E24

PROPOSED ROAD EXTENSIONS

AT

CRATERS OF THE MOON NATIONAL MONUMENT

IDAHO

BY

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extra photo slide on page 8 (see before scan)

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Report of Regional Geologist J. Volney Lewis
On Proposed Road Extensions at Craters of the
Moon National Monument, Idaho.

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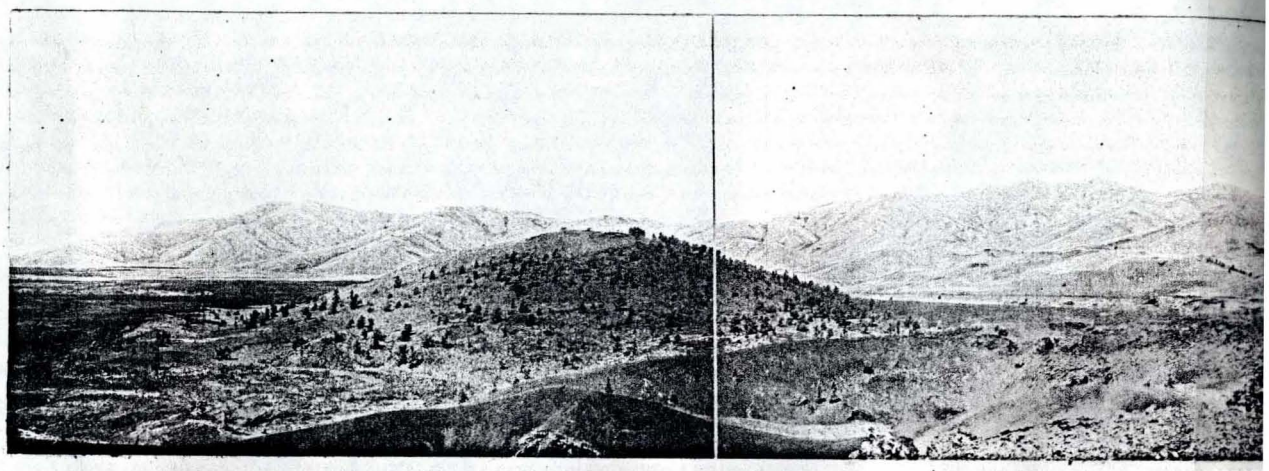
INTRODUCTION

The proposed extension of the road at Craters of the Moon National Monument from Inferno Cone to Echo Crater, a little more than four miles, traverses the heart of the Great Rift zone and displays to advantage the variety of volcanic phenomena in which the area abounds.

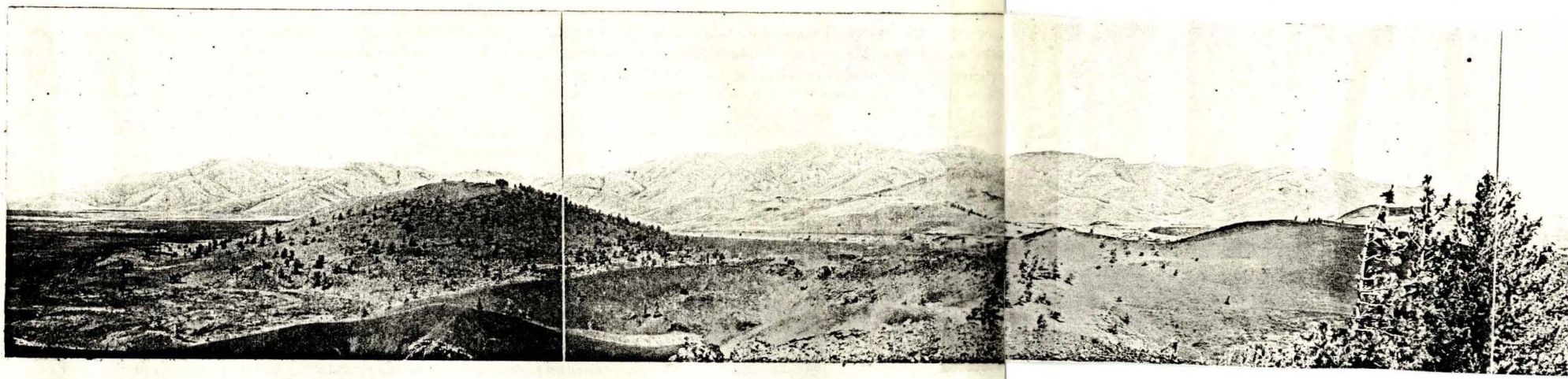
The choice of location between the alternate lines at the west side of Broken Top depends primarily upon the evaluation of the features that are made accessible or that are brought clearly into view along these lines. Such an appraisal of values, however, is somewhat difficult, especially in view of the wide range in the scale of the phenomena from broad panoramas to the minute details of lava forms.

The features are so recent in origin that they still stand as purely constructional forms, unchanged by weathering and erosion. From the alternative lines are viewed the great cinder cones, standing like islands in a sea of lava; deep craters, some breached by flows, some broken and distorted; great sinks, collapsed into the depths; steep, fragile spatter cones, or fumarole chimneys; lava fields of amazing extent and variety, fascinating in their weird desolation—graceful, billowy pahoehoe, jagged, forbidding aa; and most fundamental of all, the Great Rift, which dominates the whole character and pattern of the monument.

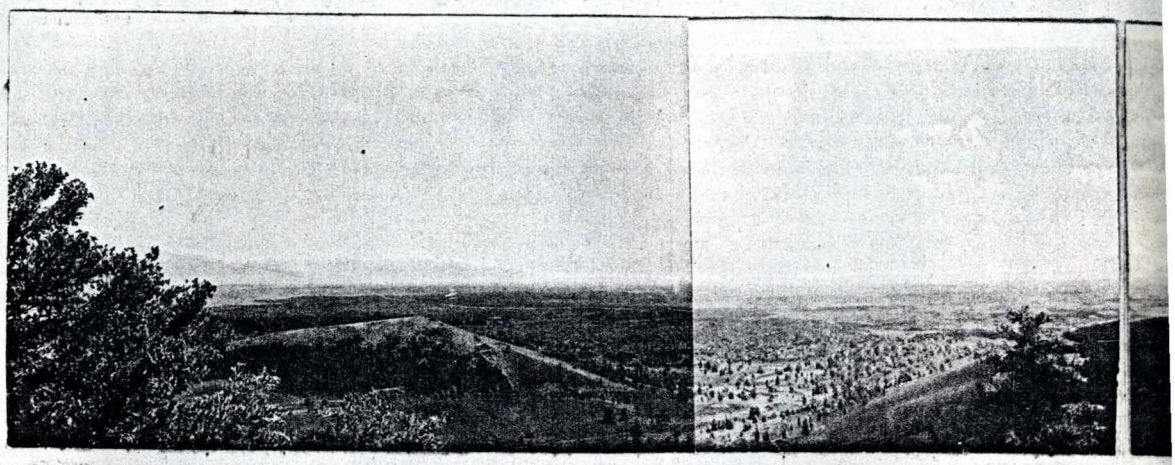
These features are not all seen to equal advantage, however, from the two alternate lines.



(1) From the summit of Big Craters, panorama northwest, north, and northeast. Against the background of the White Knob Mountains, Silent Cone at the left, Paisley Cone at the right. In the foreground, left of the middle, one of the smaller of the Big Craters, and at the middle the summit of North Crater; a glimpse of Sunset Crater beyond and its lava flow in the canyon of Little Cottonwood Creek. At the right of the middle, between the trees, buildings at Headquarters are visible.



(1) From the summit of Big Craters, panorama northwest, north, and northeast. Against the background of the White Knob Mountains, Silent Cone at the left, Paisley Cone at the right. In the foreground, left of the middle, one of the smaller of the Big Craters, and at the middle the summit of North Crater; a glimpse of Sunset Crater beyond and its lava flow in the canyon of Little Cottonwood Creek. At the right of the middle, between the trees, buildings at Headquarters are visible.



(2) From the Big Craters a panorama northeast, east, south, west, and northwest—nearly a complete circle. Right of Paisley Cone (at the left) is the broad dome of Inferno Cone, with the road at its south slope. Great Butte, on the far horizon, is a landmark from the road to Blackfoot. Crescent Butte, in the distance (behind the top of the leaning tree in the foreground).

From the road at Inferno Cone the new location crosses the lava in the middle distance to the north slope of Broken Top (immediately left of the prominent Big Cinder Butte). At the south and west, Blue Dragon and Big Crater flows merge into broad fields of lava. White Knob Mountains in the distance.

In the foreground, right of the middle, are remnants of crater walls and, right of Silent Cone, one of the smaller of the Big Craters. Near the extreme right, the dark tip of Sunset Crater and right of the tree, a building at Headquarters.

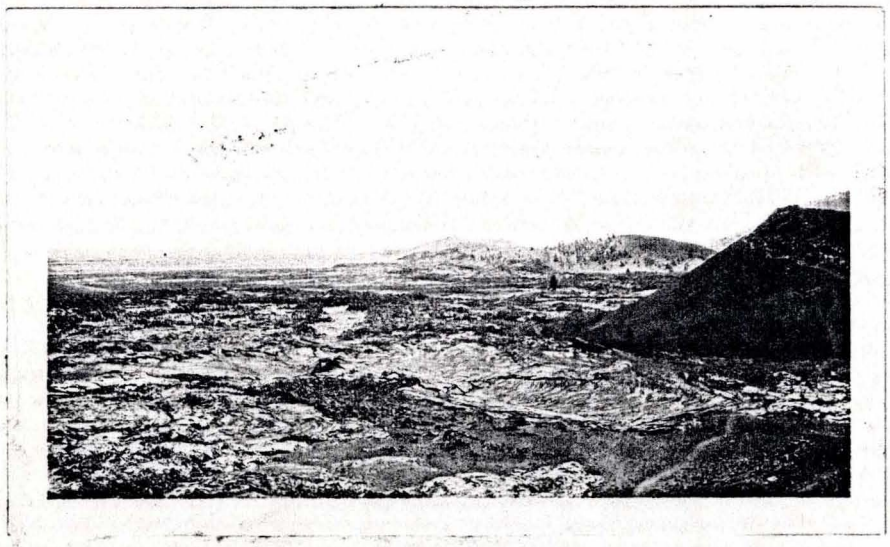


FEATURES ALONG THE PROPOSED ROAD

Near the beginning of the proposed extension of the Monument road (Fig. 1) are seen many of the prominent features at the northwest, near the Monument Headquarters. Turning to the southeast and the south (Fig. 2) much of the course of the proposed road may be seen from the top of Big Craters.

From the loop road, on the broad smooth flank of Inferno Cone, the new line taken off in the middle distance and follows an old wagon trail across the lava plain to the north foot of Broken Top, at the left of the dominant Big Cinder Butte. Here, by the dark field of aa lava, the survey branches into two alternate lines (Sta. 50 to Sta. 63).

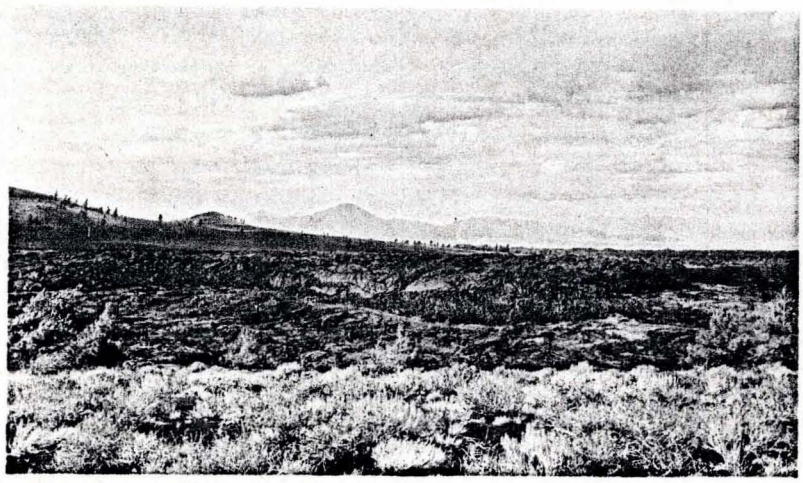
The upper line rises over the low shoulder at the right (west) slope of Broken Top; the lower line follows the foot of the cone and keeps to the low ground. The two unite on the flat lava plain between Broken Top and Big Cinder Butte. Continuing southeastward the location bears to the right of Crescent Butte, which appears in the nearer distance—beyond the top of the leaning tree in the foreground.



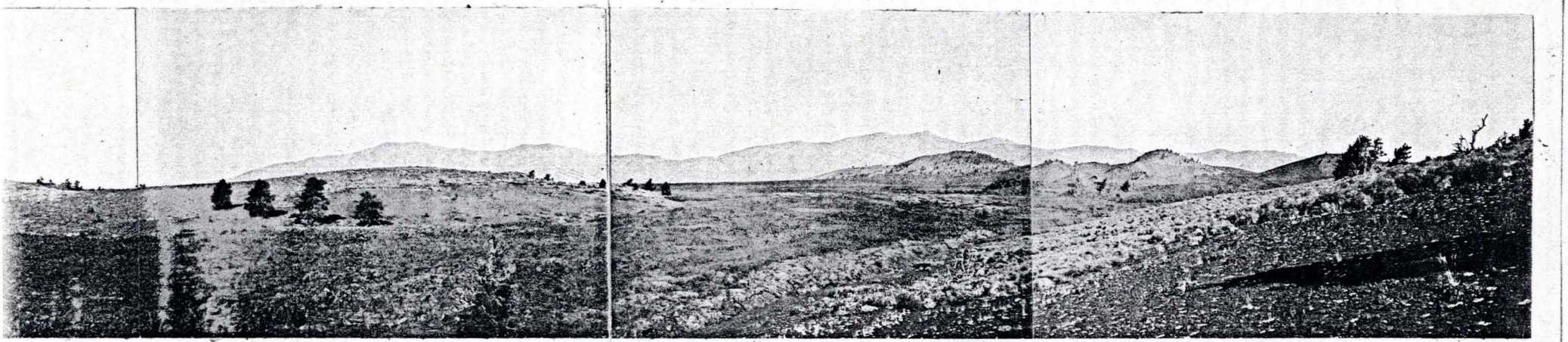
(3) The road crosses the broad lava slope in the middle distance to the foot of Broken Top, at the right.

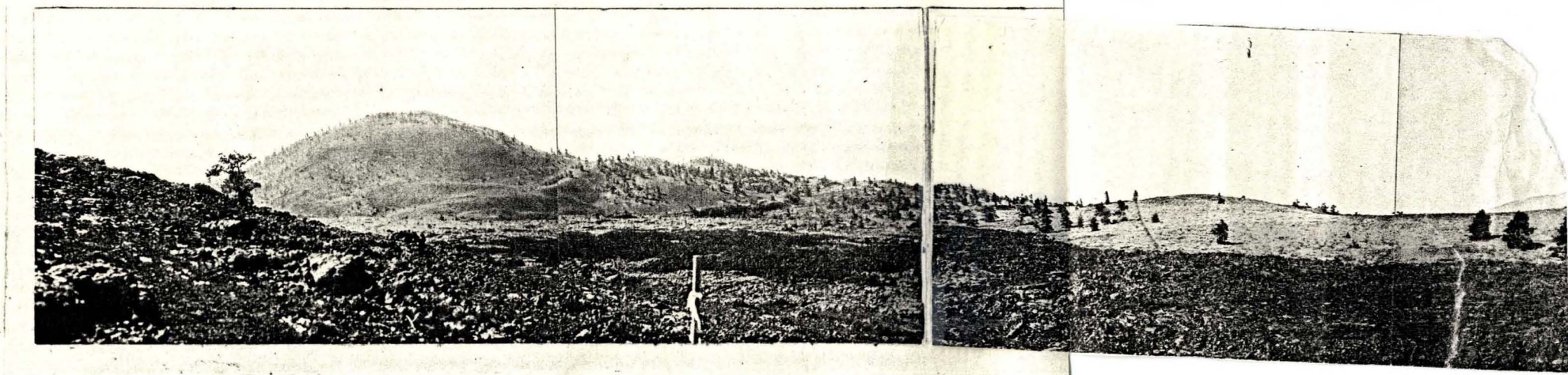
THE UPPER LINE

From the upper line survey, over the low shoulder of Broken Top, a portion of the view is shown in Fig. 5, looking southeast, south, west, and northwest. At the foot of the slope in the right foreground (northwest toward Big Craters and Inferno Cone) the alternate lines separate. Prominent over wide areas at the west is the arm of Big Crater flow which extends, toward the left, between Broken Top and Big Cinder Butte. At the left the continuation of the upper line is marked by the stake and the tree, where it passes around the shoulder and down the slope of the cone, toward the east foot of Big Cinder Butte.



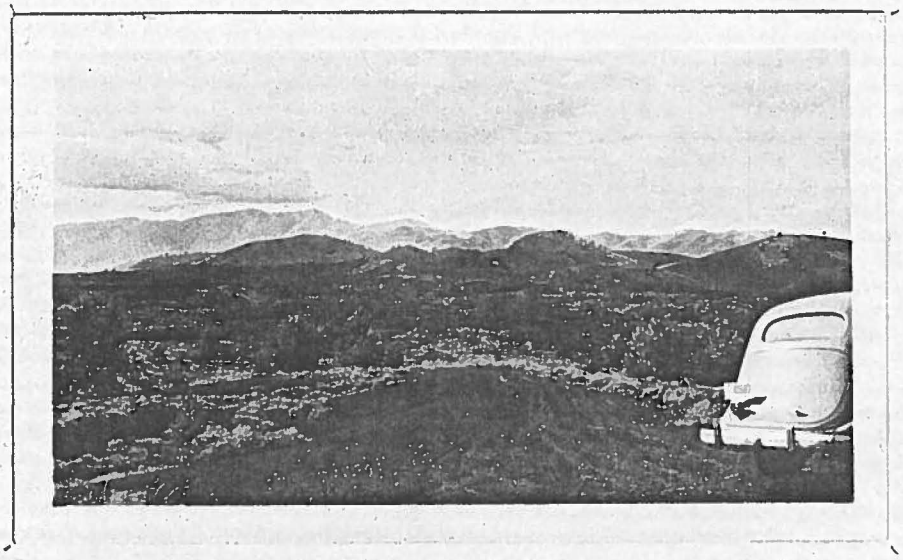
(4) Across Big Sink Waterhole from the north slope of Broken Top. At the left the summit of Paisley Cone and the slope of Inferno Cone.





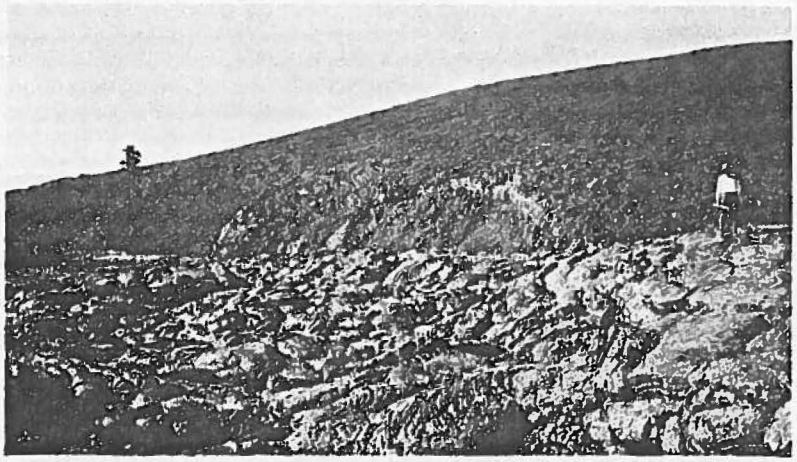
(5) From the upper line survey on the west slope of Broken Top, panorama southeast, south, west, and northwest. At the left Big Cinder Butte, at the right Silent Cone, Big Craters, and Inferno Cone, against the background of the White Knob Mountains.

Prominent across most of the view is an arm of Big Crater Flow, with rugged aa in foreground and at the left of the middle; pahoehoe toward the extreme left, between the near slope of Broken Top and the prominent Big Cinder Butte.



(6) Down the northwest slope of Broken Top. Big Craters in the middle distance; Silent Cone at the left, Inferno Cone at the extreme right. White Knob Mountains in the background.

Across Big Sink Waterhole at the north, the broken edge of the collapsed lava, as seen from the north slope of Broken Top, appears in Fig. 4. From the same slope Fig. 6 looks northwest across another portion of the same lava to White Knob Mountains, in the background. In the nearer distance are the Big Craters, with Silent Cone at the left and Inferno Cone, where the new road extension begins, at the extreme right.

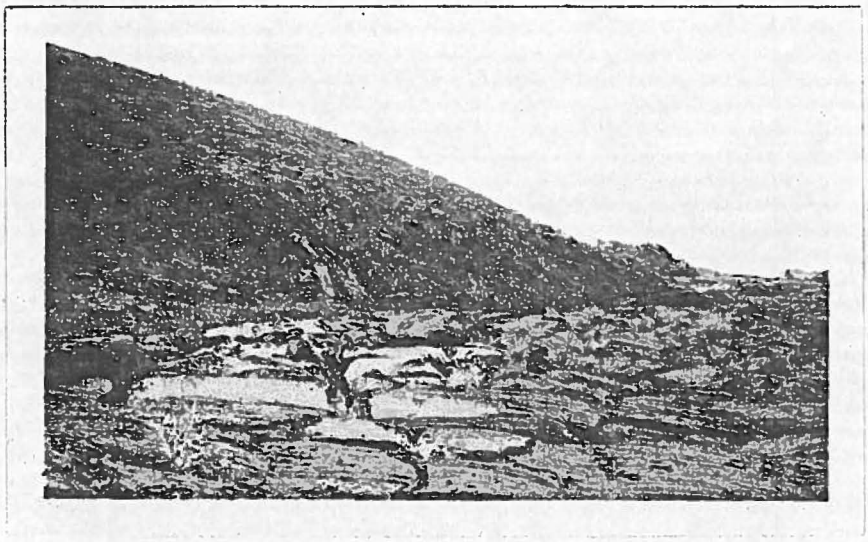


(7) The upper line location, at the top of the bluff (fault cliff), viewed from the lower line, looking northwest.

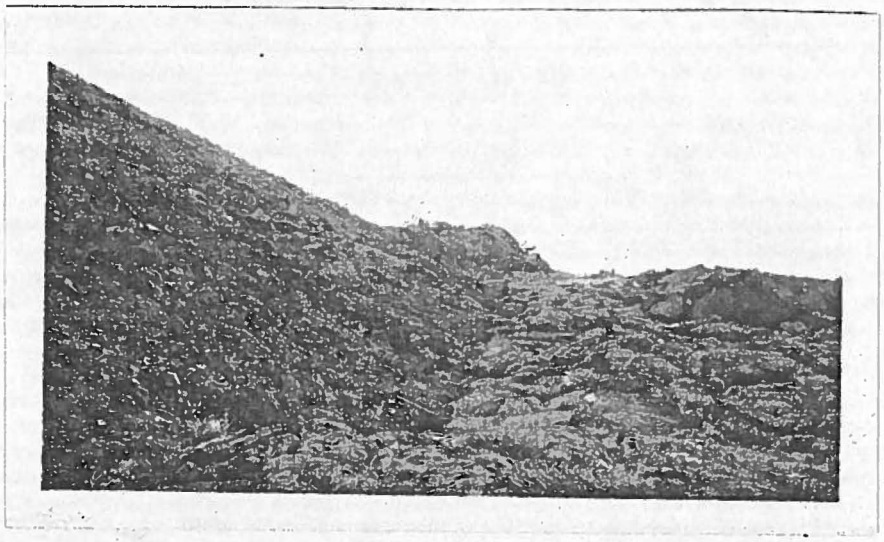


(8) The upper line location, at the top of the bluff (fault cliff), looking northwest from the lower line survey.

The upper line location skirts the top of the bluff along the southwest side of Broken Top (Figs. 7,8) and gradually descends, with the declining bluff (rift or fault cliff) to the rift trench at the foot of the slope (Figs. 9, 10).

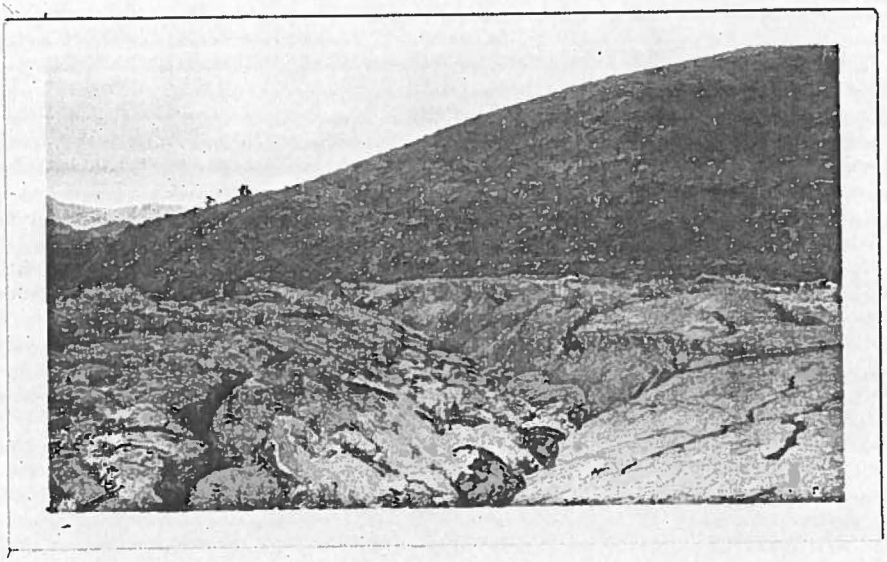


(9) The upper line descends along the top of the bluff to the rift trench at the foot and crosses to the flat lava at the extreme right.

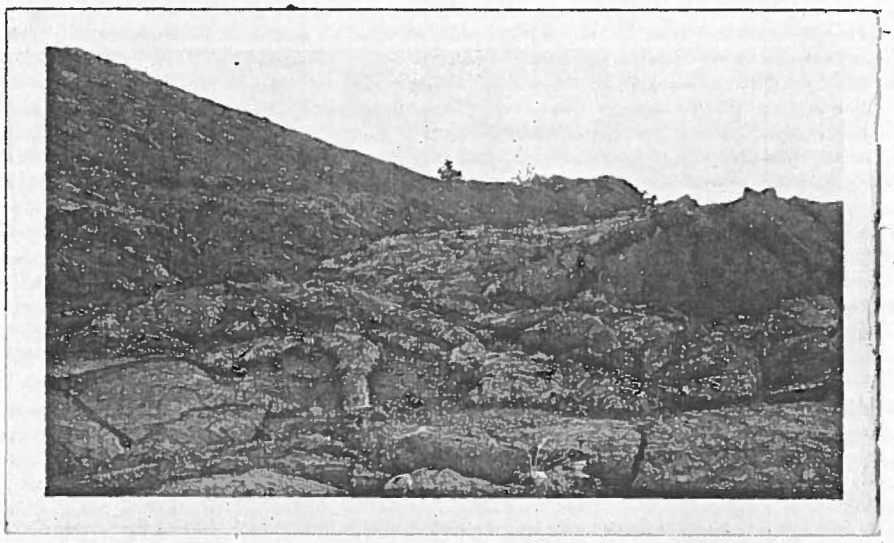


(10) Low bluff along which the upper line descends to the rift trench, then crosses to the level lava plain at the right.

Fig. 11 looks back up the slope along the top of the bluff from the edge of the flat lava. Rivulets of recent lava appear in the rift trench at the foot of the slope (Figs. 12, 13).



(11) Back (northwest) up the slope of the upper line along the top of the bluff. The line crosses to the smooth lava, the broken edge of which shows at the right, with newer pahoehoe at the left.



(12) Rivulets of recent lava in the rift trench at the foot of Broken Top, where the upper line survey crosses to the flat lava at the right.

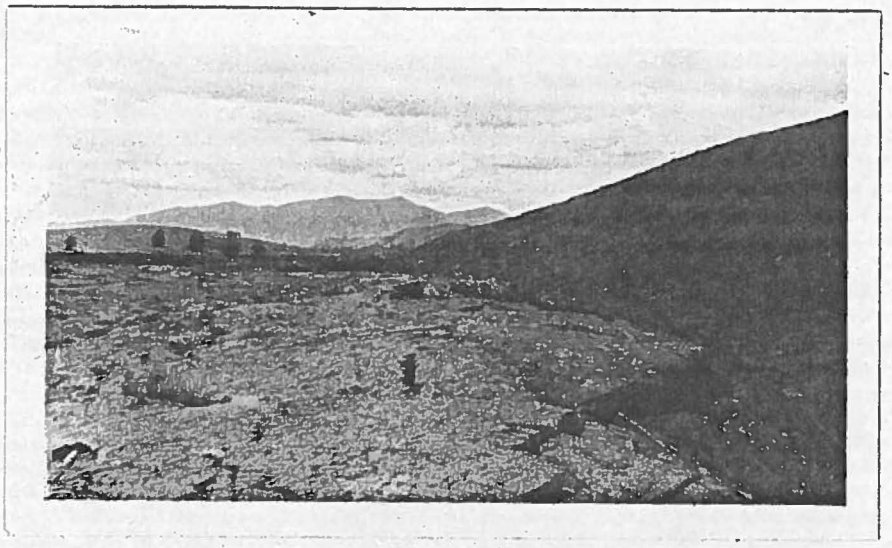
A road embankment, perhaps ten feet high, will be required across the rift trench at the foot of Broken Top, where the upper line crosses to the flat lava at the left (Fig. 14). The border of the flat lava is arched and broken along this trench (Figs. 14, 15), and in some cracks, rivulets of recent lava flowed (Fig. 16).



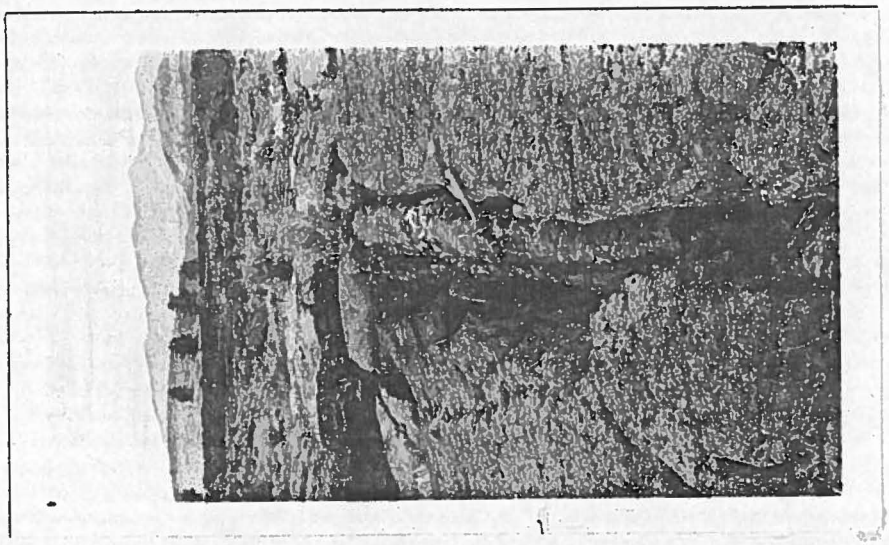
(13) Rivulets of recent lava in the rift trench beside the crossing of the upper level road survey.



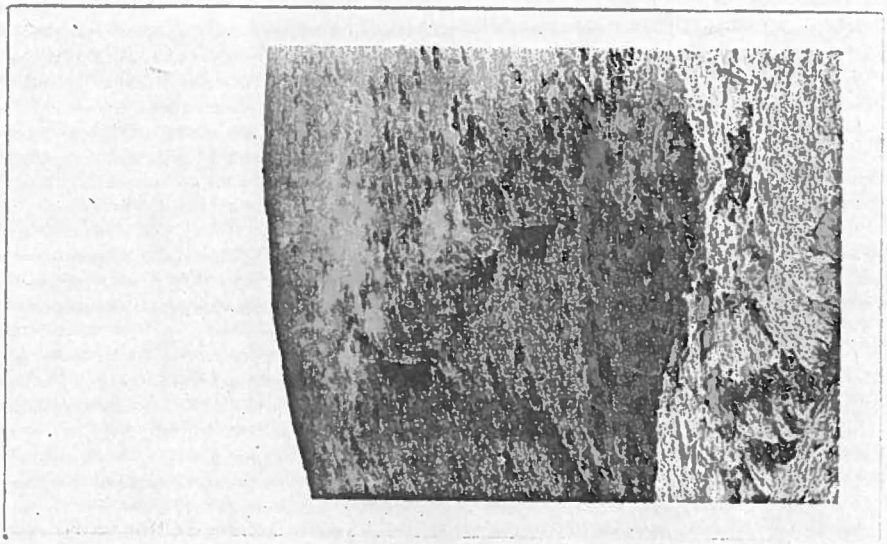
(14) Flat lava plain arched and broken along the rift where the upper line crosses from the foot of Broken Top. White Knob Mountain in the distance.



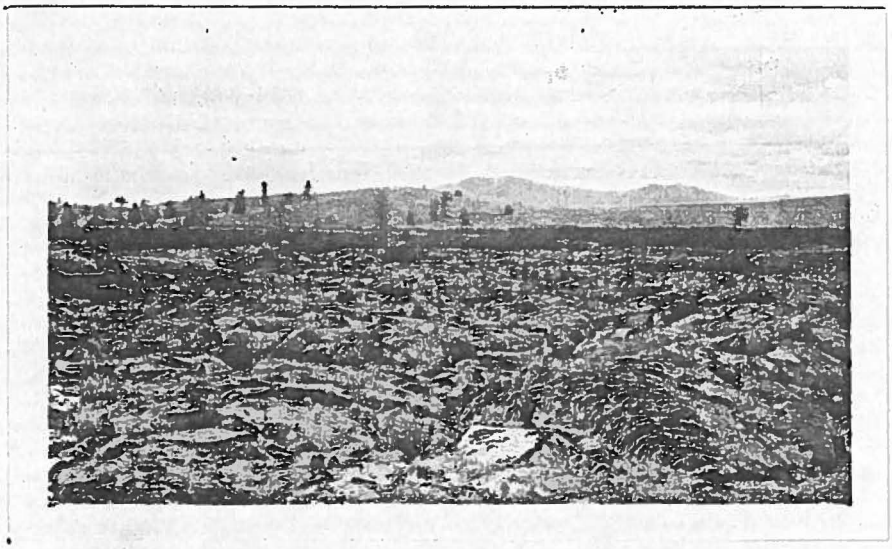
(15) Arched and broken border of the flat lava plain along the rift at the foot of Broken Top. The upper line road survey crosses in the middle distance. White Knob Mountains in the background.



(16) Rivulet of recent lava in a crack of the flat lava plain along the rift at the foot of Broken Top — near the crossing of the upper line survey.



(17) The rift in the south slope of Broken Top, nearly parallel to that at the foot where the road crosses and 150 to 200 feet distant. It is clearly seen from the upper line and is also near the lower line, where they approach the junction point on the flat lava plain.



(18) The broad pahoehoe field is also alongside the upper line, and the lower line crosses the middle of it. The ragged aa, rising above the pahoehoe, is clearly seen from both lines.

Character of the materials - The bluff (Fig. 19) over which the upper line has been located is a fault cliff produced by a rift or fissure, portions of which are still open (Fig. 9). Cinders cover most of the surface of Broken Top and give the impression that the cone is composed of them exclusively, but the slope above the bluff shows also many bombs and irregular clots of spatter lava that were only partially covered by the last shower of cinders.

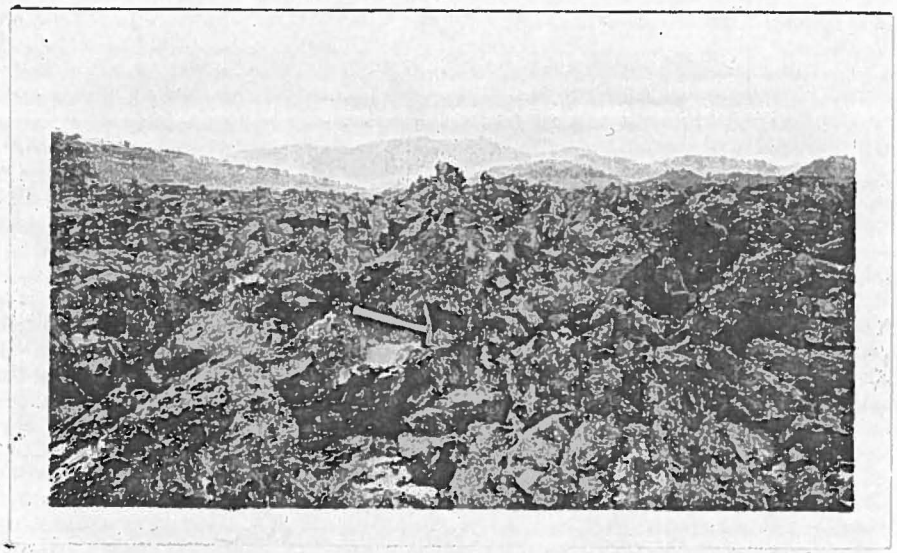
The cross-section exposed in the bluff (Fig. 19) shows a layer of spatter lava several feet thick, beneath which cinders again are preponderant. From the viewpoint of road construction this layer of coarser, partly adherent spatter lava is advantageous, as it will provide a stronger bench for the road than loose cinders alone.



(19) Near view of the bluff, or fault cliff, at the west foot of Broken Top, as seen from the lower line survey. Beneath an upper layer of bombs and spatter lava, cinders again dominate. The upper line location skirts the top of the bluff.

THE LOWER LINE

Around the southwest foot of Broken Top the lower line traverses a belt of aa lava (Fegs. 20-22) and then emerges upon a field of billowy and locally broken and sunken pahoehoe (Fegs. 18, 23). Some depressions will require road embankments eight to ten feet high.



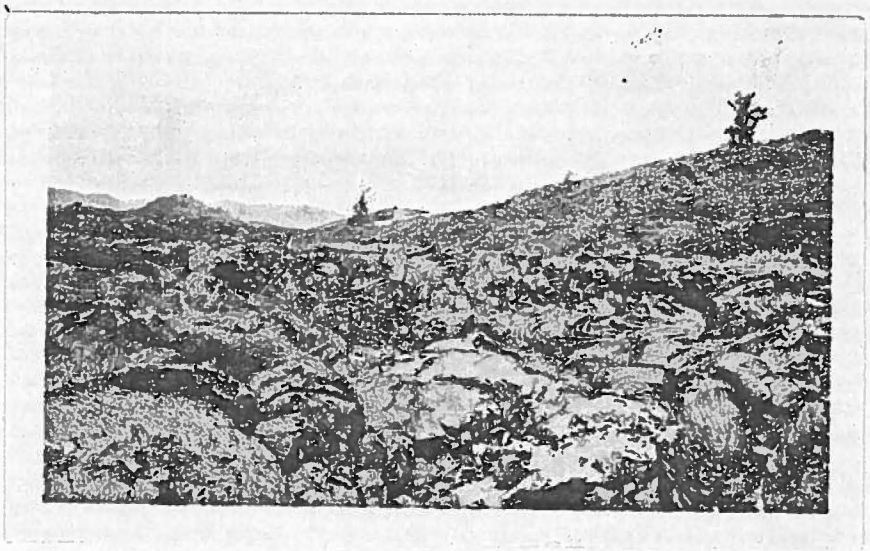
(20) Aa lava along the lower line survey. Looking northwest toward White Knob Mountains.



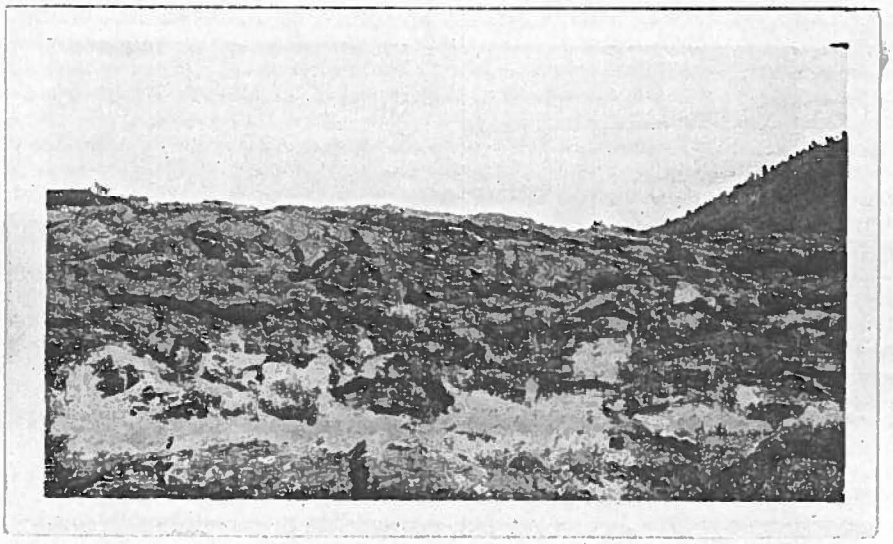
(21) Aa lava at Sta. 56 on lower line survey, by the trail to Great Owl Cavern.



(22)
Aa lava on lower line survey, near pahoehoe at middle distance.



(23)
Pahoehoe lava on lower line, showing depression to be crossed by embankment. Upper line at tree on top of bluff.

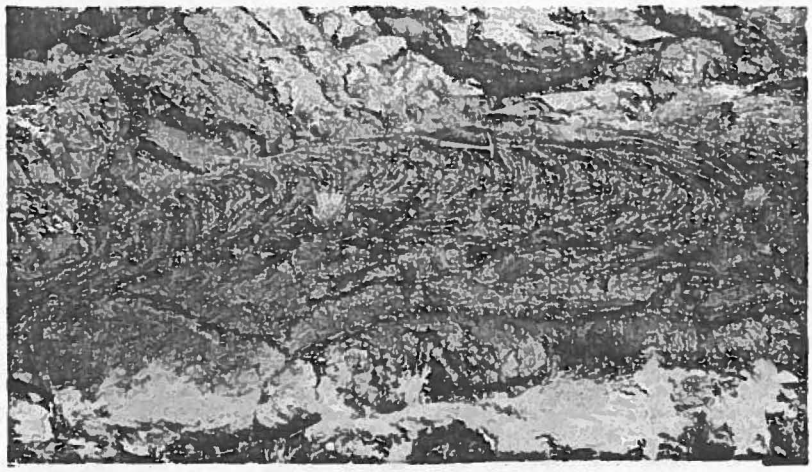


Sunken pahoehoe on lower line, requiring road embankment; also broken edge of level lava on which line continues. Foot of Big Cinder Butte at right.

Diversified flow markings.- On the pahoehoe lava along the lower road location innumerable fascinating and instructive details appear in the surface forms. Among the most varied and interesting are the manifold types of flow markings, especially those formed by wrinkling in the cooling and stiffening surface film on the liquid lava that flowed beneath. Simple wrinkles (Figs. 25-32) are numerous. Fantastic twisted and distorted forms (Figs. 33-38) are less common.



(25)
Flow wrinkles on sunken pahoehoe lava along lower line survey.



(26)
Sunken pahoehoe lava with flow wrinkles, along lower line survey.



(27)



(28)

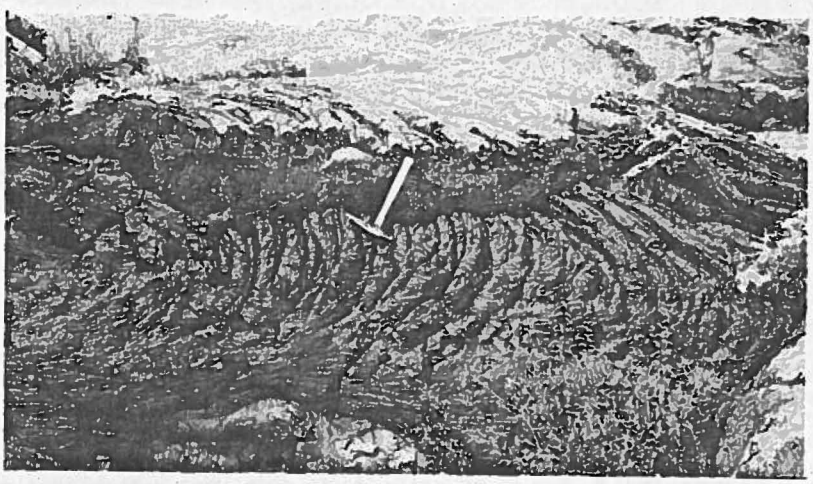
(27), (28) Deeply corrugated and contorted flow wrinkles on pahoehoe lava along lower line survey. Aa lava beyond.



(29) Flow wrinkles, contorted and heaped up, along lower line road survey.



(30)
Wrinkles broken by cooling crack. Lower line survey.



(31)
Flow wrinkles broken by cooling crack and settling. Lower line survey.



(32)
"Curled" flow wrinkles formed on striated surface. Lower line survey.



(33)
"Curled" flow wrinkles, heaped up. Lower line survey.



(34)
Distorted flow wrinkles. Lower line survey.



(35)
Distorted "curled" flow wrinkles, Lower Line survey.



(36) Deeply contorted hollow wrinkles. Lower line survey.



(37)



(38)

(37) "Stretch" flow lines and broad wrinkles, showing where broken (at the pick) a different type of wrinkles beneath. Lower line.

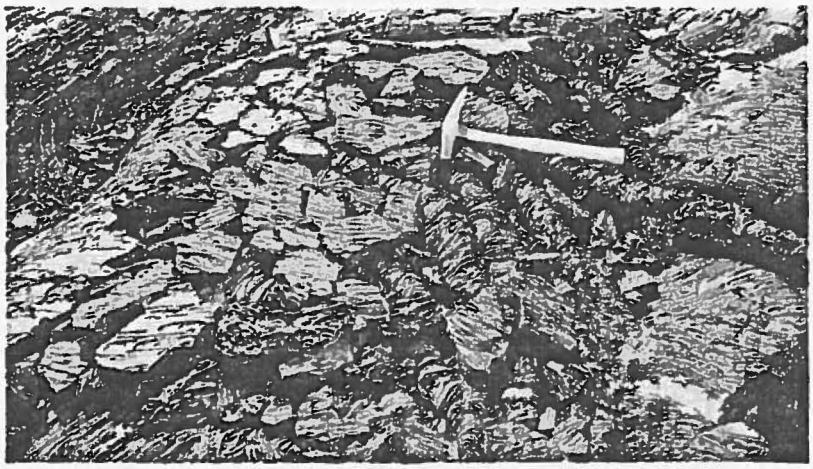
(38) "Stretch" flow lines, with large wrinkles beneath.





(39) (40)

(39) Hollow wrinkles partly broken away (near Pick), showing similar wrinkles beneath. Lower line survey.
(40) Parallel flow lines breaking away and exposing "curled" wrinkles beneath. Lower line survey.



(41) Smooth flow surface broken and exposing "curled" wrinkles beneath. Along lower line survey.



(42)
Smooth lava marked with parallel flow lines. Along lower line survey.

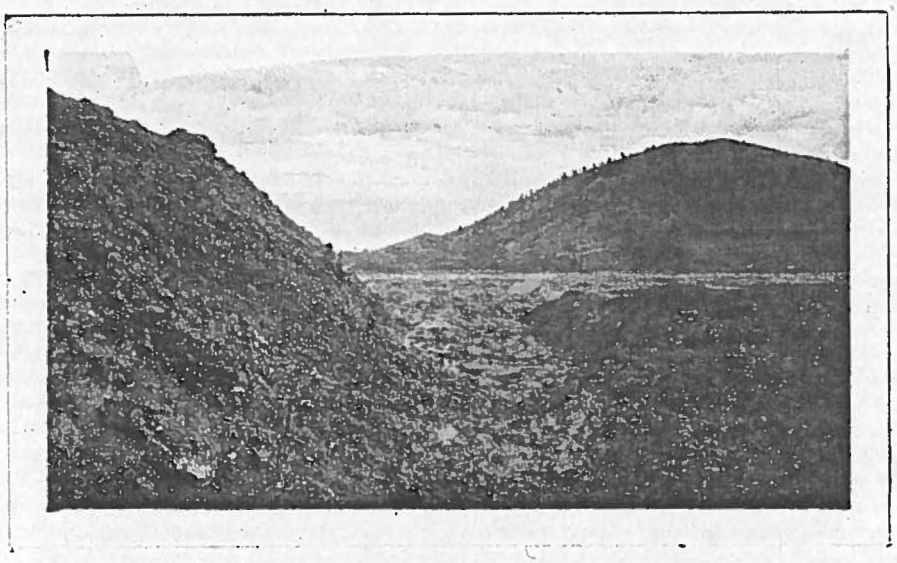
Many wrinkles where broken, are found to be hollow, showing that they were lifted above the liquid lava beneath. Probably in part they were supported by the steam and gases that escaped from the liquid and were trapped under the cooling surface film. Under some of these uplifted films a second wrinkled film was formed (Figs. 39-41), with patterns that differed in many places from those at the surface. Wrinkled second films were formed in places also beneath the finely striated, or "Streatched", surface marking (Figs. 40-41), which in places occupies large areas (Fig.42).

Many of these and a great variety of other interesting details will necessarily be covered or blasted away if a road is built across this pahoehoe lava. It may be said, however, that such features are plentiful, and hence an abundance of them would still remain. Perhaps more objectionable would be the contrast

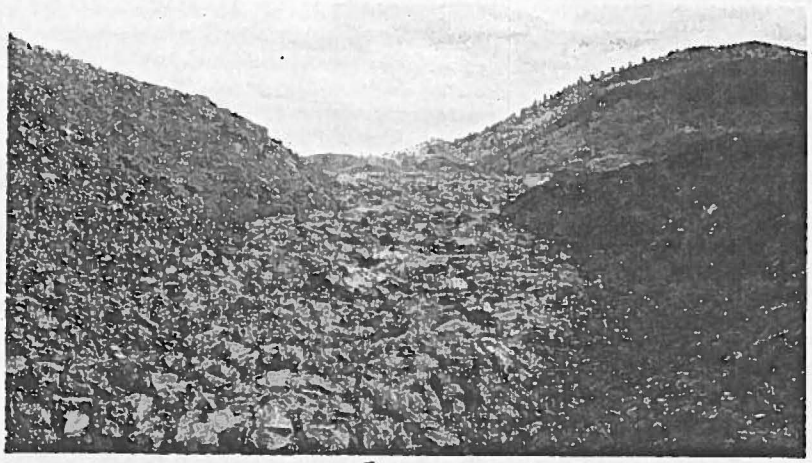
between the cinder roadways and these graceful curved and variegated flow features, which literally mark every rod of the distance across the pahoehoe.

FEATURES COMMON TO BOTH LINES

The alternate road surveys along the west side of Broken Top along part of the course follow opposite sides of the rift (Figs. 43, 44) and in places look down into the horizontal "V" formed by the spreading apart of the two sides of the rift at the southeast. Into this open end of the "V" a tongue of late lava flowed. Apparently the continuation of this fissure formed the rift trench that shows on the lower east slope of Big Cinder Butte.



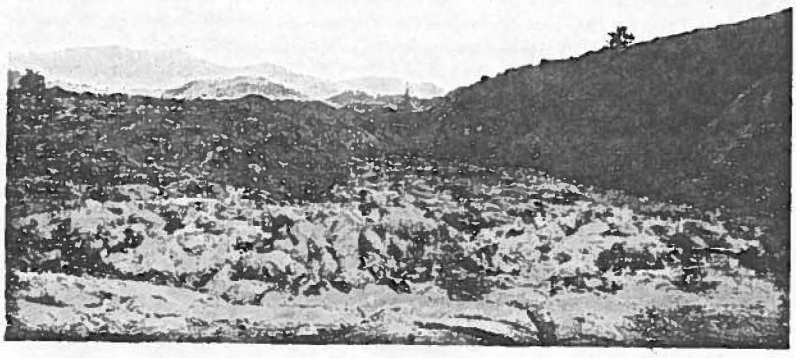
(43) Rift trench at the west foot of Broken Top into which a tongue of lava flowed. Big Cinder Butte at the right, showing rift trenches on the lower east slope.



(44)
Up the slope of the lava in the rift "V" of Fig. 43.

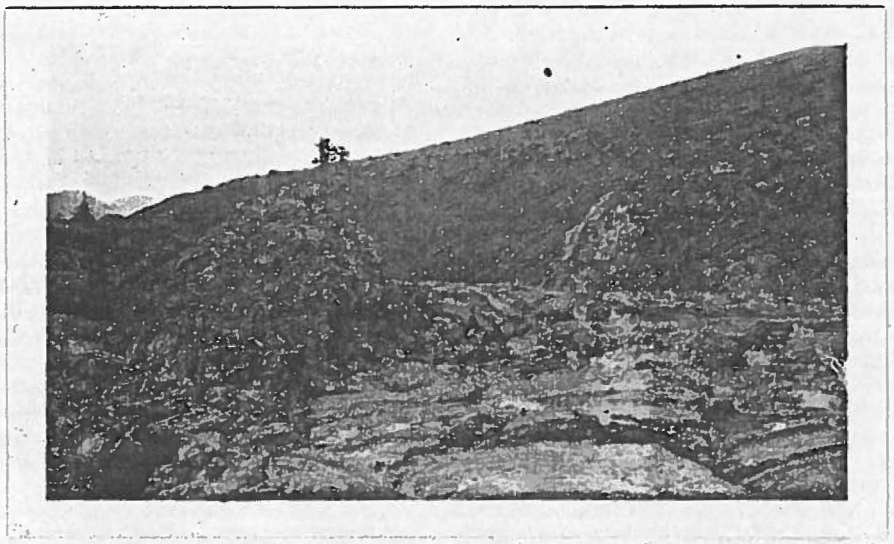


(45)
Into the open end of the "V" down the flow of pahoehoe



Into the "V" rift at foot of Broken Top. White Knob Mts. in distance; Silent Cone and Big Craters nearer.

Figs. 45 and 46 look back (northwest) into the rift "V". The materials at the left have been torn from the foot of Broken Top and floated away by the escaping lava. Some portions of this slice of Broken Top were floated away separately (Figs.47, 48).



(47) Fragment from the foot of Broken Top floated away about 200 feet from the rift at the right. Along the top of the rift cliff the upper line road is located.

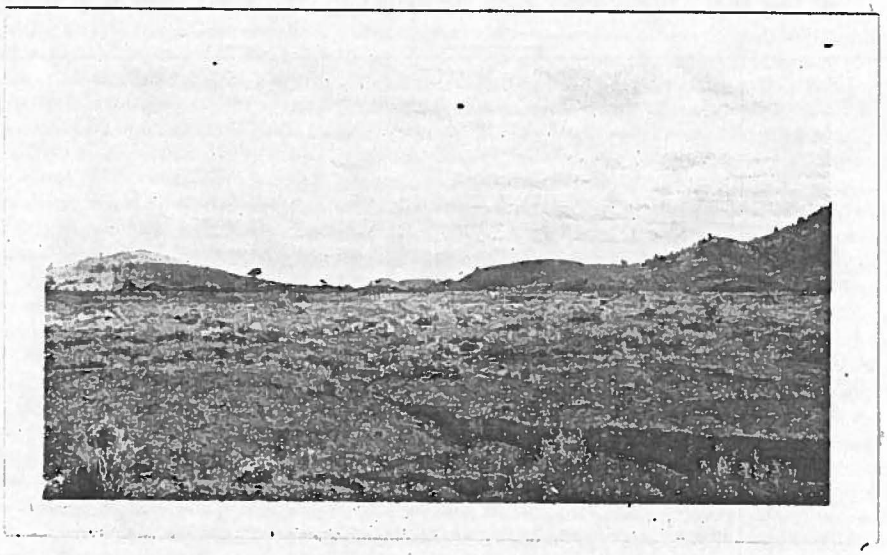


(48) Nearer view of the fragment of Broken Top, showing the spatter lava of which it is composed.

Both the upper and the lower lines are located near the broken border of the flat lava plain (Fig. 49) where the later pahoehoe lava impinged upon it. The lower line crosses this broken border and the upper line crosses from Broken Top to the flat lava alongside this contact. On this flat lava plain (Fig. 50) the two surveyed lines unite.

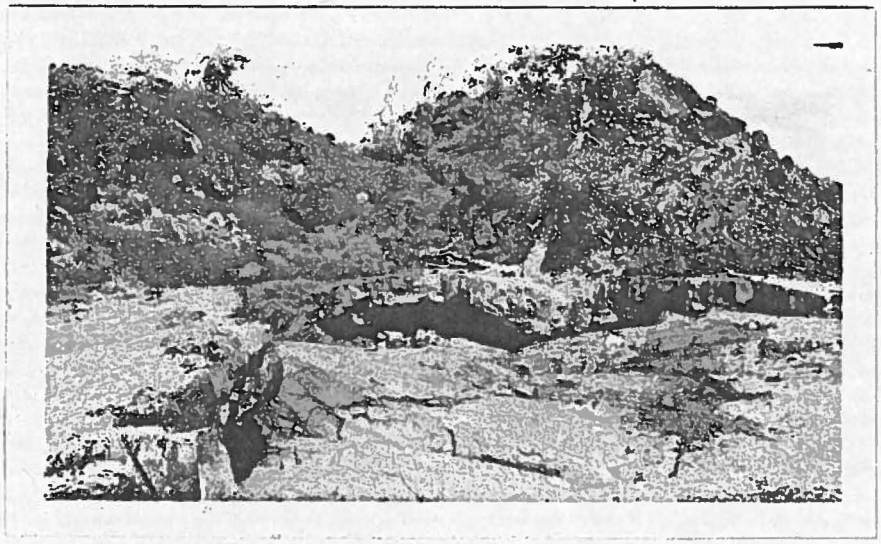


(49) Broken border of the flat older lava where the later pahoehoe impinged upon it. Beside the upper and lower lines, west of Broken Top.



(50) Flat lava plain where the two road locations unite, in the middle distance. Half Cone at the left; rift-trenched slope of Big Cinder Butte at the right.

Near the two road lines and their junction point on the flat lava plain are the mounds of spatter lava and the partially collapsed dome of Buffalo Caves (Figs. 51, 52). The cave shows lava tubes at three successive levels, and many former flow levels of lava are marked on the walls (Fig. 52).



(51) Collapsed dome of Buffalo Caves and mounds of spatter lava at the south foot of Broken Top.



(52) Collapsed dome of Buffalo Caves, showing multiple tubes and marks of flow levels. South foot of Broken Top.

SUMMARY OF FEATURES ON THE ALTERNATE LINES-

The alternate lines for the proposed road at the southwest of Broken Top — the upper line rising over the low bluff, the lower line skirting the foot of the slope — both present certain advantages and disadvantages, which may be summarized for comparison.

A road anywhere in this area will necessarily produce a scar in the landscape in the sense that it will present a striking contrast with its surroundings. The choice between the alternate locations must depend in large measure on the appraisal of the values that are adversely affected and of the offsetting advantages to be derived from one or the other location.

Advantages compared.- The upper line affords a panoramic view of the broad and impressive flows that fan out from Big Craters and diverge among the numerous peaks at the northwest, north, and northeast of Broken Top. The contrasted aa and pahoehoe types of lava stand out distinctly over broad areas. Particularly interesting is the intimate view afforded of the lava tongue that enters the basin between Broken Top and Big Cinder Butte, where it meets conflicting flows from both of these sources. These features and their relationships are not seen from the lower line.

On the other hand the lower line traverses both aa and pahoehoe lavas and hence affords a near view of their varied details. Many features can not be seen to advantage, however, from a moving automobile. A parking space on the pahoehoe lava would permit the visitor to walk over its curved surfaces and to approach the borders of the impassable aa.

Along the upper line also a similar parking space could be provided at the edge of the pahoehoe field, near where the road would cross from Broken Top to the flat lava plain. Furthermore, from this place the rift phenomena along the foot of Broken Top (Figs. 8-13) can be conveniently observed.

The upper location thus combines the advantages of both the comprehensive views and the intimate and interesting details, whereas the lower line affords only the latter.

Disadvantages compared.- The smooth road along the upper line would be clearly visible even on the smooth slope of Broken Top, and also the scar of the road bench would show from other portions of the Monument. However, where the road rises along the north slope very little cutting will be required, and the visibility of the bench on the steeper southwest slope will be kept at the minimum by the proposed method of end-haul construction, so as to avoid the dumping of materials down the slope; also the surface along the crest of the rift cliff will also tend to make the road less conspicuous.

The high line will require an embankment, or fill, where it crosses the rift from the lower slope of Broken Top to the flat lava plain, as the trench is some 12 to 15 feet deep. Probably this embankment can be reduced to ten feet or less by continuing the down grade to the middle of the trench and then rising to the edge of the lava plain.

The lower line also would require two or more small embankments across depressions in the billowy and partly sunken

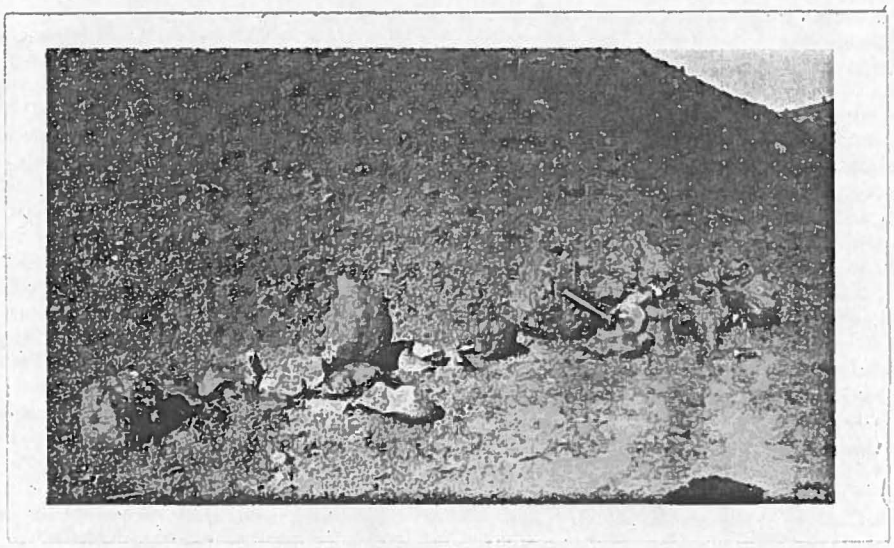
pahoehoe flow, and together these perhaps will more than offset the one fill required on the upper line. Across the fields of both aa and pahoehoe lava the lower road would present a more conspicuous contrast than the trace of the upper line on the slope of Broken Top. Furthermore, the lower line necessarily destroys or conceals many attractive details in the surface of the pahoehoe. Although such features are plentiful, scarcely any two are duplicates, and the upper location avoids such injury altogether.

Thus the disadvantages, or objectionable features, of the upper line appear to be distinctly less weighty than those of the lower line.

Conclusion.- The advantages of the upper location are thought to outweigh to a marked extent those of the lower, and its objectionable features are less important. All things considered, therefore, the upper line is considered preferable, and hence its adoption was recommended in the preliminary memorandum of August 11, 1936.

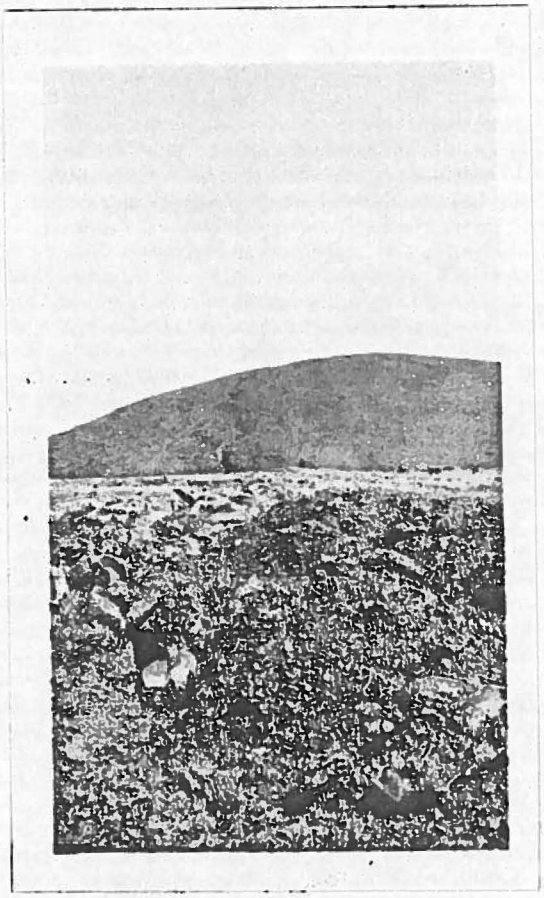
THE ROAD EXTENSION SOUTHEAST OF BROKEN TOP

Along the line near Big Cinder Butte and Half Cone lava bombs are numerous (Fig. 53).

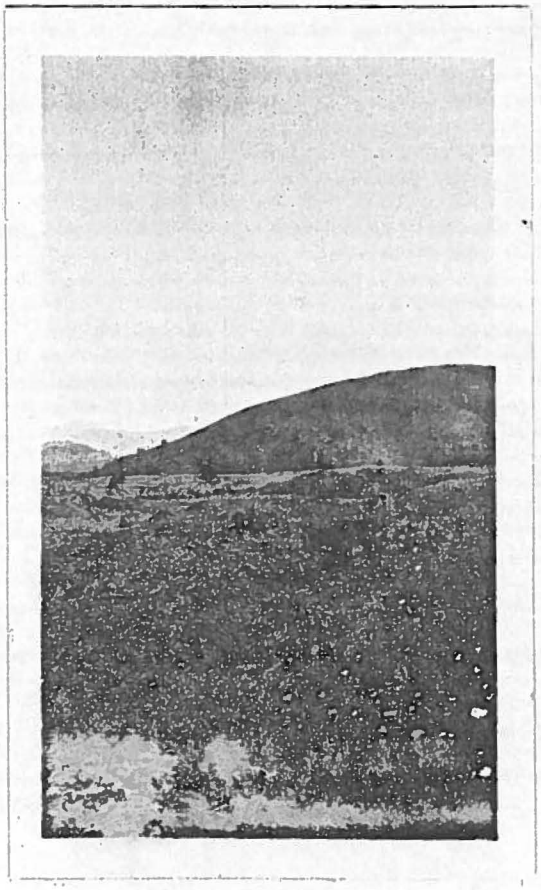


(53) Lava bombs, a few of the many forms, between Half Cone and Big Cinder Butte.

A belt of faulted and disturbed lava near the road marks the apparent continuation of the rift that cuts the south slope of Broken Top (Figs. 54, 55).

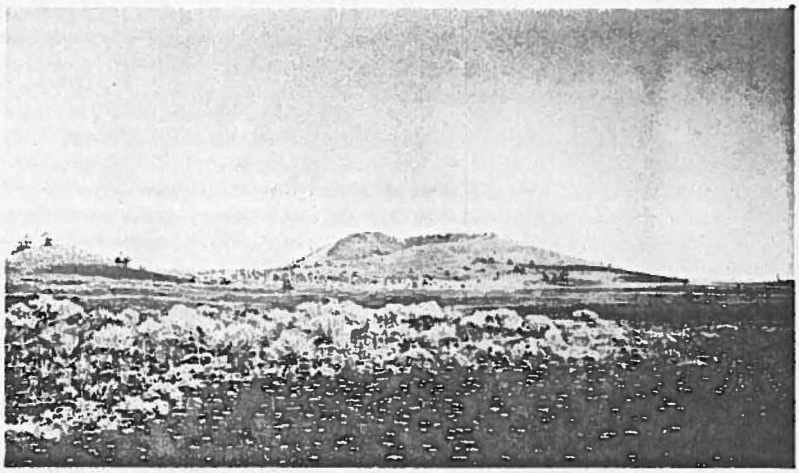


(54)
Shattered lava along a rift, which continues up the south slope of Broken Top. The road location lies across the flat lava in the middle distance.



Disturbed lava and cinders along the rift that cuts the south slope of Broken Top, in the distance.

Trench Mortar Flat.- The entrance to Trench Mortar Flat affords a view into the breached crater of Crescent Butte (Fig. 56) and of the rift with craters at its southwest slope (Fig. 57).

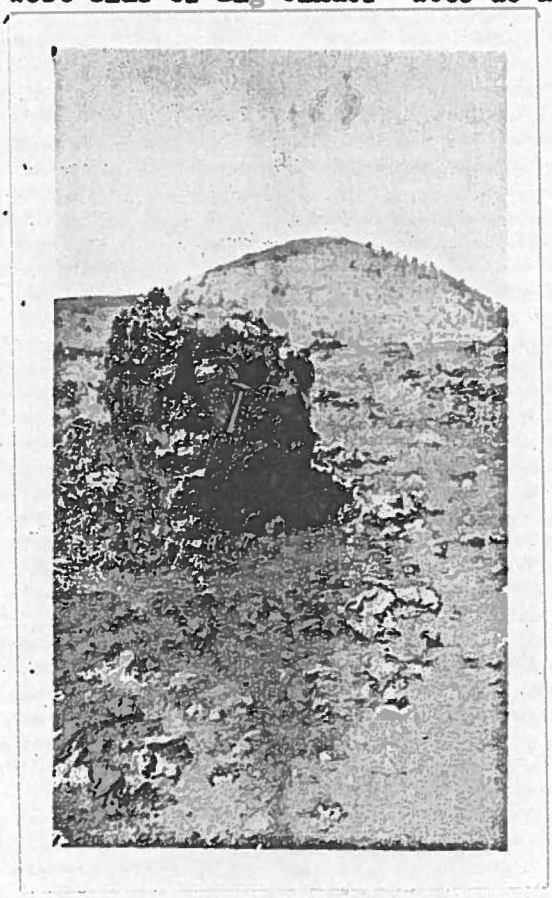


(56)
Crescent Butte, Across Trench Mortar Flat.

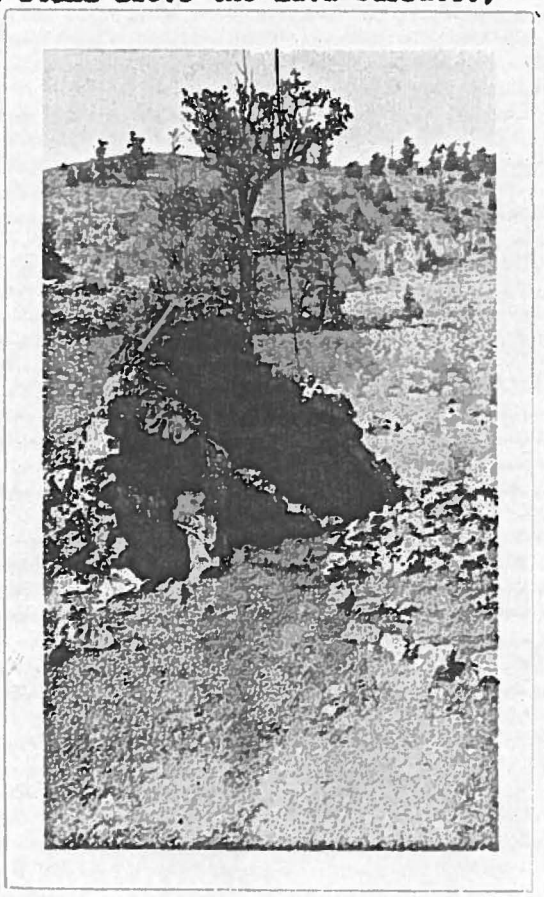


(57)
Crater in the rift at the southwest foot of Crescent Butte.

Numerous tree molds, because of their fancied resemblance to mortars, have supplied the name of Trench Mortar Flat. Living Trees, seared and charred by the advancing flow, in turn chilled the sheaths of lava (Fegs. 58-63) that wrapped their trunks. Most of the flow passed on, but these sheaths stand like hollow stumps above the present surface. (In contrast, the tree molds at the west side of Big Cinder Butte do not stand above the lava surface.)



(58)



(59)

(58) Tree mold, southwest side of Trench Mortar Flat. Big Cinder Butte in the background.

(59) Double tree mold, Trench Mortar Flat. Thin, fragile walls broken away at the northeast; thick, heavy walls at the southwest. Mature living tree in the rift trench in the middle distance.

The molds preserve many details of knots and branches, also the checkered shrinkage cracks of the charred wood; but the wood itself has disappeared completely, leaving not even a trace of enduring charcoal. If the trees had rotted away, as some have supposed, the charcoal at least would remain. Not only were they charred and killed by the scorching lava, but in all probability they were also ignited and completely burned.



(60)

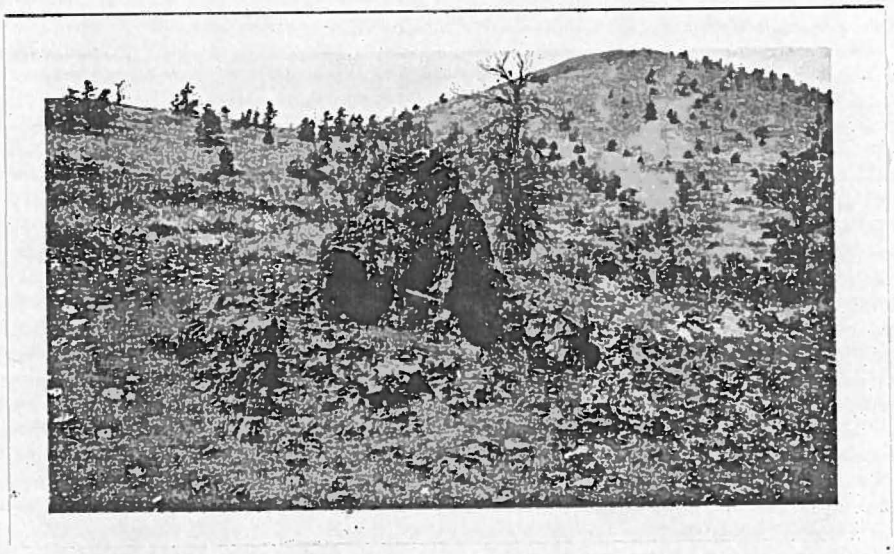


(61)

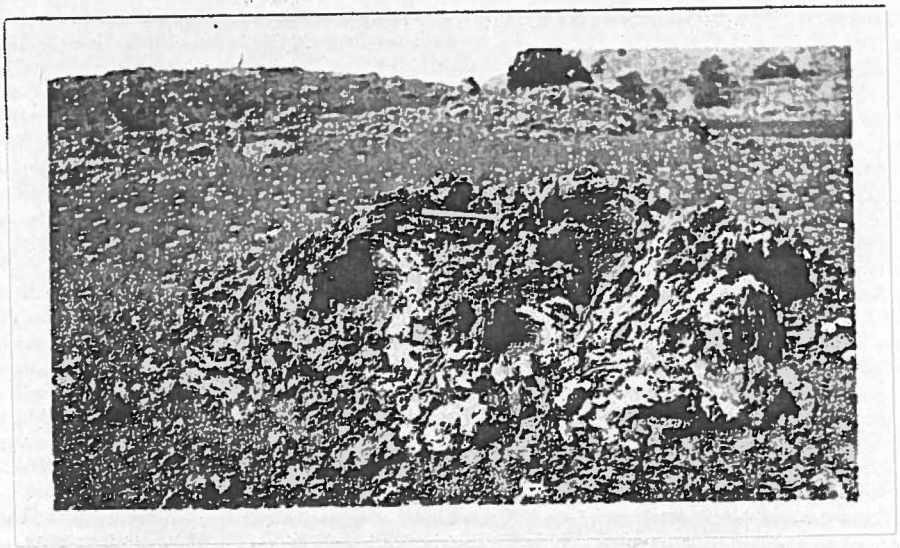
(60) Tree mold, Trench Mortar Flat. Slope of Big Cinder Butte in the background.

(61) Tree mold that served also as a fumarole vent; oval cross-section 12 by 14 inches. Trench Mortar Flat.

Most of the molds are higher and notably thicker on the southwest side, indicating that the flow approached from this direction and also that it was moving with appreciable speed and hence had not advanced far from the outlet vent.

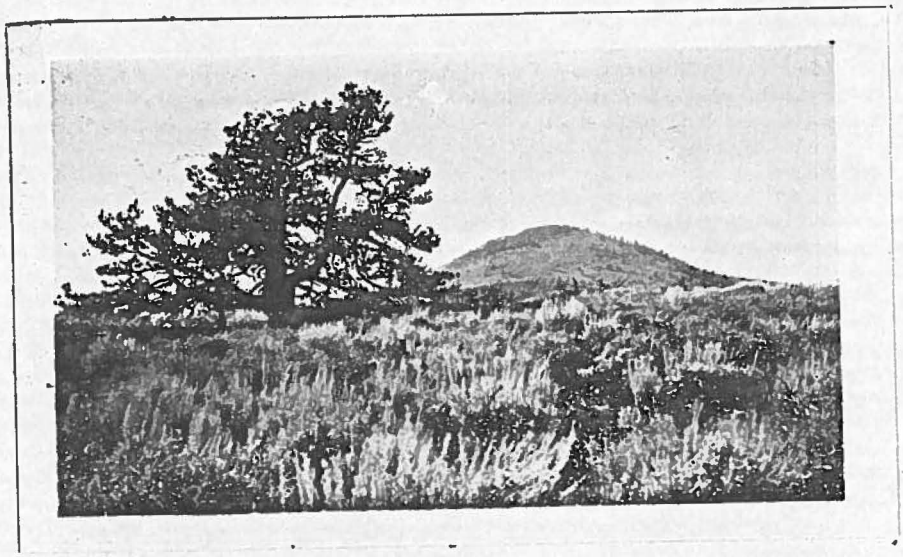


(62) Double tree mold, Trench Mortar Flat. Thin walls broken away at the northeast; heavy walls, with heaped-up lava, at the southwest. Big Cinder Butte at the right; living trees in the rift trench in the middle distance.



(63) Cluster of tree molds, with a rift trench in view at the left background. Slope of Big Cinder Butte at the right distance.

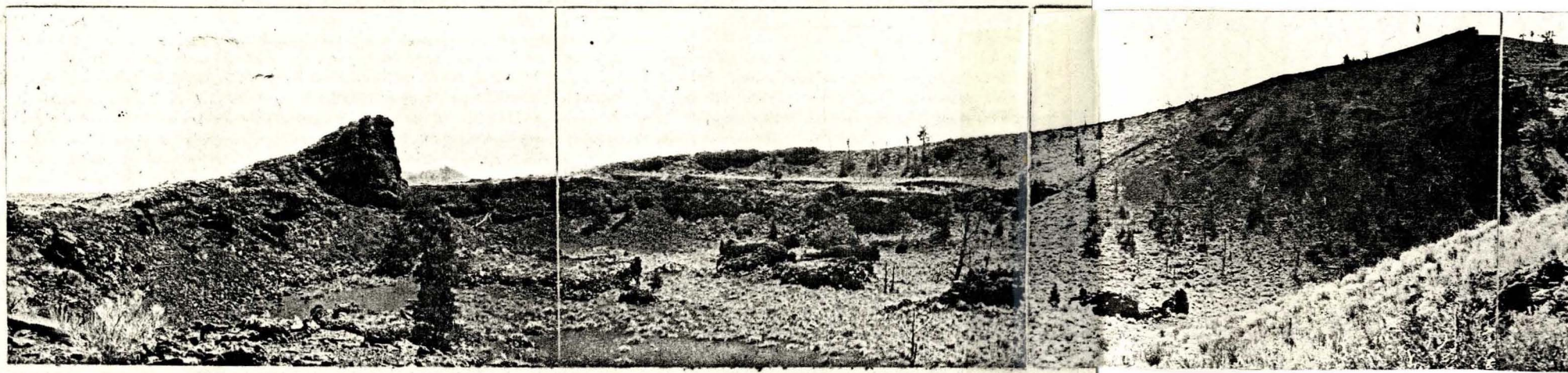
The tree molds are smaller than the trees on which they were formed, for they bear the impression of charred and cracked wood, not bark. Presumably, however, the trees had not lost many inches in diameter before the lava became sufficiently chilled at the contact to hold its form. Molds up to 2½ feet in diameter were measured. Some of the trees were doubtless three feet, or about the size of mature trees that grow in the vicinity today (Fig. 64)



(64) Living tree in the vicinity of the tree molds and about the size of the largest of the molds. Trench Mortar Flat. Big Cinder Butte in the distance.

One tree mold a little more than one foot in diametar (Fig. 59) also served as a fumarole vent. It is lined with a brownish-red glass that is blebby in places and has many drip-points, attesting the high temperature of the escaping gases. This also suggests the nearness of the vent from which the lava flowed.

Echo Crater — the proposed terminus.- Some features of Echo Crater are shown in the panorama, Fig. 65. Considerable areas of the opening are concealed, however, behind the higher ground at both the left and the right. Scenically this crater is a worthy objective for the proposed extension of the monument road, but further valuable additions can be made by the construction of a terminal loop that touches the severely rifted borders of Little Prairie, as suggested below.



(65) Echo Crater, panorams from the north rim looking east, south, and southwest. Considerable portions of the crater are concealed

LITTLE PRAIRIE LOOP ROAD PROPOSED

It seems wise to abandon the former plan for the extension of the road to Little Prairie Waterhole, inasmuch as the narrow fissure at that place would appear in some measure as an anticlimax after Echo Crater. Nevertheless, a relocation and looping of the road by way of the rifted border of Little Prairie would add considerably to the variety of new features and hence to the value of the road as a whole.

The Great Rift — a unique feature.- The outstanding feature of the Craters of the Moon, and apparently standing alone in the national park system, is the Great Rift. This zone of fissures extends for twelve miles across the middle of the Monument. It is remarkable for its numerous open chasms — manifest evidence of the breaking forces that have so recently been active there.

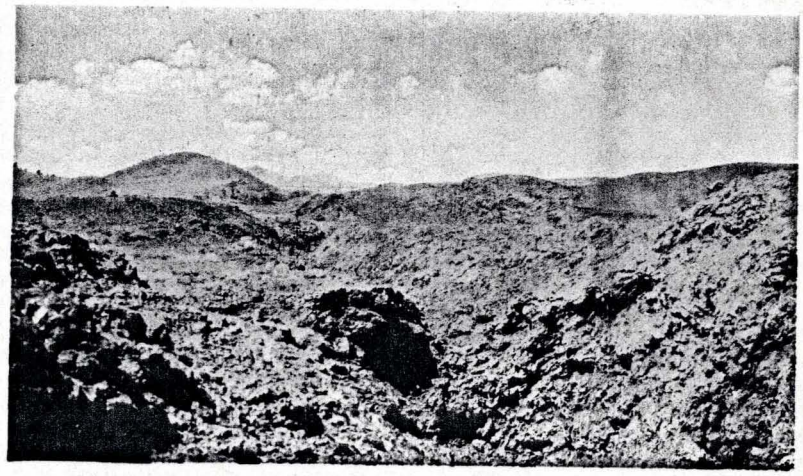
The Great Rift provided the outlets for broad fields of lava; along its course grew up numerous cones and craters. It dominates the plan and the whole spectacular assemblage of volcanic phenomena.

Many fine features of the Monument are conspicuous and hence are easily observed and enjoyed by the visitor; but the Great Rift is accessible at only one point on the road—the Big Craters— and there the open fissures are not in evidence. The extension of the road to Echo Crater will present a wide range of interesting features along this zone and will enhance to a marked degree the attractiveness of the Monument, but few fissures of the Great Rift itself will be seen along this course.

The relocated and looped extension of the road to Little Parairie would remedy this deficiency by making accessible a striking

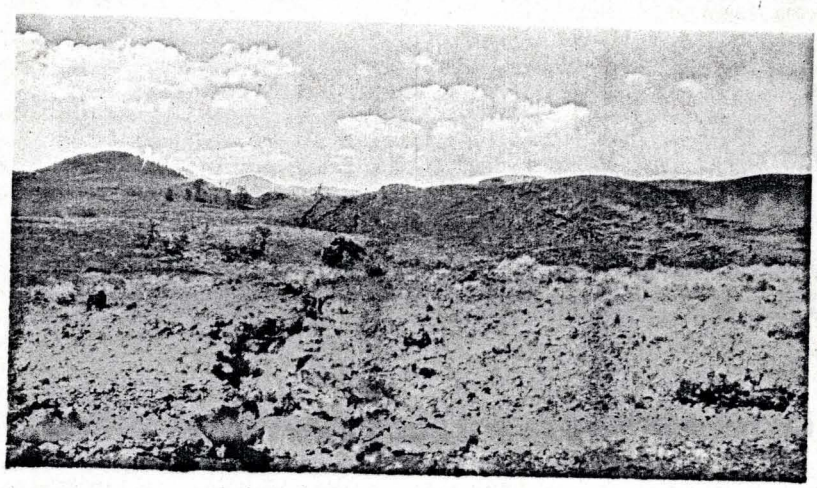
series of open fissures, which are all the more startling and impressive because they rift the surface of the flat lava plain.

Approximate road location.- An extension of the road about 1700 feet in an east-northeasterly course from the proposed terminus at Echo Crater would reach a fine exhibit of fissures in the Great Rift zone (Figs. 66-69) at the northwestern border of Little Prairie. Deep narrow chasms and the sunken pits are strongly developed along parallel lines, branching in places and amazingly fresh-vivid reminders that indeed "something has happened here." On the fissured and shattered plain the thrilling sense of profound earth-rending forces is all the more impressive.



(66)

Open fissure, deep chasms in many places. Northeast of Echo Crater. Big Cinder Butte in left distance.

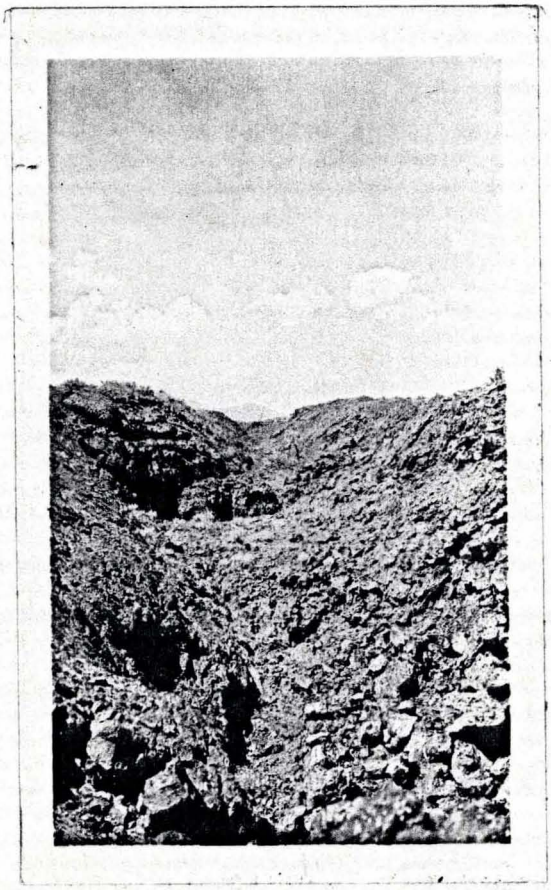


(67)

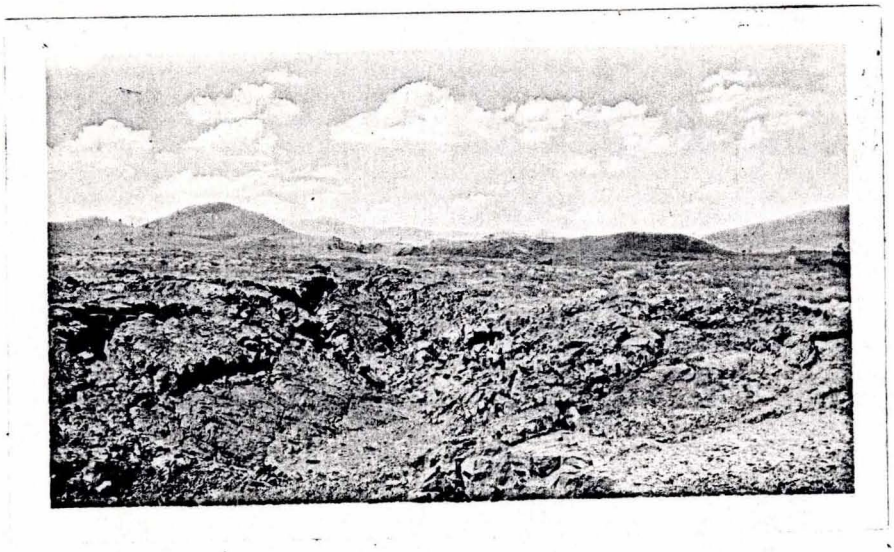
Fissures in the Great Rift, northeast of Echo Crater.

The proposed road would follow northwest, along-and across-these spectacular fissures another 1700 or 1800 feet, to the deep pit of Yellowjacket Waterhole; thence, looping back westward about 1300 feet, it would join the southbound road and close the loop at the southeast foot of Coyote Butte.

The loop as suggested, with an aggregate length of some 4800 feet, would present an exhibit that is believed to be unique in the whole range of national park phenomena.



(68) A portion of an open fissure partially filled with broken lava. Northeast of Echo Crater. Summit of Big Cinder Butte in the distance.



(69) Open fissures and sunken lava in the Great Rift zone northeast of Echo Crater. In the middle distance, from left to right, Coyote Butte, Big Cinder Butte, and Crescent Butte. White Knob Mountains in the background.

CONCLUSIONS AND RECOMMENDATIONS

1. Location of the road.- In general, the location of the proposed extension of the Monument road, from the geologic point of view, as surveyed and marked from Inferno Cone to Echo Crater, is excellent. On account of the controlling topographic conditions along many parts of the line only minor relocations would be practicable, and no such changes are considered desirable.

2. Alternate routes at Broken Top.- As between the two routes surveyed at the west and southwest sides of Broken Top, the upper line, over the lower slope of Broken Top, is preferred as having the greater advantages and the less weighty objections.

3. Parking facilities on the upper line.- In order to present the features of the area to the best advantage, parking

areas are considered essential: (a) On the shoulder of Broken Top, near the highest point in the line, for the broad panoramic view: (b) On the flat lava plain southwest of Broken Top, near the rift at the foot of the slope and near the border of the pahoehoe lava, for the lava details and rift features.

4. Little Prairie loop road.- A loop road to the fissures of the Great Rift along the northwest border of Little Prairie is recommended in order to present an adequate exhibit of this fundamental structure of the Monument.

Respectfully submitted,

J. Volney Lewis
Regional Geologist

San Francisco, California
September 21, 1936