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CRACK-IN-THE-GROUND, LAKE COUNTY, OREGON

By

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Open cracks or fissures in the earth's surface are not uncommon; they occur fairly often as a result of earthquakes or volcanic activity, but they usually become filled with rock rubble or lava and disappear in a very short time. A large fissure that stays open for hundreds of years is, therefore, a rare feature. Such a fissure occurs in a remote part of central Oregon. It is a deep, narrow rift about 2 miles long, and it has remained open for perhaps a thousand years. For lack of any official name for it, the feature is referred to simply as "Crack-in-the-Ground."

Location and History

Crack-in-the-Ground is situated in northern Lake County in T.26 S., R. 17 E. As shown on the accompanying geologic sketch map (plate 1), it can be traced from the southwest edge of the Four Craters lava field diagonally to the southeast until it disappears in lake sediments that mark the north shoreline of prehistoric Christmas Lake.

The feature can be reached by road, but the last few miles are not suitable for cars with low road clearance. The route starts from the east side of Silver Lake on Oregon Highway 31. From this point the course leads 19 miles northeast on a paved road to Christmas Valley Lodge, then east on a graveled road 1 mile and north on a graded dirt road 4 miles. At this mileage a rough, bouldery road branches off to the left and winds northwesterly through the sagebrush. It approximately parallels the west side of the fissure for 2 miles and then skirts the western edge of Four Craters lava field (see map). This road passes within 150 yards of the northern end of Crack-in-the-Ground, where lava has flowed into the fissure and filled it.

Homesteaders in the area have known about this giant fissure for many years. Reuben Long of Fort Rock, Oregon, reports (written communication,

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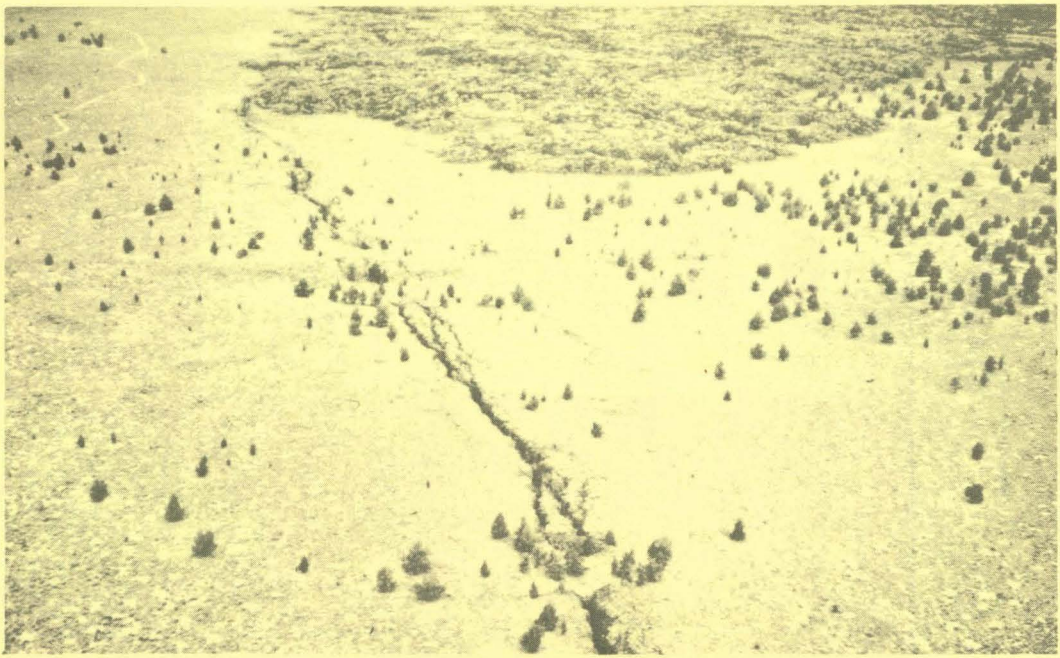
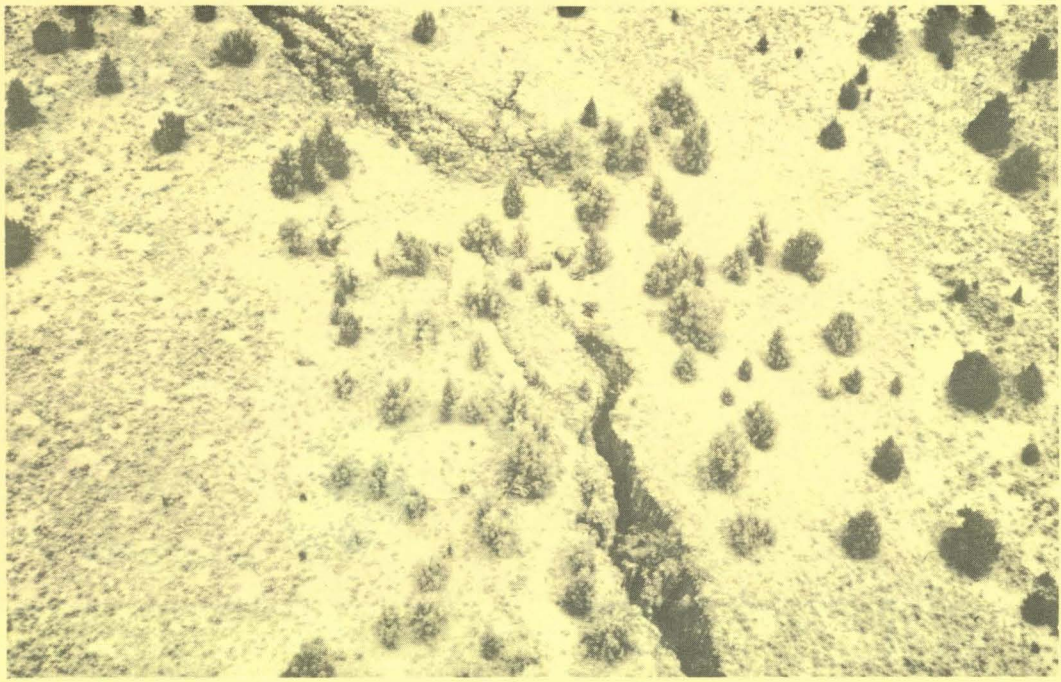


Figure 1. Aerial view of Crack-in-the-Ground looking north-northwest. Four Craters lava field in the background. Road shows in upper left corner.

Figure 2. Looking down on a portion of Crack-in-the-Ground. The fissure has been filled and bridged over in the center of the picture.



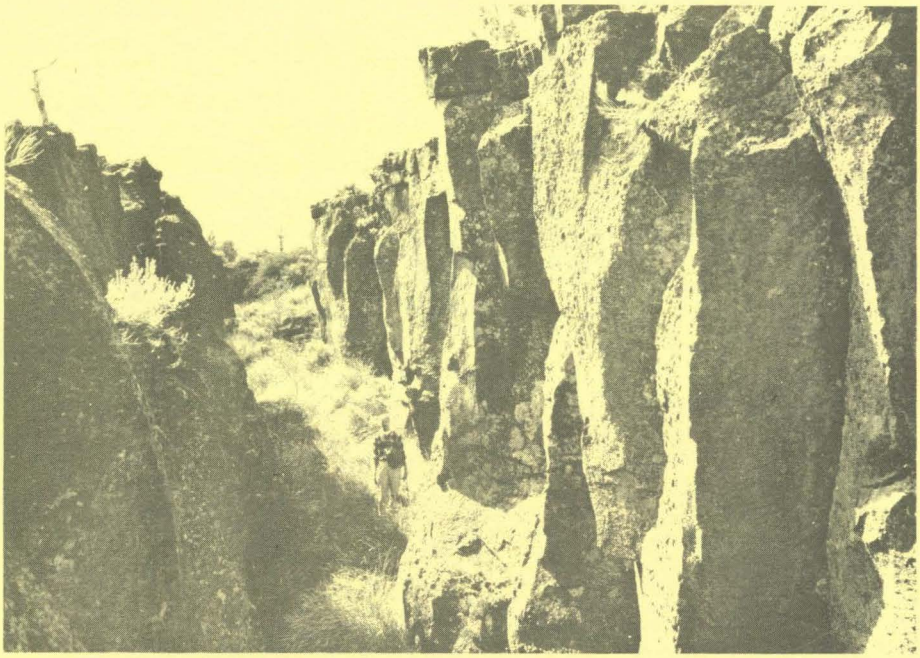


Figure 3. View of Crack-in-the-Ground showing the irregularity of the walls and fill in the bottom.

Figure 4. One of the deeper portions of Crack-in-the-Ground where access can be had from the surface. (Black lines drawn to define walls.)

1964) that when he lived at Christmas Lake as a boy he used to explore "The Crack," as it was called locally. He remembers that the homesteaders went there to hold picnics and make ice cream, using ice they found in caves in the chasm.

Description

Crack-in-the-Ground is a tension fracture in basalt. The walls are rough and irregular and show no lateral and but very slight vertical movement. The crack is open for a distance of more than 2 miles, but continues to the northwest and southeast as a trace which, although not visible on the ground, is revealed on aerial photographs. Where best developed, the fissure is from 10 to 15 feet wide at the top, narrowing downward. The depth varies, but is as much as 70 feet in some places. Figures 1 and 2 are aerial views of the crack and figures 3 and 4 are closeups.

Erosion and weathering have been at a minimum in this desert climate of northern Lake County, but over the many years that Crack-in-the-Ground has existed, some rock has sloughed off the walls and sand has blown or washed in to fill the bottom. At several places the walls have slumped, thus bridging the gap and allowing access to the deeper parts of the fissure. Winter ice is sometimes preserved during the summer in the deeper, more cavernous places where cold air is trapped.

Geologic Setting

Crack-in-the-Ground is closely related to the Four Craters lava field, one of the many isolated centers of recent volcanic activity within the high lava plains of central Oregon. Older rocks in the map area which pre-date the breach but which are broken by it include several ages of volcanic rocks and lake-bed sediments as described below.

Lake beds and alluvium

Large, shallow lakes filled the broad Fort Rock-Christmas Lake Valley beginning in late Pliocene time and continuing intermittently through the Pleistocene. During the Recent epoch, these lakes gradually shrank to small, brackish potholes and irregularly shaped saline pools. Lake beds, alluvium, and wind-blown materials of varying thicknesses mantle the floor of the basin, and wave-cut terraces around the rims represent various levels of the ancient lakes.

Explosion tuffs

The oldest volcanic rocks exposed in the area are erosional remnants of maars or tuff rings of late Pliocene to Pleistocene age. The remains of a maar just west of the Four Craters lava field is shown on plate 1. This mass of yellow-brown basaltic tuff and breccia is similar in composition and layering to Fort Rock and other remnants of maars and tuff rings, which were once numerous and widely distributed in and around the edges of the large lake basins of central Oregon (Peterson and Groh, 1963-b).

Green Mountain basalt

Surrounding the basaltic tuff remnants are younger basaltic lava flows that originated from Green Mountain, an eruptive center immediately to the northwest of the map area. The Green Mountain lavas form a low shield some 10 to 12 miles in diameter. The flows on the southern edge encroached on the pluvial lake that then filled the Fort Rock-Christmas Lake Valley and became the northern shore line. These lavas are of the pahoehoe type. Where they are exposed in the walls of Crack-in-the-Ground there are two or more flows with an overall thickness of at least 70 feet. Their surface is masked with a thin layer of soil composed mainly of fine pumice, windblown sand, and silt from lake beds in the adjacent Fort Rock-Christmas Lake Valley. Tumuli and other flow-surface features are present. Several small cinder cones near the summit of the Green Mountain shield still retain most of their initial characteristics even though they are covered by vegetation. From these observations, the Green Mountain lava is believed to be of late Pleistocene age.

Four Craters basalt

The Four Craters lava field, named in an earlier report (Peterson and Groh, 1963-a), formed from basaltic lava that flowed mainly south and east from centers along a fissure trending N. 30° W. The sluggish flows piled up a hummocky layer of black, spiny aa lava on the slightly sloping Green Mountain lava surface. Four cinder cones aligned along the fissure rise from 250 to 400 feet above the lava surface. The distance from the northernmost cone to the southernmost is roughly $2\frac{1}{4}$ miles. The southernmost cone is especially interesting, because several sectors of it were rafted off to the southeast on a slightly later lava flow. The freshness of the lava and lack of soil and vegetation on the surface indicate a Recent age for this field.

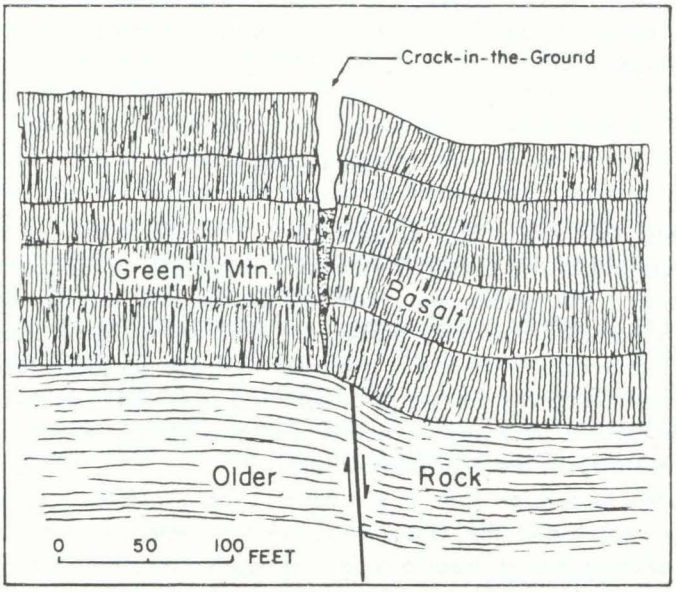


Figure 5. Generalized geologic cross section of Crack-in-the-Ground.

Origin of Crack-in-the-Ground

The eruptions from the Four Craters were accompanied by a slight sinking of the older rock surface to the southeast. This shallow, graben-like sink is about 2 miles wide and extends to the south into the old lake basin. Crack-in-the-Ground marks the western edge of this small, volcano-tectonic depression and parallels a zone of weakness concealed beneath the Pleistocene Green Mountain lava flows. The fracture is the result of rupture from simple tension along a hingeline produced by the draping of the Green Mountain flows over the edge of the upthrown side of the concealed fault zone (figure 5). The initial fracturing was probably propagated rather quickly over its length as the central block began to sink to form the shallow graben. Vertical displacement of the graben is no more than 30 feet and it diminishes to the southeast. There is the suggestion that the shallow graben continues on into the old lake basin and acts as a sump for present-day Christmas Lake and other ephemeral ponds and potholes. The sinking of the graben block and the accompanying rift on its western edge probably began with the first eruptions of the Four Craters. Crack-in-the-Ground

opened before the last volcanic activity, and at its northwest end a tongue of lava piled up, tumbled into, filled, and buried the chasm for several hundred yards.

Conclusion

The eruption of the Four Craters Lava, the accompanying subsidence, and the opening of the Crack-in-the-Ground fracture probably took place no more than 1,000 years ago. Even though some filling by soil wash and windblown material has taken place, and some slumping of blocks from the walls has occurred, the crack is a relatively fresh geologic feature. This stark freshness is partly the result of subdued chemical weathering in the arid climate and a lack of any recent violent earth movements or renewed volcanic activity in the immediate area.

A system of tension fissures similar to Crack-in-the-Ground has been previously reported in the Diamond Craters by Peterson and Groh (1964), but none of these has as great a length or depth. Another fault-fissure zone that trends northwest from Newberry Volcano to Lava Butte south of Bend, Oregon, has been studied by Nichols and Stearns (1938). This fissure is associated with the recent volcanism of the area and stands open in several places.

Further investigations in the field, together with study of aerial photographs, may reveal the existence of other interesting cracks in remote parts of Oregon where volcanism and faulting have occurred.

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GEOLOGIC SETTING AND ORIGIN OF THE GIANT FISSURE

The origin of Giant Fissure is intimately associated with the volcanism of the Four Craters lava field. This lava field flowed out on an older basaltic lava surface originating from an eruptive center which now is Green Mountain. A thin soil cover has been produced by weathering of this older basalt although one rather young appearing tumulus was observed. Some of the soil is probably eolian in origin, carried in from the adjacent Fort Rock-Christmas Valley lake beds. The southern edge of this large basalt shield comprising Green Mountain, some 10 to 12 miles in diameter, presents a sharp scarp at its southern edge which represents both the termini of the flows and erosion by the pluvial lake of the Fort Rock-Christmas Valley basin. Several small cinder cones near the apex of this shield still retain most of their characteristic landforms although weathered and covered by vegetation. Two known remnants of dissected maars and possibly a third are surrounded by the basalt flows as islands or kipukas. From these observations, the basalts of Green Mountain are believed to be of Pleistocene age, probably the late Pleistocene.

The Four Craters lava field, named in a previous report by the writers (Peterson and Groh, 1963), is rather unique for the almost perfectly straight alignment of its four basaltic cinder cones along a trend of about N. 30° W., unquestionably fault or fissure controlled. Heights of the cones vary between 250 and 350 feet, and the distance from the northernmost to the southernmost is roughly 2½ miles. Oddly, the southernmost cone has had several sectors of its cone carried off on a lava flow that moved to the southeast. Presumably, lava flowed out beneath the base of the cone, pulling away part of the cone, which was then transported relatively undisturbed as a mound on the surface of the flow. Apparently the cone was able to repair itself rapidly by new eruptions of pyroclastics, as this action was repeated several times and no great amount of breaching presently exists. Most of the lava extruded has flowed to the east and southeast favored by the general topographic slope. Several small inliers of the older surface are present within the field where the blocky aa type flows did not coalesce. Closer measurement places the area covered by the lavas at about 8 square miles against a previously estimated 12 square miles (Peterson and Groh, 1963).

The cinder cones and lavas of this field have very fresh surfaces and are judged to be about 1,000 years old, perhaps even less.

At the southern edge of the Four Craters lava field, a shallow graben is present. The graben extends southeasterly almost to the Christmas Valley basin and northwesterly under the lavas, being about 2 miles wide and a little over 3 miles in length. The west side of the graben is bounded by an east facing scarp of moderate slope which strikes generally N. 30° W. with deviations of several degrees from this trend along some segments. Vertical displacement along this scarp runs about 20 to 30 feet, but near the southern end tapers off into the general topography. The Giant Fissure is on the upthrown side, at the top of, and parallel to this scarp.

Since the Giant Fissure shows practically no displacement between the sides, it is not an upward extension of the fault which bounds the graben. Rather it is thought that the fault, or more probably a fault zone, does not reach the surface, and the scarp represents a monoclinal warp in the Green Mountain basalt which overlies the fault. This fault probably existed in the older rock as part of the regional pattern, but no movement took place after

the Green Mountain basalt covered the area. The latest movement has accompanied the recent volcanism. The fissure is the result of rupture from simple tension produced by the draping of the rock over the edge of the upthrown block and thus accompanying the relatively rapid sinking of the graben. The extension of length required for this warping was taken care of by continued widening of the fissure. It appears that the original fracture was propagated rather rapidly over the length of the present fissure, some 2 miles, aided by the comparatively brittle nature of the rock.[1]

The initiation of the fissure may have been the result of earth movements triggering the volcanism of the Four Craters lava field, or the converse. However, the evidence is strong that as the extrusions of lava were progressing, the graben was sinking to adjust for the loss of magma in the chamber below.[2] Thus it may be considered as a typical example of a volcano-tectonic depression on a somewhat smaller scale than usual for these structural features. That the fissure and graben were present before the last of the volcanism ceased is shown by one of the last lava flows which

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[1] Except for a few splits, the fissure is a single open crack over its length.

[2] The rather small dimensions of the graben seem to indicate that the magma reservoir which fed the Four Craters lava field was not at a very great depth.

was dammed up against the scarp and rose high enough to fill the fissure and to overflow it.

Limited time in the field prevented investigation on the east side of the graben. Photogeologic study, though, shows the eastern scarp to be shorter, disappearing to the south in less than two-thirds of a mile from the edge of the lava field. A very short fissure disappearing under the lavas appears to be present also, thus demonstrating a similar origin.

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Open fissures - range in width from a few inches to 10' visibly open for as much as 50'; many are probably open to a much greater depth.
Irregular walls - narrowing of fissures downward. -

Most spectacular is the Great Crack along the southwest rift zone of ~~Hawo~~ Kilauea volcano - extend continuously for more than 8 miles with widths of 30 to 40 feet and visible depth as much as 40 to 50'
Opening of fissure result from tension - little or no evidence of shearing movement.

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CONCLUSION

Wide open cracks in rock of the earth's surface do not remain so for any great length of time. Slumping and sloughing of the walls, filling by soil wash and air-borne material, through the agency of the elements is rapid. The Giant Fissure already shows these effects to a considerable degree, yet what remains attests to its youth.

A system of large fissures similar to the Giant Fissure has been previously reported (Peterson and Groh 1964), but none of these have as great a length and width. These fissures also have a different cause, which is doming believed to be produced by the intrusion of a small laccolith. A great fault-fissure or rift zone reaching from several miles to the northwest of Lava Butte and passing southeasterly beyond Newberry Crater has been studied by Nichols & Stearns (1938). Very recent volcanism is clearly associated with this zone and at several places open fissures exist, notably just to the southeast of Lava Butte. In all these examples of open fissures, there can be seen the fundamental connection of magmatic activity with crustal movement in latest Recent time.

CRACK-IN-THE-GROUND, LAKE COUNTY, OREGON

Norman V. Peterson and E. A. Groh

Open cracks or fissures at the earth's surface are not uncommon, yet those that are large and that persist over long periods of time are a rarity. These cracks or fissures that do occur are most often described as products of earthquakes, landslides in unconsolidated debris, or with volcanic activity. They generally do not remain as open cracks for any great length of time But become filled with debris as settling takes place or are sometimes filled with lafa from erupting sources nearby or from withing the crack itself.

In a rather remote part of central Oregon in northern Lake County, there is an open fracture or crack that is large and persistent and that has remained open for at least the last 1000 years. It is a geological rarity and merits a description.

On the small scale maps available for this area it is hot shown or named. Until a more appropriate name is selected it will be referred to as Crack-in-the-Ground.

Crack-in-the-Ground is a crack or fissure that can be traced for at least 2 miles from the southwest edge of the Four Craters Lava Field (see index & sketch map) beginning in sec. 3, T. 26 S., R. 3 E. It trends diagonally to the southeast through sections 11,13, and 24 until it disappears in the lake sediments that mark the north shoreling of old Christmas Lake.

At its northern end where fresh spiny aa lava has filled and flowed over it (figure 1) it is within 150 yards of a rough single lane dirt road that skirts the western edge of the Four Craters Lava Field. This road

can be reached by traveling north from Christmas Valley Lodge for 1½ miles then northeast for 2 miles, then due north to the dirt road that parallels Crack-in-the-Ground. This road is not well marked but is easily visible on aerial photographs of the area. Crack-in-the-Ground also stands out on even the high altitude aerial photographs. (figure of aerial photo)

Crack-in-the-Ground is a type of tension crack or fissure that is open for a length of over 2 miles. It is from 10 to 15 feet wide with visible depths as much as 70 feet. (figure 2) Erosion and weathering are subdued in the desert climate but their effects are present as some slump- of the walls and infilling by windblown sand has taken place. At several places along the fissure the walls have slumped allowing access to the deeper parts of the crack. Similar spectacular open fissures, have been described by Jaggar (1947), along the southwest rift zone of Kilauea

volcano in Hawaii. One of these, that opened in 1921, the "Great Crack" extended continuously for more than 8 miles with widths of 30 to 40 feet and depths as much as 40 to 50 feet. Rising lava filled and overflowed from

many of the observed Hawaiian fissures but there is no evidence to show that molten lava was present at any place in Crack-in-the Ground. The walls are rough and irregular and no lateral or vertical movement is apparent.

Geologic Setting and Origin

Crack-in-the-Ground is closely associated with the Four Craters Lava Field, one of the many isolated centers of recent volcanic activity within the High Lava Plains of Central Oregon. The crack extends from the southwest edge of this volcanic center across a flat underlain by lava flows and into the broad Fort Rock-Christmas Lake Valley. By the time the ~~[illegible]~~ lava was erupting to build the Four Craters , the large lakes that once filled this valley had shrunk to small brackish potholes and irregular saline pools.

The Four Craters Lava Field consists of 4 cinder cones aligned in a N 30 W direction separated and surrounded by about 8 square miles of black spiny aa lava. Heights of the cones vary from 250 to 400 feet above the lava surface, and the distance from the northernmost to the southernmost is roughly 2½ miles. The southernmost cone is interesting in that it has had several sectors of its cone rafted off on a later lava flow that moved to the southeast.

The oldest rocks in the area are erosional remnants of Plio-Pleistocene maars or tuff riggs. These masses of yellow-brown basaltic tuff and breccia are similar to Fort Rock and other erosional remnants that have similar compositions. The original maars and tuff rings were common and widely distributed in and around the edges of the large lake basins of central Oregon.

These older basaltic tuff remnants are surrounded by basaltic lava flows that originated from Green Mountain, an eruptive center to the north. The lavas from Green Mountain form a low shield some 10 to 12 miles in diameter. The flows on the southern edge encroached on the plubial lake that then filled the Fort Rock-Christmas Lake Valley and became the northern shore line. These lavas are of the pahoehoe type and where they are exposed in the crack there are at least two flows with an overall thick ness of at least 60 feet. The surface is masked with a thin soil zone mainly windblown sand ~~from~~ and silt from the adjacent Fort Rock-Christmas Lake Valley lake beds. Tumuli and other flow surface features are present and several small cinder cones near the summit of the Green Mountain shield still retain most of there initial characteristics even though they are covered by vegetation. From these observations, the Green Mountain lava is believed to be of Pleistocene age.

The Four Craters Lava Field, named in an earlier report (Peterson and Groh, 1963), formed from basaltic lava that flowed out from centers along a N 30 W fissure mainly in a east and south direction. The sluggish flows piled up a ~~layer~~ hummocky layer on the gently slightly sloping Green Mountain lava surface.

The eruptions from the Four Craters were accompanied by a slight sinking of a segment of the surface to the southeast. This shallow graben-like sink is about 2 miles wide and extends to the the south into the the old lake basin. Crack-in-the-Ground marks the western edge of this small volcano-tectonic depression and parallels a zone of weakness beneath the Pleistocene Green Mountain lava flows. The fracture is the result of rupture from simple tension along the hingeline produced by the draping of the Green Mountain flows over the edge of the up side of the concealed fault zone. The initial fractureing was probably propagated rather quickly over its length as the central block began to sink in the graben.

Vertical displacement is no more than 30 feet within the graben and becomes less and less to the southeast. There is the suggestion that the shallow graben does continue ~~xxxxx~~ on out into the old lake basin and acts as a sump for Christmas Lake, Fossil Lake, and other ephemeral ponds and pot-holes. The sinking of the graben block and the accompanying crack on its western edge probably began with the first eruptions of the Four Craters, ~~xxxxx~~ and Crack-in-the-Ground stood open before the last. At the northwest end a tongue of lava piled up, filled, and buried the fracture for several hundred yards.

Conclusion

The eruption of the Four Craters Lava, the accompanying subsidence, and the opening of the Crack-in-the-Ground fracture probably took place no more than 1000 years ago. Even though some filling by soil wash, and airborne material has taken place, and some slumping of blocks from the walls is present the crack is a relatively fresh geologic feature. This stark freshness is partly the result of subdued chemical weathering in the arid climate and a lack of any recent violent earth movements or renewed volcanic activity in the immediate area.

A system of tension fissures similar to Crack-in-the-Ground has been previously reported in the Diamond Craters, Peterson and Groh (1964), but none of these has as great a length or depth. Another fault or fissure zone that trends northwest from Newberry Volcano to Lava Butte south of Bend, Oregon, has been studied by Nichols and Stearns (1938). This fissure is associated with the recent volcanism in this area and stands open in several places.

Recent volcanic features with long persistent fractures like Crack-in-the-Ground, again point up the similarity of the surface ~~of the moon~~ to our central Oregon terrain. The use of Cracks-in-the-Moon for initial shelter after moon landings is visualized and certainly seems plausible.

CRACK-IN-THE-GROUND, LAKE COUNTY, OREGON

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