Conclusions

General - The conclusions drawn from this study will be of two types (1) similarities or lack of similarities between cinder cones of Crater Lake and Lassen Volcano areas and (2) suggestions for further investigations that might be fruitful. It should be noted that only a few of the possible characteristics of cinder cones were measured and type (1) above is based on this data.

Similarities and Differences of Cinder Cones - The most obvious similarity that both areas cones display is height. The range of heights for the Crater Lake area is 225 ft. In the Lassen cones this range is 330 ft. Thus the difference between maximum and minimum heights of cones from the two areas amounts to only 54 ft. The average height of the Crater Lake cones is 524 ft. while those of Lassen are 490 ft. This difference of 34 ft. is somewhat less than that shown above.

In considering the comparison of the length of the maximum and minimum axis, the averages will be most significant. The following table provides this data:

	Crater Lake	Lassen Volcano
Maximum Axis		
a. longest	4,990 ft. (Timber Crater)	6,860 ft. (Red Lake Mtn
b. shortest	2,495 (Goose Nest)	2,322 (Cone Lake Rd.
c. difference (a-b)	2,495	4,538 ft.
d. average of all cones	3,960	3,898 ft.
Minimum Axis		
a. longest	3,010 ft. (Crater Peak)	3,960 ft. (Red Lake Mtn
b. shortest	2,045 (Goose Nest)	1,914 (Black Butte)
c. difference (a-b)	965	2,046
d. average of all cones	2,652	2,703

From this data it appears that the average lengths of the maximum and minimum axis for the two areas is even more similar than the heights were. There is however a rather large difference in extremes (longest and shortest) of axis lengths. The difference in extremes in the Lassen cones seem to be about twice as large as those of the Crater Lake cones.

The average symetry ratio for the Crater Lake cones is 1.52 while that of the Lassen cones is 1.34. This difference of 0.18 may be significant enough to indicate a greater degree of symetry for Lassen cones. The extremes seem to point out this same conslusion. For Lassen the difference between maximum and minimum symetry ratios (1.73 and 1.13) is 0.60 while for Crater Lake (1.97 and 1.20) it is 0.77. So not only are the Lassen cones more symetrical but they seem to be more uniform in symetry.

A similar comparison of the angle between axis for the cones shows the average for Crater Lake cones is 65^{o} while it is 72^{o} for the Lassen cones. It is interesting to note that this angle always exceeded 49^{o} but never exceeded 79^{o} for Crater Lake cones (difference of 30^{o}). For Lassen cones the lowest was 52^{o} and the highest was 86^{o} (difference of 34^{o}). There seems to be little difference between the two areas based on this characteristic

In analyzing the strikes of the axis it seems as though they are completely random, a conclusion one would not predict considering wind direction. The overwhelming consensus of opinion is that the wind was predominently in the west or southwest. (5, Smith, p 1812). This strike data may have connotations that bear on the relative ages of the cinder cones as compared to the pumace deposits that

are so prevalent in the Crater Lake area (5, Smith, p 1812-1815). It appears that little can be concluded from the strike data as it relates to a comparison of the two areas.

Suggestions for Further Study - It seems that the above approach to the study of cinder cone characteristics is worthwhile. The following suggestions would merit consideration if future study were undertaken:

1. An analytical inspection for relationships (perhaps by graphing) of the data provided by this paper.
2. A determination of average slope of cones for the two areas.
3. A determination of volumes of cones for the two areas.
4. A general expansion of these techniques to other cinder cones in other areas.

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