AUGUST 1977
VOLUME 39, NO. 8

THE ORE BIN

STATE OF OREGON
DEPARTMENT OF GEOLOGY AND MINERAL INDUSTRIES

The Ore Bin

Published Monthly By

STATE OF OREGON
DEPARTMENT OF GEOLOGY AND MINERAL INDUSTRIES
Head Office: 1069 State Office Bldg., Portland, Oregon 97201
Telephone: [503] 229-5580

FIELD OFFICES

2033 First Street, Baker 97814
521 N.E. "E" Street, Grants Pass 97526

Subscription Rates
1 year, $3.00; 3 years, $8.00
Available back issues, $.25 at counter, $.35 mailed

Second class postage paid at Portland, Oregon

State of Oregon
Department of Geology
and Mineral Industries
1069 State Office Bldg.
Portland, Oregon 97201

The ORE BIN
Volume 39, No. 8
August 1977

THE GEOLOGY OF JORDAN CRATERS, MALHEUR COUNTY, OREGON

Bruce R. Otto and Dana A. Hutchison*

Introduction

Many areas in Malheur County in southeastern Oregon have surprisingly young volcanic features. At Jordan Craters (Russell, 1903), comparatively recent olivine basalt flows filling a broad valley once occupied by Cow Creek cover an area of approximately 72 sq km (28 sq mi). Figure 1 shows the location of Jordan Craters. The entire volcanic field is covered by three 7-1/2' topographic maps: Jordan Craters North, Jordan Craters South, and Cow Lakes. The area discussed in this article lies within the Jordan Craters quadrangle and can be reached by a 26-mile dirt road which runs west from U.S. Highway 95 (see Road to Jordan Craters, p. 138-139).

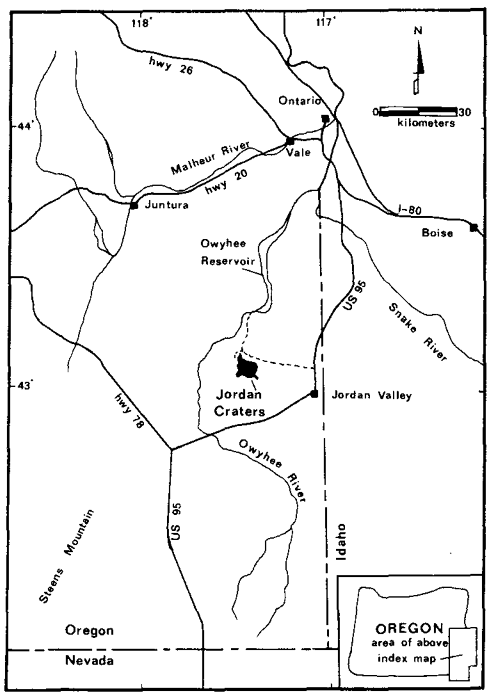

Figure 1. Index map showing location of Jordan Craters in southeastern Oregon.

The climate of the area is typical of high desert regions, having wide annual and diurnal temperature ranges and low annual precipitation. Typical plants of the area are sage brush, cheat grasses, mosses, and lichens.

Previous geologic work in the area includes a master's thesis on the petrography of the Cow Lakes basalts (Millhollen, 1965). Kittleman and

* Article written while the authors were students at Boise State University, Boise, Idaho.

others (1965) briefly described the extrusive volcanics and published a regional map (Kittleman and others, 1967) which shows the general extent of the lava field. The same area is also covered by Walker (1977) in his geologic map of eastern Oregon.

Our interest in the Jordan Craters volcanic field was aroused during field trips to the area when numerous questions were raised about the geologic history of many features at the northwest end of the flow. Of prime interest was Coffeepot (Morcom) Crater because of its complex history and relationship to the rest of the volcanic field.

Regional Setting

The Jordan Craters volcanic field lies in a topographic depression of the Owyhee Plateau. Elevations range from 1,200 to 1,400 m (4,000 to 4,600 ft). Rocks in the area are mostly volcanic, predominantly basalt, rhyolite, and welded ash-flow tuffs. Although Millhollen (1965) has defined and described six basalt flows, only the youngest is discussed here.

The youngest lava, an olivine basalt, flowed southeastward from Coffeepot Crater for a maximum distance of 16 km (10 mi), filling stream valleys that were part of the Cow Creek drainage system. The lava overlies Tertiary Leslie Gulch Tuff to the west and Plio-Pleistocene basalts to the north, east, and south (see Geologic Map of Coffeepot Crater, centerfold). Kittleman (1965) believes that the youngest Jordan Crater basalt flow might have originated during historic times because it shows a high degree of surface-feature preservation and lacks soil cover. Studies based on growth rates of lichen and weathering rates of exposed and unexposed basalt suggest that the flow may be between 4,000 and 9,000 years old (Robert R. Kindschy, personal communication to editor, 1977).

Millhollen (1965, p. 21) suggests the presence of a north-south structural trend in the area because of the alignment of four source vents of older flow fields. Clark's Butte, to the south of Jordan Craters, and other shield cones are also located along this lineament. This regional trend is also evident on LANDSAT imagery in the form of lineations extending from the north through Vale, Oregon, and terminating in the Jordan Craters area. Kittleman (1965, p. 13) suggests the possibility of structural control of the Owyhee Canyon along this same north-south line.

Geomorphology

Geomorphic features found at Jordon Craters (Figure 2) fit into one of two categories: major flow features or features found in the crater area.

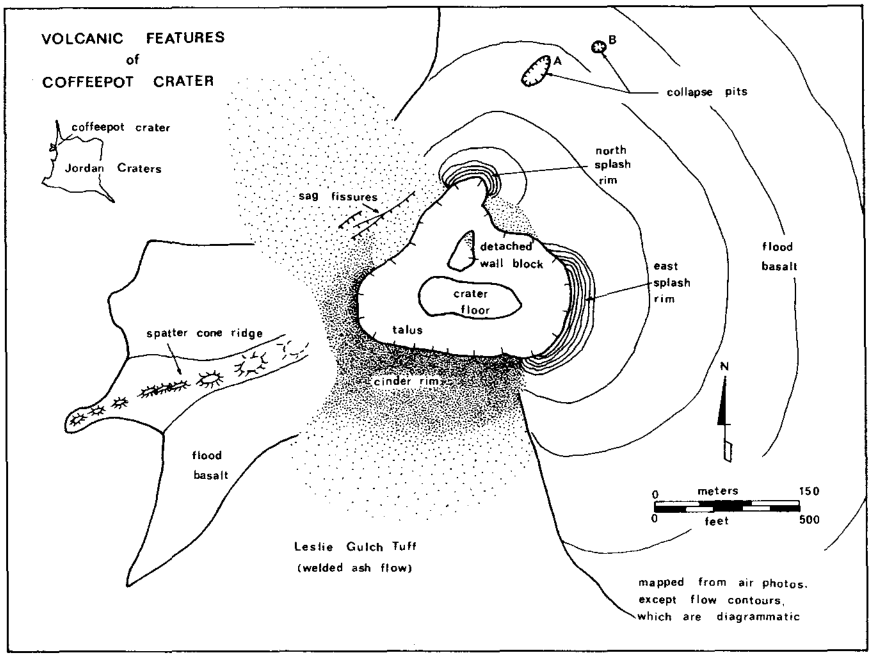

Figure 2. Volcanic features of Coffeepot Crater.

Major flow field

The major flow field is roughly square in planimetric view and approximately 8 km (5 mi) on each side. The southeastern corner is somewhat extended where the lava followed the Cow Creek drainage. Minimum flow thickness near Coffeepot Crater in the small collapse pit is estimated to be 23 m (75 ft). Approximately 1.6 cu km (0.4 cu mi) of basalt issued from the crater.

The major flow, 98 percent of which lies to the east and southeast of the crater, was an extremely liquid, high-temperature, pahoehoe lava flow, with a smooth, undulating, and sometimes ropy surface (Figure 3). Surface features include gas release formations, such as lava blisters and tumuli (small solid mounds on the crust of a lava flow); crustal flow formations, such as pressure ridges and squeeze-ups (small extrusions of viscous lava through fractures on the solidified surface of a lava flow); collapse features, such as pits and sags; and numerous flow structures, such as ropy surface (Figure 4) and lava channels (Figure 5).

A pressure ridge is an elongated piece of congealed crust that has been pushed upward by movement of lava below the crust. One pressure ridge at Jordan Craters (Figure 6) is 92 m (300 ft) long and more than 9 m (30 ft) deep in the central fracture. On the flanks of the pressure ridge, many polygonal blocks of basalt

Figure 3. Pahoehoe lava-flow surface at Jordan Craters.

Figure 4. Ropy surface on pahoehoe lava flow.

Figure 5. Lava channel.

Figure 6. Pressure ridge.

have been "popped" from the surface of the flow and now lie strewn about in a blocky mass.

Two large collapse pits are located just northeast of the main crater (Figure 7). The two pits (Figure 8, A and B) are parts of a large lava-tube system which may have been the main route of lava transport from the source vent to the far reaches of the major flow field. Figure 8 shows a portion of the major flow field from the western edge to about midway into the field. Outlined in the figure are collapse or withdrawal features which probably indicate a lava-tube system of major proportions. It is reasonable to assume that the deepest portions of the lava flow followed the drainage patterns of Cow Creek and that a major tube system was confined to this deep part of the flow. Be careful when walking near the rims of the collapse pits. The crust is thin and might break, and a fall into one of the pits could be fatal.

Lava tubes fall into two categories, large and small (Greeley, 1971, p. 5). The small tubes, which are generally less than 10 m (33 ft) wide and a few hundred meters long, are often feeder tubes that extend from the larger tubes to the front of the flow. Large lava tubes (Ollier and Brown, 1965) form in lava flows that are several kilometers long. These larger lava tubes tend to meander, like a river on a flood plain, within the molten flow field. Meandering continues until the cooling lava confines the mobile conduit to a definite channel. When the lava is eventually extruded from the tube near the flow front, a lava coating is left lining the walls of the tube. Remnants of this coating may be seen in many

Figure 7. Air photo of Jordan Craters. South is at top of photograph, Coffeepot Crater is to the right, collapse pits are at lower center and left. The pits are not filled with water; they are in deep shadow.

portions of tubes and collapse pits. In some instances, when all the lava is not extruded from a tube, it congeals instead within the tube.

Figure 8 shows four types of large tube features preserved at Jordan Craters. Figures 8C and 8D show spalling of roof material, which eventually produces a collapse pit (Figure 8A). Figure 8B shows a cluster of tubes, each of which has formed adjacent to or on top of other tubes. Figure 8D shows a portion of a dome along the path of the larger lava-tube system which was still semimolten when the lava was withdrawn, causing the roof to deform plastically downward.

The two large collapse pits have distinctive features. The larger of the two (A) is 29 m (95 ft) long, 15 m (50 ft) wide, and 15 m (50 ft) deep. The east rim shows minor amounts of flow and spatter which may have resulted from outgassing or outdraining at that point to relieve pressure produced by partial damming of the lava conduit. The interior of this pit has flow lines and a well-developed lava lining on the walls.

The smaller pit (B) is more nearly circular in shape and has had less roof material removed by spalling. The pit has an opening diameter of about 12 m (40 ft) and is 16 m (52 ft) deep. It has the same interior features as the larger pit, with some important

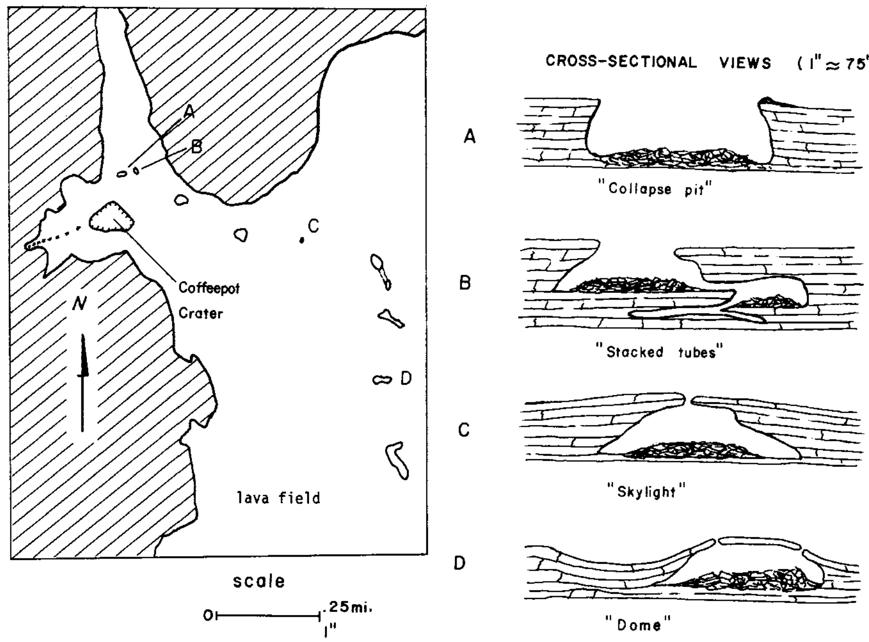

Figure 8. Outlines of collapse features indicative of major lava-tube system. Map adapted from air photos.

additions. The floor of the pit is false, in that another tube lies beneath it. Figure 8B shows multiple lava tubes stacked upon one another. A false floor like this can be produced by multiple flow activity or by downward erosion by the lava within the tube (Greeley and King, 1975, p. 27). A most interesting phenomenon, seen in pit (B) on the under side of the false pit floor (deep lava-tube ceiling), is the incorporation of rounded, heat-altered, nonbasaltic rocks into the flow basalt. These rocks, which appear to have the same properties and composition as the surrounding country rock, the Leslie Gulch Tuff, are rounded, perhaps by a stream. Since the location of the pit crater is near the geometric center of the former stream valley, the stream cobbles were undoubtedly picked up by the flowing lava. Some of the cobbles were melted by the heat of the lava to form glass which hangs from the ceiling of the deeper tube. In addition to the cobbles, very large clusters of gypsum crystals that line portions of the walls can be found in lava tube (B).

Crater area

A line of spatter cones forms a ridge which trends S. 54° W. for a distance of 304 m (1,000 ft) from the rim of Coffeepot Crater

GEOLOGIC MAP OF COFFEEPOT CRATER, JORDAN CRATERS AREA, MALHEUR COUNTY, OREGON

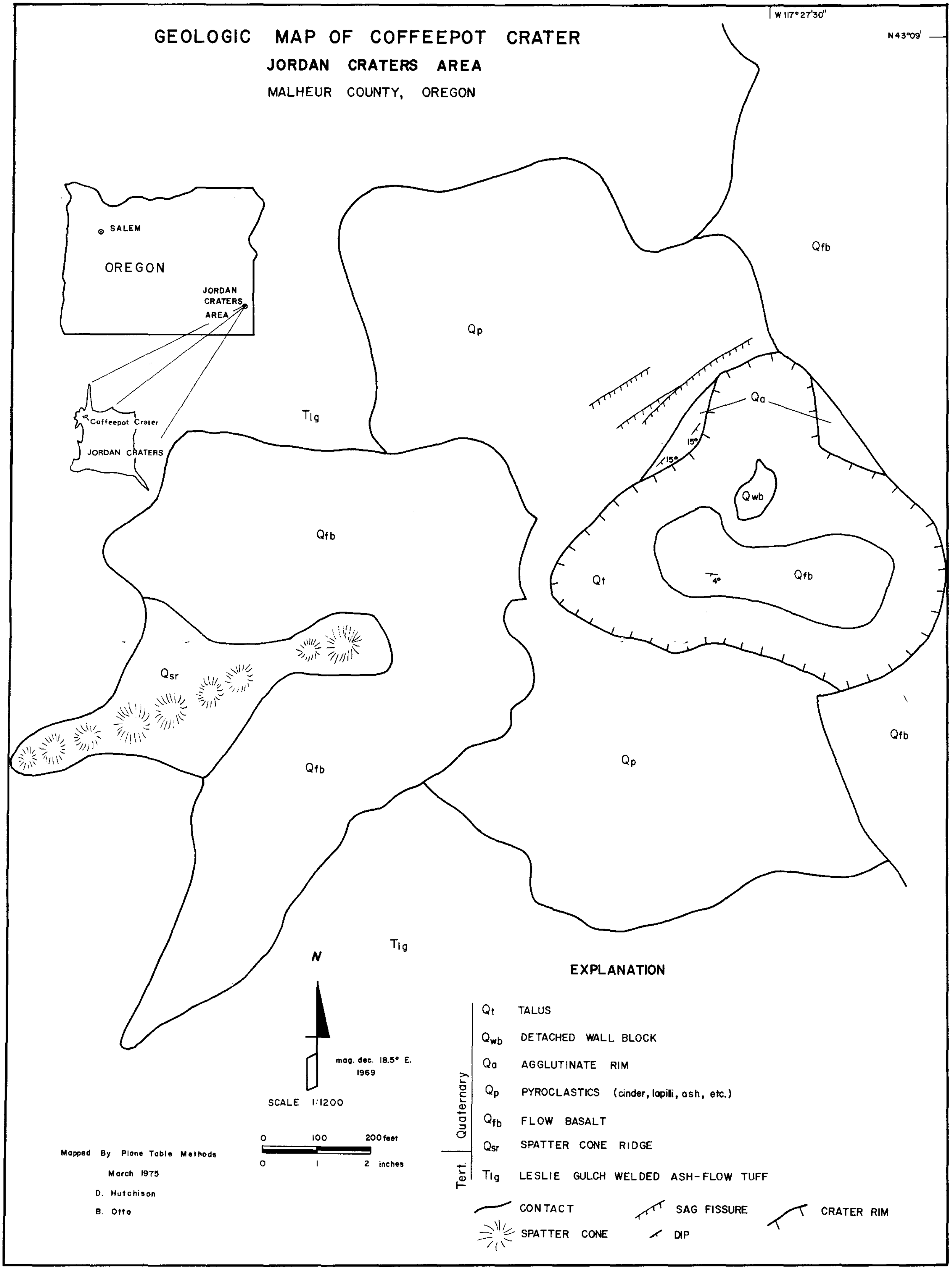

Figure 9. Coffeepot Crater with line of spatter cones in foreground. Note cracks in left (northwest) wall of crater.

(Figure 9). On the same linear trend 0.8 km (0.5 mi) to the west is an isolated spatter rampart consisting of three small, low-profile cones. Alignment of the spatter cones and crater over a distance such as this suggests a zone of crustal weakness. The spatter cones increase in size toward the crater, with the smallest approximately 5 m (16 ft) high and 5 to 6 m (16 to 20 ft) in diameter. The largest cone, which apparently had its top blown off, is 18 m (60 ft) in diameter and 6 m (20 ft) high. Many of the spatter cones are still intact and have a distinct bubble shape. Some are as much as 6 m (20 ft) deep with an opening at the top that is only 30 cm (12 in) in diameter. Compositionally, the spatter cones resemble the agglutinated (lumps of lava stuck together while still hot) portion of the crater rim. One of the spatter cones, approximately 12 m (40 ft) high and 9 m (30 ft) in diameter, has been incorporated into the west crater wall. A cross-sectional view of this feature shows basalt flows interbedded with the agglutinated spatter.

Coffeepot Crater, which is approximately 80 m (260 ft) deep from the highest portion of the crater rim, is a small-scale example of a stratovolcano. The crater is basically heart shaped, with a 230-m (1,050-ft) east-west axis and a shorter 170-m (560-ft) north-south axis (see Geologic Map of Jordan Craters, centerfold). In a clockwise direction, the crater walls show the following features: In the west wall is red- to gray-colored cinder, interbedded with flows of dense olivine basalt. The beds in the west wall dip 15° toward the center of the crater and appear to have sagged downward several meters while still in a semiconsolidated state. On the northwestern rim of the crater, downward and inward movement has created three large cracks, 30 m (100 ft) long and 1

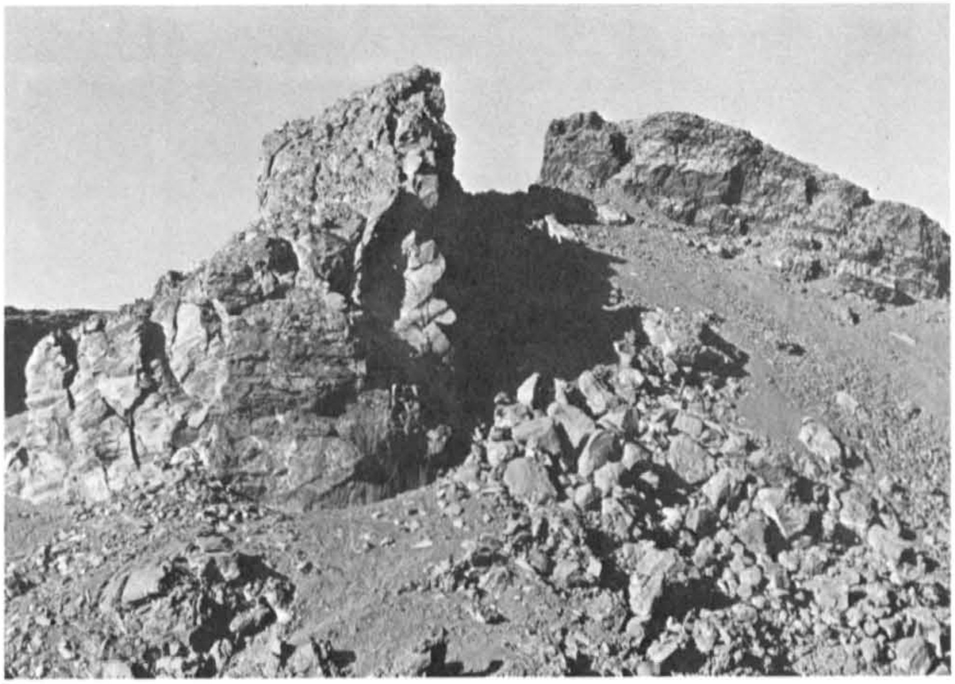

Figure 10. Detached wall block, north crater wall.

to 5 m (3 to 16 ft) wide, subparallel to the crater wall (Figure 9). The agglutinate which forms the upper part of the crater rim can be seen in these cracks. To the north, the stratified volcano walls are missing; and thinly laminated flows of vesicular olivine basalt form the rim.

On the northeast side of the vent, another segment of the interbedded agglutinate is visible in a prominent point which projects toward the center of the crater. Southwest of this point a large slump block dips toward the center of the crater (Figure 10). The northern part of this block is composed of interbedded layers of cinder, agglutinate, and massive olivine basalt. The lava which coats the south face of the block is striated and grooved (Figure 11).

The north and east sections of the crater wall are composed entirely of thinly laminated, vesicular olivine basalt. The uppermost part of the east crater rim is composed of an accumulation of basalt which splashed over the rim and built up to a height of 3 to 4 m (10 to 13 ft). Below this splash rim, on the inside of the vent, are large detached segments of congealed lava-lake crust, some of which are as much as 15 m (50 ft) across.

The entire south wall of the crater is composed of interbedded cinder, agglutinate, and massive basalt. The beds range in thickness from 0.5 to 10 m (1.5 to 33 ft). Toward the west end of the

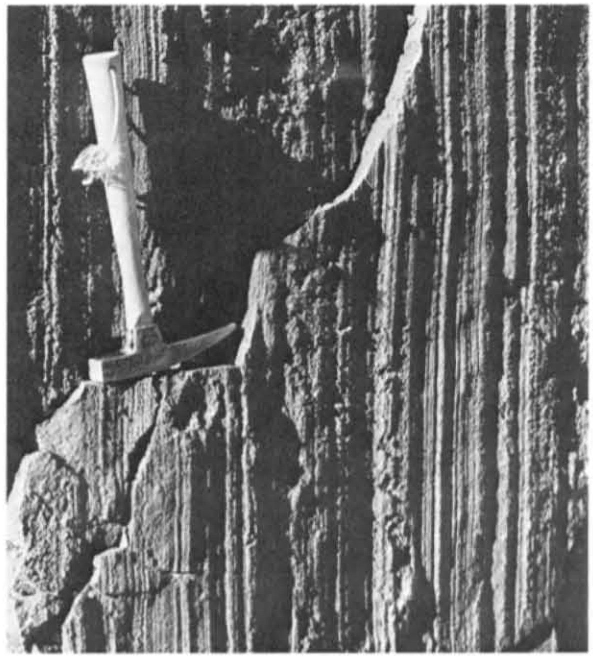

Figure 11. Grooves left by subsidence of lava-lake crust.

south wall, the volcanic beds are underlain by a soil horizon which in turn overlies the Leslie Gulch Tuff. The soil zone, which is approximately 1 m (3 ft) deep at its thickest part, pinches out in both directions over a distance of 90 m (300 ft) and contains numerous fragments of the underlying tuff.

Above the soil horizon in the southwest wall lies a plano-convex cinder deposit which is approximately 90 m (300 ft) long and 6 m (20 ft) thick, which appears to be part of a buried cinder cone. Mass wasting (downslope transport of soil and rock because of gravity) has removed part of the original 4- to 6-cm (1.6- to 2.4-in) lava coating which once covered the entire cinder cone.

The floor of the crater itself is composed of vesicular olivine basalt which shows many pahoehoe flow features such as pressure ridges, lava tubes, ropy structure, and tumuli. The crater floor has been tilted slightly toward the south. Debris which has fallen from the crater walls covers approximately 50 percent of the floor.

Interpretations of Geologic History

Volcanism over a long period of time has largely destroyed evidence of the earliest events. Mass wasting of rock debris into the crater has also decreased visibility of the crater walls. Enough features remain, however, to be able to interpret a generalized geologic history.

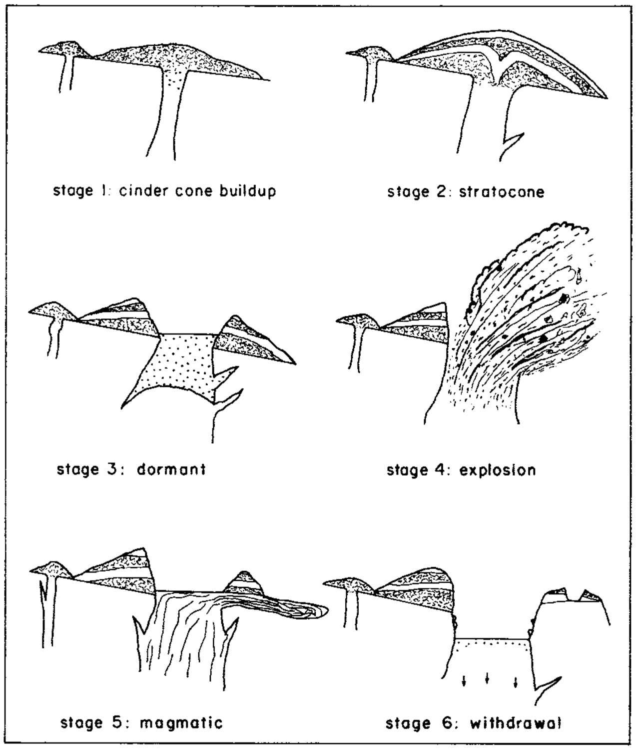

Figure 12. Cross-sections from east to west showing stages in geologic history of Coffeepot Crater. Not to scale.

Before volcanism began, the area now covered by the Jordan Craters lava was part of the Cow Creek drainage. A small portion of the old horizon is seen in the vent. An eruption from small cinder and spatter cones in the sagebrush-covered hills was likely to have been the first event (Figure 12, stage 1). As the spatter cones continued to grow, the greatest activity was concentrated at the east end of the zone of weakness. Here a cinder cone progressed through stages of stratovolcano formation (Figure 12, stage 2) until it reached the height of the south crater rim. Volcanic activity stopped; and during subsequent degassing of the lava lake in the crater, the agglutinated part of the rim was formed.

As time progressed, Coffeepot Crater became dormant (Figure 12, stage 3), and the magma in the plumbing system cooled downward, forming a volcanic plug. Volcanic activity resumed when the resurging magma developed enough pressure to blow the plug along a zone of weakness and destroy portions of the crater wall (Figure 12, stage 4). The zone of failure of the volcanic plug controlled the direction of the explosion; and pressure was relieved by an explosion directed toward the north and east, resulting in destruction of those sections of the crater wall except for one large block, which was torn loose from the crater wall and tilted toward the center.

After this explosion, the fluid lava was able to flow freely from the vent (Figure 12, stage 5), forming the bulk of the lava field seen today. Lava flowed downslope and was confined to an old stream valley where it formed a major lava-tube system.

When the hydrostatic head of the lava was relieved, the lava pooled in the vent. As minor fluctuations in the levels of the lava lake occurred, thin laminar flows issued from the vent and formed the north and east walls of the crater. As the flows built up, it became increasingly difficult for the lava to escape; and a splash rim developed.

Concurrent with or subsequent to the buildup of the splash rim, the lava lake went through a period of degassing, causing small eruptions and lava fountaining. This activity produced most of the cinders which cover the vent area.

The last events were crusting of the lava lake, followed by withdrawal of the magma (Figure 12, stage 6). As withdrawal occurred, the semisolidified crust was warped and deformed; and as it was drawn down, it left vertical grooves and striations on the crater walls.

After volcanism ceased, gravity caused sliding and slumping of material from the crater walls into the crater itself. What is left today is a remnant of a stratovolcano partially buried in its own debris.

Other volcanoes have features similar to those of Coffeepot Crater. Wildhorse Corral, in the Great Rift of Idaho, has terraces on the crater walls. According to Greeley and King (1975, p. 12), these terraces, which are the result of a fluctuating lava-lake level, indicate a multiphase eruptive history. Mt. Vesuvius in Italy also has a multistage history, stratovolcano walls similar to those of Coffeepot Crater, and a history of explosive eruptions (Green and Short, 1971, p. 12).

Road to Jordan Craters

These directions begin at the junction of a dirt road going west and U.S. Highway 95, 7.6 miles north of Jordan Valley and 2.8 miles south of Sheaville. The junction is marked by a sign, and the road is easy to follow. When in doubt, follow the most heavily traveled road. The route is covered by five 7-1/2 topographic maps: Hooker Creek, Downey Canyon, Mahogany Gap, McCain Creek, and Jordan Craters North. During wet weather, the road is extremely muddy. Watch out for cattle.

Mileage *	**	
0.0	0.0	Junction of dirt road and U.S. Highway 95.
0.9	0.9	Farm road marked "Carter-Baltzor" to right. Go straight.

* Intervals (in miles)
** Cumulative mileage

7.0	7.9	Bridge.
0.8	8.7	Junction with small road. Go right.
1.5	10.2	Bridge.
1.0	11.2	Junction. Go right, following sign pointing to Jordan Craters.
6.7	17.9	Junction. Go straight, ignoring first side road to left and second side road to right. From here on you can see Coffeepot Crater and the lava field to your left in the distance.
5.8	23.7	Fence and cattleguard. Ignore small roads going to right on each side of fence. Cross cattleguard and stay on main road.
1.5	25.2	Junction. Sign points to Jordan Craters. Leave main road and take road to left.
2.9	28.1	Parking lot at base of Coffeepot Crater.

Editor's Note

Because of its geology, flora, and fauna, Jordan Craters has been designated a Federal Research Natural Area under the management of the Vale District Bureau of Land Management. A Research Natural Area is a naturally occurring physical or biological unit where natural conditions are maintained as much as possible for research and educational purposes. Readers interested in learning more about the Jordan Craters Research Natural Area may contact Robert R. Kindschy, BLM Wildlife Biologist, Box 700, Vale, Oregon 97918.

Visitors to Jordan Craters are urged to do nothing to disturb this unique area and are warned to exercise caution when walking because portions of the crater walls and lava-tube roofs may collapse unexpectedly.

References

Greeley, R., 1971, Geology of selected lava tubes in the Bend area, Oregon: Oregon Dept. Geol. and Mineral Indus. Bull. 71, 47 p.

Greeley, R., and King, J.S., 1975, Geologic field guide to the Quaternary volcanics of the south-central Snake River Plain, Idaho: Idaho Bur. Mines and Geol. Pamph. 160, 49 p.

Green, J., and Short, N.M., 1971, Volcanic landforms and surface features: New York, Springer-Verlag, 519 p.

Kittleman, L.R., Green, A.R., Haddock, G.H., Hagood, A.R., Johnson, A.M., McMurray, J.M., Russell, R.G., and Weeden, D.A., 1967, Geologic map of the Owyhee region, Malheur County, Oregon: Eugene, Univ. Oregon Museum of Natural History Bull. 8.

Kittleman, L.R., Green, A.R., Hagood, A.R., Johnson, A.M., McMurray, J.M., Russell, R.G., and Weeden, D.A., 1965, Cenozoic stratigraphy of the Owyhee region, southeastern Oregon: Eugene, Univ. Oregon Museum of Natural History Bull. 1.

Millhollen, Gary L., 1965, The petrography of the basalts of the Cow Creek Lakes area, Malheur County, Oregon: Univ. Oregon master's thesis.
Ollier, C.D., and Brown, M.C., 1965, Lava caves of Victoria: Bull. volcanol., v. 28, p. 215-229.
Russell, I.C., 1903, Geology of southwestern Idaho and southeastern Oregon: U.S. Geol. Survey Bull. 217, p. 48-54.
Walker, G.W., 1977, Geologic map of Oregon east of the 121st meridian: U.S. Geol. Survey Misc. Geol. Inv. Map I-902.

* * * * *

COPIES OF VIRTUE FLAT GEOLOGIC MAP AVAILABLE

The geologic map of the Virtue Flat 7-1/2-minute quadrangle, Baker County, Oregon, is now available as an Ozalid print at the Department's Portland and Baker offices. The map is at the scale of 1:24,000. Different shades of gray and white distinguish rock units. The map covers part of the Virtue gold mining district. Major rock units are argillite, chert and tuff of the Elkhorn Ridge Argillite Formation, altered gabbro and associated rocks of pre-Upper Triassic age, basalt flows of Miocene age, and lake and stream deposits of Pliocene age. Price of the map is $2.00.

* * * * *

NEW BULLETIN PUBLISHED

"Geologic Hazards of Parts of Northern Hood River, Wasco, and Sherman Counties, Oregon," Bulletin 91, is Department environmental specialist John D. Beaulieu's most recent environmental geology study. The bulletin, which can be purchased for $8.00 at all three Department offices, has 95 pages, 13 black-and-white geologic hazards maps of communities, 39 photographs and charts, 7 tables, and 10 multicolored maps (scale 1:62,500).

* * * * *

POSITION OF STATE GEOLOGIST TO OPEN

Advisable qualifications include ability to supervise staff of about 30; direct activity for a project area covering 97,000 square miles; supervise environmental, geothermal, oil and gas, land use planning, industrial minerals and metals investigations; proficiency in securing Federal, State, and local government funding; oversee publishing, analytical, and field exploration activities; work harmoniously with State Legislature and other State and Federal agencies. For further details write: R.W. deWeese, State of Oregon Department of Geology and Mineral Industries, 1069 State Office Building, Portland, Oregon 97201, by September 15, 1977. An equal opportunity employer.

AVAILABLE PUBLICATIONS

(Please include remittance with order; postage free. All sales are final - no returns. A complete list of Department publications, including out-of-print, mailed on request.)

BULLETINS		Price
26.	Soil: Its origin, destruction, and preservation, 1944: Twenhofel	$ .45
33.	Bibliography (1st suppl.) geology and mineral resources of Oregon, 1947: Allen	1.00
35.	Geology of Dallas and Valsetz quadrangles, Oregon, rev. 1964: Baldwin . .	3.00
36.	Papers on Tertiary foraminifera: Cushman, Stewart and Stewart, 1949: v. 2, . .	1.25
39.	Geol. and mineralization of Morning mine region, 1948: Allen and Thayer . .	1.00
44.	Bibliog. (2nd suppl.) geology and mineral resources of Oregon, 1953: Steere.	2.00
46.	Ferruginous bauxite deposits, Salem Hills, 1956: Corcoran and Libbey	1.25
49.	Lode mines, Granite mining district, Grant County, Oregon, 1959: Koch . .	1.00
53.	Bibliog. (3rd suppl.) geology and mineral resources of Oregon, 1962: Steere, Owen	3.00
57.	Lunar Geological Field Conf. guidebook, 1965: Peterson and Groh, editors .	3.50
61.	Gold and silver in Oregon, 1968: Brooks and Ramp	8.00
62.	Andesite Conference guidebook, 1968: Dole	3.50
63.	Sixteenth biennial report of the Department, 1966-1968	1.00
64.	Mineral and water resources of Oregon, 1969: USGS with Department. . . .	3.00
65.	Proceedings of Andesite Conference, 1969: [copies]	10.00
67.	Bibliog. (4th suppl.) geology and mineral resources of Oregon, 1970: Roberts	3.00
68.	Seventeenth biennial report of the Department, 1968-1970	1.00
71.	Geology of selected lava tubes in Bend area, Oregon, 1971: Greeley . . .	2.50
72.	Geology of Mitchell quadrangle, Wheeler County, 1971: Oles and Enlows . .	3.00
75.	Geology and mineral resources of Douglas County, 1972: Ramp	3.00
76.	Eighteenth biennial report of the Department, 1970-1972	1.00
77.	Geologic field trips in northern Oregon and southern Washington, 1973 . .	5.00
78.	Bibliog. (5th suppl.) geology and mineral resources of Oregon, 1973: Roberts	3.00
79.	Environmental geology inland Tillamook and Clatsop Counties, 1973: Beaulieu .	7.00
80.	Geology and mineral resources of Coos County, 1973: Baldwin and others . .	6.00
81.	Environmental geology of Lincoln County, 1973: Schlicker and others . . .	9.00
82.	Geol. hazards of Bull Run Watershed, Mult., Clackamas Counties, 1974: Beaulieu	6.50
83.	Eocene stratigraphy of southwestern Oregon, 1974: Baldwin	4.00
84.	Environmental geology of western Linn County, 1974: Beaulieu and others . .	9.00
85.	Environmental geology of coastal Lane County, 1974: Schlicker and others .	9.00
86.	Nineteenth biennial report of the Department, 1972-1974	1.00
87.	Environmental geology of western Coos and Douglas Counties, 1975	9.00
88.	Geology and mineral resources of upper Chetco River drainage, 1975: Ramp .	4.00
89.	Geology and mineral resources of Deschutes County, 1976	6.50
90.	Land use geology of western Curry County, 1976: Beaulieu	9.00
91.	Geologic hazards of parts of northern Hood River, Wasco, and Sherman Counties, Oregon, 1977: Beaulieu	in press

GEOLOGIC MAPS		
Geologic map of Galice quadrangle, Oregon, 1953		1.50
Geologic map of Albany quadrangle, Oregon, 1953		1.00
Reconnaissance geologic map of Lebanon quadrangle, 1956		1.50
Geologic map of Bend quadrangle and portion of High Cascade Mtns., 1957 . . .		1.50
Geologic map of Oregon west of 121st meridian, 1961		2.25
Geologic map of Oregon east of 121st meridian, 1977		3.75
Geologic map of Oregon (9 x 12 inches), 1969		.25
GMS-2:	Geologic map of Mitchell Butte quadrangle, Oregon, 1962	2.00
GMS-3:	Preliminary geologic map of Durkee quadrangle, Oregon, 1967	2.00
GMS-4:	Oregon gravity maps, onshore and offshore, 1967 [folded]	3.00
GMS-5:	Geologic map of Powers quadrangle, Oregon, 1971	2.00
GMS-6:	Prelim. report on geology of part of Snake River Canyon, 1974	6.50
GMS-7:	Geology of the Oregon part of the Baker quadrangle, Oregon, 1976 . . .	in press

The ORE BIN
1069 State Office Bldg., Portland, Oregon 97201

Second Class Matter
POSTMASTER: Form 3579 requested

The Ore Bin

Available Publications, Continued:

THE ORE BIN		Price
Issued monthly - Subscription	[Annual]	$ 3.00
	[3-year]	8.00
Single copies of current or back issues	[Over the counter]	.25
	[Mailed]	.35

OIL AND GAS INVESTIGATIONS

1.	Petroleum geology, western Snake River basin, 1963: Newton and Corcoran	3.50
2.	Subsurface geology, lower Columbia and Willamette basins, 1969: Newton	3.50
3.	Prelim. identifications of foraminifera, General Petroleum Long Bell #1 well.	2.00
4.	Prelim. identifications of foraminifera, E.M. Warren Coos Co. 1-7 well, 1973	2.00
5.	Prospects for natural gas prod. or underground storage of pipeline gas	5.00

SHORT PAPERS

18.	Radioactive minerals prospectors should know, 1976: White, Schafer, Peterson.	.75
19.	Brick and tile industry in Oregon, 1949: Allen and Mason	.20
21.	Lightweight aggregate industry in Oregon, 1951: Mason	.25
24.	The Almeda mine, Josephine County, Oregon, 1967: Libbey	3.00
25.	Petrography, type Rattlesnake Fm., central Oregon, 1976: Enlows	2.00

MISCELLANEOUS PAPERS

1.	A description of some Oregon rocks and minerals, 1950: Dole	1.00
2.	Oregon mineral deposits map (22 x 34 inches) and key (reprinted 1973):	1.00
4.	Laws relating to oil, gas, & geothermal exploration & development in Oregon	
	Part 1. Oil and natural gas rules and regulations, 1977.	1.00
	Part 2. Geothermal resources rules and regulations, 1977	1.00
5.	Oregon's gold placers (reprints), 1954	.50
6.	Oil and gas exploration in Oregon, rev. 1965: Stewart and Newton	3.00
7.	Bibliography of theses on Oregon geology, 1959: Schlicker	.50
	Supplement, 1959-1965: Roberts	.50
8.	Available well records of oil and gas exploration in Oregon, rev. 1973: Newton	1.00
11.	Collection of articles on meteorites, 1968 (reprints from The ORE BIN)	1.50
12.	Index to published geologic mapping in Oregon, 1968: Corcoran	.50
13.	Index to The ORE Bin, 1950-1974	1.50
14.	Thermal springs and wells, 1970: Bowen and Peterson (with 1975 suppl.)	1.50
15.	Quicksilver deposits in Oregon, 1971: Brooks	1.50
16.	Mosaic of Oregon from ERTS-1 imagery, 1973	2.50
18.	Proceedings of Citizens' Forum on potential future sources of energy, 1975	2.00

MISCELLANEOUS PUBLICATIONS

Oregon base map (22 x 30 inches)	.50
Landforms of Oregon (17 x 22 inches),	.25
Mining claims (State laws governing quartz and placer claims)	.50
Geological highway map, Pacific NW region, Oregon-Washington (pub. by AAPG)	3.00
Fifth Gold and Money Session and Gold Technical Session Proceedings, 1975 (including papers on gold deposits, exploration, history, and production	5.00

Color postcard, GEOLOGY OF OREGON	[each]	.10
	[3]	.25
	[7]	.50
	[15]	1.00