DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

MISCELLANEOUS INVESTIGATIONS SERIES
MAP I-1632

INTRODUCTION

The Snake River Plain of southern Idaho (fig. 1) is a broad, flat lava plain that consists of late Tertiary and Quaternary basaltic volcanic rocks. Much of the volcanism was confined to volcanic rift zones, which are concentrations of volcanic landforms and structures along linear belts that are several kilometers wide and tens of kilometers long. This map depicts the geology of the most spectacular volcanic rift zone of the Snake River Plain—the Great Rift. The Great Rift is an 85-km-long and 2- to 8-km-wide, northwest-southeast-trending fracture system that extends across nearly the entire width of the Snake River Plain. Where the Great Rift volcanic rift zone intersects the Earth's surface, there is an array of cinder cones, shield volcanoes, lava cones, eruptive fissures, noneruptive fissures, and fresh-appearing lava flows.

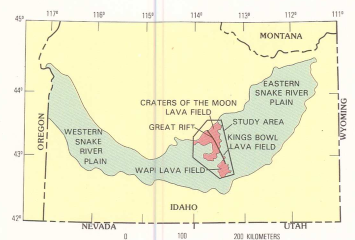


Figure 1.—Index map showing location of study area.

The map shows the geology of three Holocene to latest Pleistocene lava fields that are alined along the Great Rift: the Craters of the Moon, Kings Bowl, and Wapi lava fields.

The Craters of the Moon lava field is centered along a 45-km-long segment of the northern part of the Great Rift. The lava field is composed of more than 60 mappable units, including both single lava flows and flow units—multiple flows extruded in succession during a single eruption. The field also contains more than 25 cinder cones and 8 eruptive fissures and fissure systems. The Craters of the Moon lava field covers an area of about 1,600 km², contains about 30 km³ of lava, and is the largest basaltic lava field of dominantly Holocene age in the conterminous United States.

Radiocarbon dating, paleomagnetic studies, and field relations demonstrate that lava flows of the Craters of the Moon lava field were emplaced in at least eight eruptive periods that began about 15,000 years ago and ended about 2,000 years ago (Kuntz and others, 1983; Kuntz, Champion, and others, 1986). Eruptive periods are designated alphabetically: A through H, with A as the youngest, and H as the oldest. Each eruptive period was about 1,000 years or less in duration and was followed by an interval of quiescence that lasted from a few hundred to more than 2,000 years. Field studies show that lava flows and flow units in each eruptive period (1) typically occur in restricted parts of the lava field, (2) were erupted from source vents that lie along short (typically less than 5 km long) segments of the Great Rift, (3) typically have similar flow morphologies, (4) have similar paleomagnetic pole directions, and (5) have similar radiocarbon ages. Flows of younger eruptive periods have fresh-appearing glassy surfaces and are sparsely covered by vegetation. Flows in older eruptive periods are more extensively covered by vegetation and thin, discontinuous mantles of loess and eolian sand.

The radiocarbon ages of flows listed in the correlation of map units and shown on the map were determined from charcoal from tree molds and charcoal and carbon-bearing matter from sediments buried by lava flows. Sediment samples were obtained by backhoe excavation beneath flows along the margins of the lava field. Radiocarbon ages were determined for only one or a few flows in each eruptive period, thus the precise duration of the eruptive periods is uncertain. Nearly all samples for radiocarbon dating were contaminated by young organic material, chiefly modern roots. Samples treated for removal of young organic material give older ages than untreated samples; thus, the oldest radiocarbon age for a suite of untreated and treated samples is believed to be the most accurate estimate of the age of a flow. We conclude that the ages on charcoal and carbon-bearing material from sediments buried by flows are of variable accuracy and probably represent minimum ages for their respective flows. Details of the radiocarbon investigations are given by Kuntz, Spiker, and others (1986).

The other two Holocene lava fields on the Great Rift, the Kings Bowl and Wapi fields, represent a small-volume (about 0.005 km³) fissure eruption and a large-volume (about 6 km³) shield eruption, respectively. Both lava fields were formed about 2,300 years ago.

The Craters of the Moon lava field has been studied in more detail than any other in the Snake River Plain. Reports by Russell (1902), Stearns (1928), Murtaugh (1961), and Prinz (1970) outlined the basic geologic framework of the lava field. Lefebvre (1975) identified four major groups of pahoehoe lava flows and assigned them to four eruptive phases in the evolution of the Craters of the Moon lava field with the aid of photographs taken by the Landsat satellite. Champion and Greeley (1977) conducted preliminary studies of the paleomagnetic properties of the lava flows in the Craters of the Moon, Kings Bowl, and Wapi lava fields and found that these properties could be used for relative dating of individual flows. Preliminary, uncolored maps of the Craters of the Moon, Wapi, and Kings Bowl lava fields and of structures along the Great Rift, all at a scale of 1:125,000, were published by Kuntz and others (1980, 1983). Kuntz, Champion, and others (1982, 1986) described the Great Rift and the evolution of the Craters of the Moon lava field.

The petrochemistry of the lava flows of the Craters of the Moon lava field was described by Leeman and others (1976) and by Stout and Nicholls (1976). The Kings Bowl lava field was described by King (1977) and mapped by Covington (1977). The Wapi lava field was described by Champion (1973) and by Champion and Greeley (1977).

Standard petrographic examination of thin sections was used to prepare the petrographic descriptions of lava flows in the "Description of Map Units." The compositions of olivine were determined by visual estimation of the curvature of the isogyre and thus are only approximate. The composition of plagioclase was determined by measurement of extinction angles in crystals in which both (001) and (010) crystallographic planes were oriented vertically. Microprobe determinations of the composition of minerals in some of the flows of the three lava fields are given by Leeman and others (1976) and by Stout and Nicholls (1976).

The descriptive names of lava flows (for example "Blue Dragon" flow) in the "Description of Map Units" mostly follow the terminology of Stearns (1928) and Murtaugh (1961). The term "Lava Creek flow" was used by Anderson (1929) and by Leeman and others (1976).

The map symbols consist of letters and numbers arranged in the following system: the first letter of each symbol refers to the type of deposit (f = flow, c = cinder deposits, and e = eruptive fissure deposits); the second letter refers to the eruptive period ("a" for the youngest, through "h" for the oldest) to which the deposit belongs; and the number refers to the stratigraphic order of deposits within an eruptive period (1 designates the youngest deposit, 2 designates the next oldest deposit, and so on).

Chemical compositions of lava flows in each eruptive period are given in Kuntz and others, (1985). Rock names (for example, basalt, hawaiite, latite) used for flows in each map unit follow the nomenclature of Cox and others (1979) and are based on the weight percentages of Na_2O, K_2O, and SiO_2. The rock names used and their definitions in terms of the chemical parameters are shown in figure 2. Both names are used to describe a flow whose analysis plots in the transition zone between two rock names.

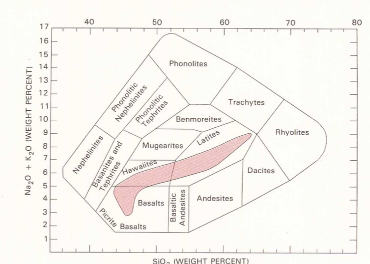


Figure 2.—Nomenclature of volcanic rocks after Cox and others (1979). Color tinted area shows location of analyses of rocks from the Craters of the Moon, Wapi, and Kings Bowl lava fields.

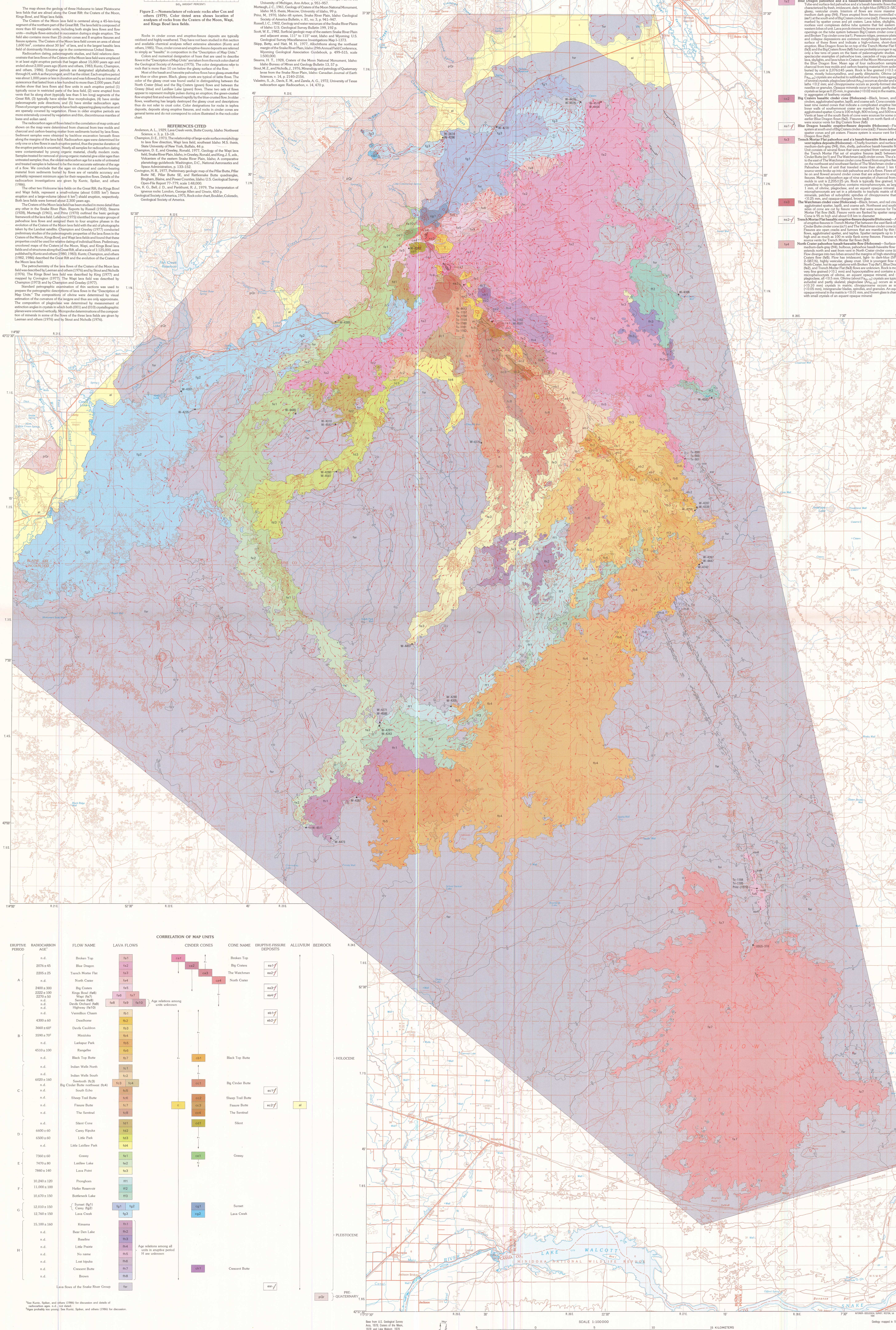
Rocks in cinder cones and eruptive-fissure deposits are typically oxidized and highly weathered. They have not been studied in thin section and available chemical analyses reflect extensive alteration (Kuntz and others, 1985). Thus, cinder cones and eruptive-fissure deposits are referred to simply as "basaltic" in composition in the "Description of Map Units."

Colors and numerical designation of hues that are used to describe flows in the "Description of Map Units" are taken from the rock color chart of the Geological Society of America (1975). The color designations refer to rock that is more than 10 cm below the glassy surface of the flow.

Most of the basalt and hawaiite pahoehoe flows have glassy crusts that are blue or olive green. Black, glassy crusts are typical of latite flows. The color of the glassy crust was found useful in distinguishing between the North Crater (blue) and the Big Craters (green) flows and between the Grassy (blue) and Laidlaw Lake (green) flows. These two sets of flows appear to represent multiple pulses during an eruption; the green-crusted flow erupted first and was followed rapidly by the blue-crusted flow. In older flows, weathering has largely destroyed the glassy crust and descriptions thus do not refer to crust color. Color designations for rocks in tephra deposits, deposits along eruptive fissures, and rocks in cinder cones are general terms and do not correspond to colors illustrated in the rock color chart.

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DESCRIPTION OF MAP UNITS[1]

SURFICIAL DEPOSITS

al — **Surficial deposits (Quaternary)**—Unit includes alluvium along streams, colluvium at base of steep slopes, and lacustrine deposits. Unit mapped only where underlying rocks are obscured along the margins of the Snake River Plain. Thin, discontinuous deposits of loess and eolian sand that partly cover flows of the Snake River Group (fsr) are not mapped. See Scott (1982) for a more detailed map and description of surficial deposits in area of this map

LAVA FLOWS OF THE CRATERS OF THE MOON, KINGS BOWL AND WAPI LAVA FIELDS

Lava flows and related cinder-cone and eruptive-fissure deposits of eruptive-period A

fa1 — **Broken Top pahoehoe basalt flow (Holocene)**—Surface- and tube-fed-pahoehoe basalt flow from obscure vents on the east and southeast sides of Broken Top cinder cone (ca1). Glassy surfaces of flow are highly vesiculated and are typically olive gray (5Y4/1) to medium-dark gray (N4). Flow is more massive and dark gray (N3) in interior. Vents are short fissures, arcuate cracks, and small spatter vents that are largely covered by tephra that has been eroded from higher parts of Broken Top cinder cone. Flows are hummocky, rough-surfaced, and cut by widely spaced joints. A lighter color on aerial photographs and a greater abundance of grass and low bushes distinguish the Broken Top flow from underlying Blue Dragon flow (fa2). Unit includes slabs of lava, as much as 10 m thick, that rest on the east and south flanks of Broken Top cinder cone. Rock is aphyric and holocrystalline with all crystals typically <0.2 mm. Olivine (about Fa_{45}) crystals are euhedral; plagioclase (An_{45-50}) crystals range from slender needles to stout laths; and intersertal clinopyroxene spindles are intergrown with an acicular, feathery, opaque mineral

ca1 — **Broken Top basaltic cinder cone (Holocene)**—Black to brown lapilli and coarse ash. West flank of cone is mantled by agglutinated spatter from younger eruptive fissure on west side of cone. Slabs of basalt lava of the Broken Top flow (fa1), as thick as 10 m, lie on the east, southeast, and south sides of cone. Cone is cut by northwest-trending fissures and normal faults of small (<1 m) displacement. Bulk of cone may have been formed by eruptions from fissure on west side of cone, possibly at same time as eruptions that were occurring from fissures (ea2) in Trench Mortar Flat. Arcuate scarps on east and south sides of cone are roughly concentric with apex of cone and may have formed by collapse of cone during eruption of Broken Top flow. Cone is 115 m high and 1 km in diameter

fa2 — **Blue Dragon pahoehoe and a'a basalt-hawaiite flows (Holocene)**—Tube-and surface-fed pahoehoe and a'a basalt-hawaiite flows that are characterized by fresh, iridescent, dark- to light-blue (5PB3/2–5B7/6), glassy, vesicular crusts. Interiors of flows are more massive and medium dark gray (N4). Flows erupted from fissure-controlled vents (ea1) at the south end of Big Craters cinder cone (ca2). Fissure system is marked by spatter cones and pit craters. Lava tubes, skylights, and rootless vent complexes define tube systems that fed eastern and western lobes of unit. Lava ponds rimmed by levees are perched above openings on the tube system between Big Craters cinder cone (ca2) and Broken Top cinder cone (ca1). Pressure ridges, pressure plateaus, and collapse depressions are common morphologic features on the surface of these flows and indicate a high-volume, short-duration eruption. Blue Dragon flows lie on top of the Trench Mortar Flat flows (fa3) and the Big Craters flows (fa5) but are probably younger in age by only a few tens of years on the basis of paleomagnetic studies. The spectacular examples of pahoehoe toes, cascades of ropy pahoehoe lava, skylights, and lava tubes in Craters of the Moon Monument are in the Blue Dragon flow. Mean age of four radiocarbon samples of charcoal from tree molds and carbon-bearing material from sediment buried by unit is 2,076±45 years. Rock is fine grained (<0.3 mm), dense, mostly holocrystalline, and partly diktytaxitic. Olivine (about Fa_{35-45}) crystals are euhedral to subhedral and many form aggregates of several crystals; plagioclase (about An_{50}) occurs as slender and stout laths <0.2 mm; and clinopyroxene occurs as poorly-formed slender needles or granules. Opaque minerals occur in equant, partly skeletal crystals as large as 0.25 mm, in granules (<0.02 mm) in the matrix, and in aggregates of feathery crystals

ca2 — **Big Craters basaltic cinder cone (Holocene)**—Black, brown, and red cinders, agglutinated spatter, lapilli, and coarse ash. Cone consists of at least nine nested cones that indicate a complicated eruptive history. Inner walls of southernmost crater are mantled by thin flows and agglutinated spatter. Cone is 100 m high, 800 m long, and 500 m wide. Vents at the base of the south flank of cone were sources for some of the earlier Blue Dragon flows (fa2). Fissures (ea3) on north flank of cone were source vents for Big Craters flows (fa5)

ea1 — **Blue Dragon basaltic eruptive-fissure deposits (Holocene)**—Fissure system at south end of Big Craters cinder cone (ca2). Fissure defined by spatter cones and pit craters. Fissure system is source vent for Blue Dragon flow (fa2)

fa3 — **Trench Mortar Flat pahoehoe and a'a basalt-hawaiite flows and near-vent tephra deposits (Holocene)**—Chiefly fountain- and surface-fed, medium-dark-gray (N4), thin, shelly, pahoehoe basalt-hawaiite flows. Unit consists of several flows that were erupted from various parts of the Trench Mortar Flat set of eruptive fissures (ea2) between Big Cinder Butte (cc1) and The Watchman (ca3) cinder cones. The a'a flow to the east of The Watchman cinder cone flowed from eruptive fissures on the northwest and southeast flanks of The Watchman cinder cone. Pahoehoe flows of unit that traveled more than about 1 km from source vents broke up into slab pahoehoe and a'a flows. Flows of unit lie on and flowed around cinder cones that are adjacent to eruptive fissures. Mean radiocarbon age of nine samples of charcoal from tree molds in unit is 2,205±25 yrs. Rock is typically fine grained, holocrystalline to hypocrystalline; contains microphenocrysts, as large as 1 mm, of olivine, plagioclase, and an equant opaque mineral. The microphenocrysts are set in a pilotaxitic to trachytic matrix of these minerals, patches of subophitic spindles of clinopyroxene that are <0.25 mm, and opaque-charged, brown glass

ca3 — **The Watchman cinder cone (Holocene)**—Black, brown, and red cinders, agglutinated spatter, lapilli, and coarse ash. Northwest and southeast sides of cone are cut by fissure vents that were sources for Trench Mortar Flat flow (fa3). Fissure vents are flanked by spatter ramparts. Cone is 95 m high and about 0.8 km in diameter

ea2 — **Trench Mortar Flat basaltic eruptive-fissure deposits (Holocene)**—A set of eruptive fissures in Trench Mortar Flat between the east flank of Big Cinder Butte cinder cone (cc1) and The Watchman cinder cone (ca3). Fissures are open cracks and furrows that are mantled by thin lava flows, agglutinated spatter, and tephra. Spatter ramparts up to 10 m high and as much as 100 m wide flank some fissures. Fissures were source vents for Trench Mortar Flat flows (fa3)

fa4 — **North Crater pahoehoe basalt-hawaiite flow (Holocene)**—Surface-fed, medium-dark-gray (N4), bulbous, pahoehoe basalt-hawaiite flow that extends north and east from vent in North Crater cinder cone (ca4). Flow diverges into two lobes around the margins of high-standing Big Craters flow (fa5). Flow has iridescent, light- to dark-blue (5PB7/2–5B7/6), highly vesicular, glassy crust. Unit is youngest flow near North Crater, but its age relations with Broken Top (fa1), Blue Dragon (fa2), and Trench Mortar Flat (fa3) flows are unknown. Rock is mostly very fine grained (<0.1 mm) and hypocrystalline and contains a few microphenocrysts of olivine, an equant opaque mineral, and rare plagioclase, all <0.5 mm. Olivine (about Fa_{50-70}) crystals are typically euhedral and partly skeletal; plagioclase (An_{45-50}) occurs as small (<0.10 mm) crystals in matrix; clinopyroxene occurs as small (<0.05 mm), intergranular blades, spindles, and granules. An equant opaque mineral in the matrix is <0.01 mm, and brown glass is charged with small crystals of an equant opaque mineral

ca4 — **North Crater basaltic cinder cone (Holocene)**—Black, brown, and red cinders, agglutinated spatter, lapilli, and ash. Crater is open to north as a result of cone collapse and rafting of remnants of crater walls by viscous lava flows. North side of cone is cut by northwest-dipping normal faults that bound slump blocks. Most of cone is believed to have formed and collapsed during eruption of Devils Orchard (fa9) and Serrate (fa8) flows. A few cinders contain inclusions of gneissic rocks, partly fused dacitic to rhyolitic rocks, and holohyaline clots of silicic pumice. Cone is 130 m high and 1 km in diameter. Crater in center of cone was source vent for North Crater flow (fa4)

fa5 — **Big Craters pahoehoe and a'a hawaiite flows (Holocene)**—Mainly surface- and fountain-fed pahoehoe hawaiite flows that extend east, west, and southwest from eruptive fissure (ea3) and cinder cone vents at the north end of Big Craters cinder cone (ca2). Unit also includes a'a and slab pahoehoe. Flows are characterized by dark-greenish-gray (5GY4/1), glassy crusts and elongated, stretched vesicles. Rock is denser and medium dark gray (N4) in interior. Flows are overlain by Blue Dragon (fa2) and North Crater (fa4) flows but lie on Serrate (fa8), Devils Orchard (fa9), and Highway flows (fa10). Rock is fine grained (mostly <0.10 mm), hypocrystalline, and partly diktytaxitic with a few microphenocrysts of olivine, an equant opaque mineral, and rare plagioclase. Olivine (about Fa_{50-70}) occurs as large (as much as 1 mm) crystals that are typically skeletal and euhedral and have glass and opaque inclusions and as smaller equant granules (<0.05 mm) in the matrix; plagioclase (An_{45-55}) crystals are mainly stubby to elongated laths (<0.2 mm) in the matrix; clinopyroxene occurs in the matrix as granules, blades, and subophitic patches that are <0.05 mm. Glass is brown and charged with granules of opaque minerals. Opaque minerals occur as larger, skeletal, equant crystals and as equant <0.002 mm granules in the matrix

ea3 — **Big Craters basaltic eruptive-fissure deposits (Holocene)**—A 30-m-long fissure flanked by spatter ramparts at northwest base of Big Craters cinder cone (ca2). Fissure and craters at northwest part of Big Craters cinder cone were source vents for Big Craters flow (fa5)

fa6 — **Pahoehoe basalt flows and associated tephra deposits of the Kings Bowl lava field (Holocene)**—Fountain-fed, thin (typically <1 m), shelly, medium-dark-gray (N4), pahoehoe basalt flows from eruptive fissures (ea4) of the Kings Bowl lava field. Surfaces of flows are highly vesicular; interiors of flows are more dense. Unit also includes a thin (<10 cm) tephra blanket of black lapilli fragments that extends about 0.5 km east of Kings Bowl. Flows formed lava ponds (not shown at this scale) near Kings Bowl. Mean age of three radiocarbon samples of charcoal from sediment buried by unit is 2,222±100 years. Rock is hypocrystalline and porphyritic with phenocrysts of olivine and plagioclase, both as much as 1.4 mm in longest dimension. The phenocrysts are set in a matrix of olivine; plagioclase; clinopyroxene needles, blades, and subophitic patches; and an equant opaque mineral, all <0.3 mm; and brown glass. Olivine (about Fa_{20-30}) phenocrysts are euhedral and skeletal with inclusions of vermicular glass and an equant opaque mineral. Plagioclase (about An_{45}) phenocrysts and crystals in the matrix are typically long, slender, euhedral laths. Feathery, intergranular crystals of clinopyroxene occur in the matrix with brown glass and scattered granules of an equant opaque mineral

ea4 — **Kings Bowl basaltic eruptive-fissure deposits (Holocene)**—A set of fissures and associated explosion pits. Fissures are as much as 3 m wide and some are open to depths of 100 m or more. Fissures locally flanked by low (<5 m) spatter ramparts and remnant upraised lava lakes. Kings Bowl, the largest explosion pit, has a length of 85 m, a width of 30 m, and a depth of 30 m. Feeder dikes are exposed in the walls of explosion pits at a few localities. Fissures were source vents for flows of the Kings Bowl lava field (fa6)

fa7 — **Pahoehoe and minor a'a basalt flows of the Wapi lava field (Holocene)**—Chiefly tube-fed, medium-dark-gray (N4), pahoehoe basalt flows that radiate from a vent complex at Pillar Butte. Pahoehoe is characterized by a filamented, glassy crust; minor amounts of slabby pahoehoe and a'a occur where pahoehoe flows collapsed or flowed over steep slopes. Pahoehoe flows have pressure ridges, tumuli, pressure plateaus, and collapse depressions that are characteristic of large-volume, short-duration eruptions. Smaller volume, short flows near vent complex are surface-, channel-, and tube-fed pahoehoe and a'a. Flows of unit cover and fill eruptive fissures of the Kings Bowl lava field (fa6), but small age difference is suspected between the two units. Age of unit, on the basis of a single radiocarbon analysis of charcoal from sage brush in sediment buried by the unit, is 2,270±50 years; an age that is not significantly different from the age of the Kings Bowl lava field. Rock is mainly holocrystalline, diktytaxitic, and coarse grained with many crystals 0.3–0.5 mm in longest dimension. Larger crystals of olivine (about Fa_{20-40}) and plagioclase (about An_{50}) are as long as 0.8 mm and 2.0 mm, respectively. Matrix consists of plagioclase laths, olivine granules, intergranular to subophitic clinopyroxene, and a feathery opaque mineral, with glass as much as about 0.1–0.5 mm

fa8 — **Serrate block and a'a latite flow (Holocene)**—Surface-fed, olive-gray (5Y4/1) to medium-dark-gray (N4), jagged, block and a'a latite flow that extends about 11 km east-northeast from a presumed source vent at or near North Crater cinder cone (ca4). Flow fronts are steep and up to 5 m high. Unit contains prominent flow ridges that are perpendicular to and convex toward the direction of flow movement. Flow also contains longitudinal furrows and cracks that are roughly parallel to the direction of flow movement. Flow contains rafted blocks (monoliths) of bedded cinders and ash, derived from a shattered cinder cone (probably North Crater; unit ca4), that were rafted on the surface of the moving flow. Rafted blocks have lengths and widths of as much as 150 m and exposed heights of up to 30 m. Bulbous lobes of lava, squeezed out at the edges of the flow (which we term "squeeze-outs"), have black (N2), filamented, glassy crusts and are common along flow margins. Flow is overlapped on south by Blue Dragon flow (fa2), and proximal parts are overlapped by Big Craters flow (fa5). Flow is nearly identical to Devils Orchard (fa9) and Highway (fa10) flows in terms of petrographic, chemical, and field characteristics, but age relations with these units are unknown. Rock is fine grained (mostly <0.10 mm) and hypocrystalline having rounded xenocrysts of anorthoclase, plagioclase, and green clinopyroxene that are each as large as 2 mm. Xenocrysts of anorthoclase have wormy, corroded rims and, commonly, corroded cores. Rock also contains xenolithic clots, as large as 3 mm, that consist of anorthoclase, plagioclase (An_{35-55}), green clinopyroxene, an equant opaque mineral, rare olivine (about Fa_{75-90}), and zircon. The matrix of the rock consists of plagioclase (An_{15-30}) laths, spindles and subophitic blades and needles of green clinopyroxene, granules of olivine, and opaque-charged, brown glass

fa9 — **Devils Orchard block and a'a latite flow (Holocene)**—Surface-fed, olive-gray (5Y4/1) to medium-dark-gray (N4), block and a'a latite flow. Flow fronts are steep and as high as 5 m. Flow extends about 7 km east from a presumed source vent at or near North Crater cinder cone (ca4). Flow is rough surfaced and contains rafted blocks of bedded cinders and ash, derived from a cinder cone (probably North Crater, ca4), that were rafted on the surface of the moving flow. Rafted blocks have lengths and widths of as much as 100 m and heights of 20 m. Squeeze-outs having black (N2), filamented, glassy crusts are common along flow margins. Flow immediately east of Paisley Cone (c) is covered by a very fine (<10 cm) layer of ash and cinders. Exact age relations of unit with Serrate (fa8) and Highway (fa10) flows are unknown. Rock is fine grained (mostly <0.05 mm) and hypocrystalline having xenocrysts of anorthoclase, plagioclase, and green clinopyroxene that are each as large as 2 mm in longest dimension. Xenocrysts of anorthoclase have corroded rims and, commonly, corroded cores. Rock also contains xenolithic clots, as large as 3 mm, that consist of anorthoclase, plagioclase (about An_{40}), green clinopyroxene, an equant opaque mineral, and rare zircon. The matrix of the rock consists of plagioclase (about An_{20}) laths, rounded crystals of olivine (about Fa_{60}), spindles of green clinopyroxene, and opaque-charged, brown glass

fa10 — **Highway block, a'a, and pahoehoe latite flows (Holocene)**—Surface-fed, steep-sided, bulbous, olive-gray (5Y4/1) to medium-dark-gray (N4), block and a'a latite flow that extends 1 km north from a presumed source vent at or near North Crater cinder cone (ca4). Flow is extremely rough-surfaced and contains furrows, spires, and blocks that produce a local relief of as much as 10 m. Bulbous, steep-sided flow fronts are as high as 15 m. Flow is 2–10 m thick where exposed in cross-section on an arcuate scarp about 0.25 km north of North Crater cinder cone. Thin (<1 m), black, glassy-surfaced, pahoehoe trachyandesite flow in the area of the campground at Craters of the Moon National Monument is included in the map unit. Exact age relations of unit with Serrate (fa8) and Devils Orchard (fa9) flows are unknown. Xenoliths of gneissic rock as large as 30 cm are rare in outcrop. Rock is fine grained (mostly <0.2 mm) and hypocrystalline and commonly contains xenocrysts of corroded anorthoclase; rounded, green clinopyroxene; an equant opaque mineral; and rare zircon, all 0.5–2.0 mm in longest dimension. The matrix of the rock consists of slender, skeletal olivine (about Fa_{60}), spindles and needles of greenish-brown clinopyroxene, slender laths of plagioclase (An_{15-25}), and rare apatite needles, all 0.2 mm in longest dimension, and opaque-charged, brown glass

Lava flows and related cinder-cone and eruptive-fissure deposits of eruptive-period B

fb1 — **Vermillion Chasm pahoehoe basalt flow and near-vent tephra deposits (Holocene)**—Chiefly fountain- and surface-fed, dark-gray (N3), pahoehoe basalt flow from eruptive fissures (eb1) at Vermillion Chasm and from eruptive fissures that extend as far as 1 km southeast of Vermillion Chasm. Unit consists of thin (mostly <1 m), shelly flows near source vents and thicker, more dense pahoehoe flows in distal parts of unit. Unit also includes red, brown, and black, partly agglutinated spatter, bomb, and cinder deposits that form ramparts and low mounds that flank eruptive fissures. Flows of unit overlie Deadhorse flows (fb2), but both units are probably part of the same episode of fissure eruptions. Unit is cut by noneruptive fissures in the area between Devils Cauldron and Vermillion Chasm. Rock is microporphyritic and hypocrystalline having abundant euhedral, partly skeletal phenocrysts of olivine (about Fa_{50-70}) and abundant laths of plagioclase (An_{40-50}), both as large as 1 mm in longest dimension. The phenocrysts are set in a fine-grained (<0.05 mm) matrix of olivine, plagioclase, intergranular clinopyroxene, an equant opaque mineral, and clear glass

eb1 — **Vermillion Chasm basaltic eruptive-fissure deposits (Holocene)**—A set of fissures flanked by large (20 m high and 200 m wide) spatter ramparts and low spatter and cinder mounds. Fissures are now marked by tephra-mantled furrows as much as 10 m wide and 10 m deep. Fissures were source vents for Vermillion Chasm flow (fb1)

fb2 — **Deadhorse pahoehoe basalt flows (Holocene)**—Chiefly fountain-fed, shelly, thin (<1 m), pahoehoe basalt flows from eruptive fissures (eb2) northwest and southeast of Black Top Butte cinder cone (cb1). Thin, glassy crusts are decomposed and broken into small fragments. Color of weathered, glassy crust is brownish gray (5YR4/1); rock in interior of flows is medium dark gray (N3). Unit also includes deposits of partly agglutinated, red, brown, and black cinders and ash that form low ramparts on flanks of eruptive fissures. Age of unit, on the basis of a single radiocarbon analysis of untreated carbon-bearing material from sediment buried by flow, is 4,300±60 years, an age that is believed to be too old on the basis of its stratigraphic relations with the Devils Cauldron flow (fb3). Rock is hypocrystalline and porphyritic and has a fine-grained (mostly <0.2 mm) matrix. Contains common phenocrysts of euhedral, partly skeletal olivine (about Fa_{50-70}) and plagioclase (An_{40-50}) laths having maximum dimensions of 1.5 mm. The matrix is intergranular and consists of plagioclase, olivine, clinopyroxene(?), an equant opaque mineral, and clear glass

eb2 — **Deadhorse basaltic eruptive-fissure deposits (Holocene)**—A set of en echelon eruptive fissures and related open cracks that indicate offset in a right-lateral sense. Fissure system has a length of about 11 km and extends from southeast margin of Vermillion Chasm flow (fb1), through Black Top cinder cone (cb1), to the southeast margin of the Craters of the Moon lava field. Fissures are flanked by low (<3m) spatter ramparts. Fissures were source vents for Deadhorse flows (fb2)

fb3 — **Devils Cauldron pahoehoe basalt-hawaiite flow (Holocene)**—Surface- and tube-fed, medium-dark-gray (N4), pahoehoe basalt-hawaiite flow that erupted from a low, broad lava dome (Devils Cauldron) that contains two lava-filled craters. Flows are hummocky and have prominent ridges and depressions. Unit is cut by noneruptive fissures in an area 1–2 km northeast of Devils Cauldron. Age of unit, on the basis of a single radiocarbon analysis of pretreated carbon-bearing material from sediment buried by flow, is 3,660±60 years. Rock is medium grained and has crystals of partly skeletal olivine (about Fa_{50-70}), needles and laths of plagioclase (An_{40-50}), and a skeletal, equant opaque mineral, all 0.1–0.4 mm in longest dimension. Smaller (<0.1 mm) crystals of olivine, plagioclase, an equant opaque mineral, and subophitic clinopyroxene constitute the matrix. Some rocks are microporphyritic having phenocrysts of olivine and plagioclase (as large as 0.4 mm) set in a matrix of brown glass and small (<0.05 mm) crystals of olivine and plagioclase

fb4 — **Minidoka pahoehoe basalt flow (Holocene)**—Tube- and surface-fed, medium-dark-gray (N4), pahoehoe basalt flows having hummocky, billowy surfaces. Lava tube systems having rootless vents carried lava as far as 35 km southwest from an obscure, lava-filled vent complex about 3 km east of New Butte. Unit is cut by noneruptive fissures about 2 km southeast of New Butte. Pressure ridges, pressure plateaus, tumuli, and collapse depressions are common morphologic features on this flow and indicate a high-volume, short-duration eruption. Age of unit, on the basis of a single radiocarbon analysis of pretreated carbon-bearing material from sediment buried by flow, is 3,590±70 years. Rock is hypocrystalline with microphenocrysts of olivine (about Fa_{50}), plagioclase (about An_{40}), and an equant opaque mineral, all as large as 0.4 mm. The larger crystals are set in a fine-grained (<0.05 mm) matrix of olivine, plagioclase, clinopyroxene, an equant opaque mineral, and brown glass

fb5 — **Larkspur Park pahoehoe hawaiite flow (Holocene)**—Surface- and tube(?)-fed, medium-dark-gray (N4), pahoehoe hawaiite flow having hummocky, billowy surface. Field relations, petrographic similarities, and paleomagnetic data suggest that unit may be an earlier phase of the Minidoka flow (fb4). Rock is fine to medium grained and hypocrystalline having laths of plagioclase (about An_{50}) that are 0.2–0.6 mm long and subhedral to euhedral olivine (about Fa_{50}) crystals that are 0.05–0.20 mm long. The larger crystals are set in a matrix of plagioclase; olivine; clinopyroxene spindles; and an equant opaque mineral, all <0.1 mm in longest dimension; and opaque-charged, brown glass

fb6 — **Rangefire pahoehoe hawaiite-latite flows (Holocene)**—Surface- and tube(?)-fed, dark-gray (N3), pahoehoe hawaiite-latite flows. Exposed in patches around and beneath the southern and eastern margins of the Devils Cauldron flow (fb3). Flows are cut by noneruptive fissures about 5 km southeast and about 5 km east-southeast of New Butte. Source vent is uncertain, but flow directions suggest a source at or near Black Top Butte cinder cone (cb1). Age of unit, on the basis of a single radiocarbon analysis of pretreated carbon-bearing material from sediment buried by flow, is 4,510±100 years. Rock is fine grained and hypocrystalline. Euhedral to subhedral crystals of olivine (about Fa_{35-50}), plagioclase (An_{35-50}), and an equant opaque mineral, all 0.1–0.6 mm in longest dimension, are set in a matrix of olivine, plagioclase, clinopyroxene, and an equant opaque mineral, all 0.05–0.10 mm, and opaque-charged, brown glass

fb7 — **Black Top Butte pahoehoe hawaiite flow (Holocene)**—Surface-fed, thin (<2 m), medium-gray (N4), pahoehoe hawaiite flow from vents at the south end of Black Top Butte cinder cone (cb1). Mostly covered by Deadhorse (fb2) and Devils Cauldron (fb3) flows. Rock is hypocrystalline and microporphyritic containing euhedral crystals of olivine (about Fa_{50}), plagioclase (An_{40-50}), and an equant, partly skeletal opaque mineral, all 0.2–0.8 mm in longest dimension. The microphenocrysts are set in a matrix of olivine; plagioclase; slender needles and patches of clinopyroxene; an equant opaque mineral; and a feathery, needle-like opaque mineral, all 0.05–0.2 mm in longest dimension; and opaque-charged, brown glass

cb1 — **Black Top Butte basaltic cinder cone (Holocene)**—Black, brown, and red cinders, agglutinated spatter, lapilli, and ash. Cone consists of at least three nested cones that indicate a complicated eruptive history. Craters are filled by lava lakes and indented by collapse pits. Southeast flank of cone cut by fissures and explosion craters of the Deadhorse fissure system (eb2). Cone is 75 m high, 600 m wide, and 1 km long. Cone is source vent for Black Top flow (fb7)

Lava flows and related cinder-cone and eruptive-fissure deposits of eruptive-period C

fc1 — **Indian Wells North a'a latite flow (Holocene)**—Surface-fed, bulbous, steep-sided, medium-dark-gray (N4), a'a latite flow that contains numerous lobes having steep fronts. Lobes are defined by flow ridges that are perpendicular to and convex toward the direction of flow movement and by longitudinal furrows and cracks that are roughly parallel to the direction of flow movement. Flow contains rafted blocks of bedded cinders that are as much as 100 m in width and length and 15 m high. Squeeze-outs with filamented- and sharkskin-textured glassy crusts are common along flow margins. Flow lines suggest a source vent at or near the northwest side of Big Cinder Butte cinder cone (cc1). Rock is fine grained and hypocrystalline having rounded, partly corroded xenocrysts of alkali feldspar (anorthoclase?), plagioclase, and green clinopyroxene that are 0.5–1.5 mm in longest dimension. Matrix consists of plagioclase (about An_{30-40}) laths, elongated crystals of olivine (about Fa_{50-60}), and granules of an equant opaque mineral, all 0.01–0.10 mm, and opaque-charged, brown glass

fc2 — **Indian Wells South a'a latite flow (Holocene)**—Surface-fed, bulbous, steep-sided, brownish-gray (5YR4/1) to medium-dark-gray (N4), a'a latite flow having flow fronts as high as 20 m. Flow contains numerous lobes having steep fronts and flow ridges that are perpendicular to and convex toward the direction of flow movement and longitudinal furrows and cracks that are roughly parallel to the direction of flow movement. Flow contains rafted blocks of bedded cinders that are as much as 100 m in width and length and up to 15 m high. Squeeze-outs having filamented- to sharkskin-textured, glassy crusts are common along flow margins. Unit may be an earlier phase of the Indian Wells North a'a flow (fc1). Flow lines suggest a source at or near Big Cinder Butte cinder cone (cc1). Unit is petrographically similar to Indian Wells North a'a flow

fc3 — **Sawtooth a'a latite flow (Holocene)**—Surface-fed, long (21 km), steep-sided, brownish-gray (5YR4/1) to medium-dark-gray (N4), a'a latite flow that contains numerous lobes having steep fronts. Flow ridges are perpendicular to and convex toward the direction of flow movement in proximal parts, and longitudinal furrows and cracks are roughly parallel to flow direction in proximal and distal parts of flow. Tephra as much as 2 m thick mantles proximal parts. Flow contains rafted blocks of bedded cinders that are as much as 100 m in width and length and up to 15 m high, and blocks (as large as 10 m) of broken a'a. Squeeze-outs having filamented, glassy crusts are common along flow margins. Source vent is at south end of Big Cinder Butte cinder cone (cc1). Age of unit, on the basis of a single radiocarbon analysis of pretreated carbon-bearing material from sediment buried by flow, is 6,020±160 years. Rock is fine grained, hypocrystalline and partly diktytaxitic having microphenocrysts of skeletal olivine (about Fa_{50-70}) and euhedral plagioclase (about An_{30-40}) as much as 0.5 mm in longest dimension. Rock also contains scattered xenocrysts and xenolithic clots of anorthoclase, plagioclase, green clinopyroxene, and an equant opaque mineral that are as large as 2 mm. The microphenocrysts, xenocrysts, and xenoliths are set in a matrix of slender plagioclase laths, olivine granules, subophitic clinopyroxene, and an equant opaque mineral, all <0.10 mm in longest dimension, and brown glass

cc1 — **Big Cinder Butte basaltic cinder cone (Holocene)**—Black, brown, and red cinders, agglutinated spatter, lapilli, coarse ash, and interbedded, thin (<1 m), frothy lava flows. Tephra is coarser in steep eastern and northern flanks of cone and finer on western flanks. Inner walls of crater are mantled by agglutinated spatter and thin lava flows. Cone is 240 m high, 1 km wide, and 3 km long, and has a volume of about 0.2 km³. Stearns (1928, p. 5) reported that "Big Cinder Butte ranks among the largest, purely basaltic cinder cones in the world." East and southeast flank of cone are cut by alined, elongated, and circular craters that are part of Trench Mortar Flat eruptive fissures (ea2). Cone is open to southeast. Cone is source vent for Sawtooth (fc3) and Big Cinder Butte northwest (fc4) flows and possible source vent for Indian Wells North (fc1) and Indian Wells South (fc2) flows

fc4 — **Big Cinder Butte northwest a'a latite flow (Holocene)**—Surface-fed, short (<1 km), blocky, medium-dark-gray (N4), a'a latite flow on northwest flank of Big Cinder Butte cinder cone (cc1). Flow largely covered by cinders and lapilli in its proximal parts. Distal parts of flow covered by Blue Dragon flow (fa2). Age relations with Sawtooth flow (fc3) are unknown but units are believed to be roughly equivalent in age because both are known to have been erupted from Big Cinder Butte (cc1). Rock is hypocrystalline and partly diktytaxitic having microphenocrysts of olivine (about Fa_{50-75}) as much as 0.5 mm in longest dimension. Also contains xenocrysts of anorthoclase and plagioclase as long as 1 mm, and xenoliths, as much as 2 mm in maximum dimension, that consist of clear clinopyroxene, an equant opaque mineral, plagioclase, anorthoclase, and zircon. The matrix of the rock is identical to the matrix of the Sawtooth a'a flow (fc3)

fc5 — **South Echo pahoehoe basalt flow (Holocene)**—Fissure-fed, dark-gray (N3), mostly thin (<1 m), pahoehoe basalt flow that is largely covered by ash and lapilli. Flow erupted from fissures (ec1) about 1 km southeast of Echo Crater cinder cone (c). Rock ranges from glassy to holocrystalline. In typical samples, microphenocrysts of skeletal olivine (about Fa_{35-45}) and plagioclase (about An_{40}) are set in a microcrystalline matrix of opaque crystals, brown to orange glass, small plagioclase laths, and rare needles and blades of clinopyroxene

ec1 — **South Echo basaltic eruptive-fissure deposits (Holocene)**—Eruptive fissures located between South Echo cinder cone (c) and The Sentinel cinder cone (cc4). Fissures largely covered by tephra and vegetation. Fissures were source vents for South Echo flow (fc5)

fc6 — **Sheep Trail Butte pahoehoe and a'a basalt flows (Holocene)**—Channel- and tube-fed, dark-gray (N3), pahoehoe and a'a basalt flows that extend as much as 30 km south from source vents at Sheep Trail Butte cinder cone (cc2). Flows are predominantly hummocky, billowy pahoehoe in proximal parts and both pahoehoe and a'a in distal parts. Isolated exposure of unit 6 to 18 km south of Black Top Butte cinder cone (cb1) is correlated with main part of unit on the basis of similarities in flow characteristics, petrography, and paleomagnetic data. Rock is typically hypocrystalline with microphenocrysts of skeletal, euhedral olivine (about Fa_{30-40}), plagioclase (about An_{50}) laths, and a skeletal, equant opaque mineral. The microphenocrysts, as large as 1.5 mm, are typically set in a matrix of opaque-charged, brown glass

cc2 — **Sheep Trail Butte basaltic cinder cone (Holocene)**—Black, brown, and red cinders, lapilli, and coarse ash. Cone consists of five nested cinder cones and associated craters that indicate a complicated eruptive history. Cone is 30 m high, 750 m long, and 800 m wide. Cone is source vent for Sheep Trail Butte flows (fc6)

fc7 — **Fissure Butte pahoehoe and a'a basalt flow (Holocene)**—Surface- and fountain-fed, dark-gray (N3), pahoehoe and a'a basalt flows erupted from crater at Fissure Butte cinder cone (cc3) and from eruptive fissure (ec2) northwest of Fissure Butte. Flows largely mantled by lapilli and ash. Rock is medium to fine grained and holocrystalline having microphenocrysts of olivine (Fa_{35-45}) and rare plagioclase (about An_{40}) as large as 0.6 mm. The microphenocrysts are set in an intergranular matrix of olivine, plagioclase, an equant opaque mineral, and rare clinopyroxene, all <0.2 mm in longest dimension

cc3 — **Fissure Butte basaltic cinder cone (Holocene)**—Black, brown, and red cinders, lapilli, and coarse ash. Cone elongated to east; northern parts of cone join with spatter ramparts that lie along Fissure Butte eruptive fissure (ec2). Cone is 150 m high, 2.5 km long, and 1 km wide. Cone is source vent for Fissure Butte flow (fc7)

ec2 — **Fissure Butte basaltic eruptive-fissure deposits (Holocene)**—Eruptive fissure that extends for about 2 km northwest of Fissure Butte cinder cone (cc3). Fissure is flanked by low (<5 m) spatter ramparts. Fissure and ramparts are largely covered by tephra. Eruptive fissure and Fissure Butte cinder cone (cc3). were source vents for Fissure Butte flow (fc7)

fc8 — **The Sentinel pahoehoe and a'a basalt flow (Holocene)**—Surface- and channel-fed, dark-gray (N3), pahoehoe and a'a basalt flow from craters and vents at the base of The Sentinel cinder cone (cc4). Flow is dominantly pahoehoe in proximal parts and partly a'a in distal parts. Flow is mantled by lapilli and ash near vents. Rock is hypocrystalline and contains larger (0.2–0.8 mm) crystals of olivine (about Fa_{30-40}), plagioclase (about An_{50}), and a skeletal, equant opaque mineral. The larger crystals are set in a finer (0.05–0.2 mm) matrix of the same minerals plus clinopyroxene and small amounts of opaque-charged, brown glass

cc4 — **The Sentinel basaltic cinder cone (Holocene)**—Black, brown, and red cinders, lapilli, and coarse ash. Cone is a composite of at least four smaller cinder cones, which indicates a complicated eruptive history. Cone is 65 m high and 1 km long. Cone is the source vent for The Sentinel flows (fc8)

Lava flows and related cinder cone deposits of eruptive-period D

fd1 — **Silent Cone a'a latite flow (Holocene)**—Surface-fed, medium-dark-gray (N4) a'a latite flow having bulbous lobes. Lobes contain flow ridges oriented perpendicular to and convex toward the direction of flow movement and longitudinal furrows and cracks that are roughly parallel to direction of flow movement. Flow contains rafted blocks of bedded cinders that are typically 100 m in longest dimension and as high as 30 m. Proximal parts of flow are mostly covered by Big Craters flow (fa5), but small (unmapped) kipukas of unit are present on west and north sides of the source vent, Silent Cone cinder cone (cd1). Rock is hypocrystalline and locally vitrophyric having larger crystals of skeletal olivine (about Fa_{50-70}), plagioclase (about An_{40}), and a skeletal, equant opaque mineral, that are all typically 0.2–0.8 mm in longest dimension. The larger crystals are set in a matrix of tiny (<0.05 mm) crystals of plagioclase, olivine, trellis-like clinopyroxene, and opaque-charged, brown glass. The rock contains rare xenocrysts of anorthoclase

cd1 — **Silent Cone basaltic cinder cone (Holocene)**—Black, brown, and red cinders, agglutinated spatter, lapilli, coarse ash, and interlayered, thin lava flows. Cone consists of three nested craters that indicate a complicated eruptive history. Cone is collapsed, faulted, and open to the northwest, the direction of exit for the Silent Cone flow (fd1). Cone is 150 m high and 1.5 km wide. Cone may have been source vent for Carey Kipuka (fd2), Little Park (fd3), and Little Laidlaw Park (fd4) flows

fd2 — **Carey Kipuka a'a hawaiite flow (Holocene)**—Surface-fed, medium-dark-gray (N4) a'a hawaiite flow having lobes and steep, bulbous flow fronts as high as 10 m. Lobes contain prominent flow ridges that are perpendicular to and convex toward the direction of flow movement and longitudinal furrows and cracks that are roughly parallel to direction of flow movement. Only distal parts of flow are exposed, proximal parts are covered by Blue Dragon flow (fa2). Source vent is unknown but may be Silent Cone cinder cone (cd1). Age of unit, on the basis of a single radiocarbon analysis of pretreated carbon-bearing material from sediment buried by flow, is 6,600±60 years. Rock is hypocrystalline and fine grained containing microphenocrysts of euhedral, partly skeletal olivine (about Fa_{50}) as large as 0.6 mm set in an intergranular matrix of plagioclase (about An_{40}); olivine; a skeletal, equant opaque mineral; and clinopyroxene, all <0.02 mm; and opaque-charged, brown glass

fd3 — **Little Park a'a hawaiite flow (Holocene)**—Surface-fed, medium-dark-gray (N4), blocky a'a hawaiite flow having lobes and steep, bulbous flow fronts as high as 10 m. Lobes are defined by prominent flow ridges that are perpendicular to and convex toward the direction of flow movement. Lobes also contain longitudinal furrows and cracks that are roughly parallel to direction of flow movement. Flow contains rafted blocks of bedded cinders as much as 100 m in longest dimension and up to 30 m high. Only distal part of flow is exposed, proximal part is covered by younger flows. Source vent is unknown but may be Silent Cone cinder cone (cd1). Age of flow, on the basis of a single radiocarbon analysis of pretreated carbon-bearing material from sediment buried by the flow, is 6,500±60 years. Rock is hypocrystalline and contains microphenocrysts of euhedral, partly skeletal olivine (about Fa_{60}) as much as 0.6 mm in longest dimension. The microphenocrysts are set in an intergranular matrix of plagioclase (about An_{40}) laths, olivine granules, and clinopyroxene; and an equant, partly skeletal opaque mineral, all less than 0.2 mm; and brown glass

fd4 — **Little Laidlaw Park a'a hawaiite flow (Holocene)**—Surface-fed, medium-dark-gray (N4), blocky a'a hawaiite flow having lobes and steep, bulbous flow fronts as high as 10 m. Lobes are defined by prominent flow ridges that are perpendicular to and convex toward the direction of flow movement and longitudinal furrows and cracks that are roughly parallel to the direction of flow movement. Flow contains rafted blocks of bedded cinders as much as 100 m in longest dimension and up to 30 m high. Source vent is unknown but may be Silent Cone cinder cone (cd1). Rock is fine grained, hypocrystalline, and partly diktytaxitic containing microphenocrysts of skeletal, euhedral olivine (about Fa_{40-60}) as large as 0.4 mm. The microphenocrysts are set in a matrix of olivine granules and plagioclase (about An_{30}) laths that are both <0.10 mm. Scattered patches of subophitic clinopyroxene as large as 0.2 mm occur in brown glass. The rock also contains large xenocrysts and xenoliths of rounded, corroded anorthoclase as large as 2 mm

Lava flows and related cinder cone deposits of eruptive-period E

fe1 — **Grassy pahoehoe and a'a basalt flow (Holocene)**—Surface- and tube-fed, dark-gray (N3), pahoehoe basalt flow. Surface is hummocky having pressure plateaus, collapse depressions, and flow ridges. Flow contains large amounts of a'a in collapsed areas and where flow flowed over steep slopes. Larger areas of a'a are lobate and contain flow ridges that are perpendicular to and convex toward the direction of flow movement and longitudinal furrows and cracks that are roughly parallel to the direction of flow movement. Flow is covered by thin, brown, olive, and red tephra having a maximum thickness of about 1 m within 1 km of the source vent at Grassy Cone cinder cone (ce1). Pressure ridges, pressure plateaus, tumuli, and collapse depressions are common morphologic features of this flow and indicate a high-volume, short-duration eruption. Age of unit, on the basis of a single radiocarbon analysis of pretreated carbon-bearing material from sediment buried by flow, is 7,360±60 years. Rock is holocrystalline to hypocrystalline and partly diktytaxitic. Porphyritic varieties contain phenocrysts of euhedral olivine (about Fa_{50}), plagioclase (about An_{45}), and a skeletal, equant opaque mineral, all as large as 1 mm. The phenocrysts are set in an intergranular to subophitic matrix of the same minerals plus clinopyroxene, a feathery opaque mineral, and brown glass. Clear to brown apatite crystals as long as 1 mm are a common accessory mineral

ce1 — **Grassy Cone basaltic cinder cone (Holocene to latest Pleistocene)**—Black, brown, and red cinders, agglutinated spatter, lapilli, coarse ash, and interlayered, thin lava flows. Cone consists of five nested craters that indicate a complicated eruptive history. Cone is 110 m high and 1.5 km wide. Cone is known source vent for Grassy flow (fe1) and the suspected source vent for Laidlaw Lake flow (fe2)

fe2 — **Laidlaw Lake pahoehoe and a'a basalt flows (Holocene)**—Chiefly surface- and tube(?)-fed, dark-gray (N3), pahoehoe basalt flows. Pahoehoe is hummocky having pressure plateaus, collapse depressions and flow ridges. Isolated exposure of unit is correlated with main part of unit based on similarities in field, petrographic, and paleomagnetic characteristics. Age of unit, on the basis of a single radiocarbon analysis of pretreated carbon-bearing material from sediment buried by flow, is 7,470±80 years. Rock is hypocrystalline, partly diktytaxitic, and nonporphyritic. Euhedral olivine (about Fa_{50}), plagioclase (about An_{50}), intergranular to subophitic clinopyroxene, and equant opaque mineral crystals are all 0.05–0.6 mm in longest dimension. A feathery to bladed, opaque mineral and an equant opaque mineral occur in cloudy, brown glass. Brown apatite crystals as long as 2 mm are a common accessory mineral

fe3 — **Lava Point a'a basalt flows (Holocene)**—Surface-fed, medium-dark-gray (N4), a'a basalt flows having steep, bulbous flow fronts and rough, corrugated surfaces. Flow fronts are as high as 10 m. In proximal parts of units, lobes are defined by flow ridges that are perpendicular to and convex toward the direction of flow movement. Longitudinal furrows and cracks are roughly parallel to the direction of flow movement. Squeeze-outs having filamented, glassy crusts are common along flow margins. Southwestern (main) lobe contains rafted blocks of bedded cinders as long as 100 m and as high as 20 m. Central exposures of unit are correlated with main lobe at Lava Point on the basis of similarities in field, petrographic, and paleomagnetic characteristics. Isolated exposure south of Huddles Hole is correlated with unit on the basis of paleomagnetic data and similarity in petrographic and field characteristics. Only distal parts of flows are exposed; source vent is unknown. Age of units, on the basis of a single radiocarbon analysis of pretreated carbon-bearing material from sediment buried by flow, is 7,840±140 years. Rock is fine grained and hypocrystalline containing a few euhedral, partly skeletal phenocrysts of olivine (about Fa_{50}) as large as 1 mm, set in an intergranular to subophitic matrix of plagioclase (about An_{50}) laths, olivine granules, an equant opaque mineral, and feathery, subophitic clinopyroxene, all <0.2 mm in longest dimension. A feathery to bladed, opaque mineral and an equant opaque mineral occur in brown glass

Lava flows of eruptive-period F

ff1 — **Pronghorn pahoehoe and a'a basalt flows (Holocene to latest Pleistocene)**—Surface and tube(?)-fed, medium-dark-gray (N4) pahoehoe basalt flows. Flows contain areas of a'a that consist of broken plates of pahoehoe where flows collapsed or moved over steep slopes. Exposed mainly in two contiguous but stratigraphically distinct flows; the western flow is younger. Only distal parts of flows are exposed, source vent is unknown. Age of units, on the basis of a single radiocarbon analysis of pretreated carbon-bearing material from sediment buried by flow, is 10,240±120 years. Rock is hypocrystalline and partly diktytaxitic containing scattered phenocrysts of euhedral, partly skeletal olivine (about Fa_{50}) as large as 0.8 mm. The phenocrysts are set in a matrix of crystals that are all <0.3 mm and consist of granular olivine, plagioclase (An_{40-50}) laths, blades of clinopyroxene intergrown with a feathery opaque mineral, subophitic clinopyroxene that is also intergrown with a feathery opaque mineral, and an equant, partly skeletal opaque mineral, and opaque-charged, brown glass

ff2 — **Heifer Reservoir pahoehoe basalt flows (Holocene to latest Pleistocene)**—Surface and tube(?)-fed, medium-dark-gray (N4) pahoehoe basalt flows. Flows covered by thin (<5 cm), discontinuous deposits of eolian sand near edges. Exposure south of Huddles Hole is correlated with exposure near Pratt Butte on the basis of similarity in field and paleomagnetic characteristics. Only distal parts of flows are exposed, source vent is unknown. Age of units, on the basis of a single radiocarbon analysis of pretreated carbon-bearing material from sediment buried by flow, is 10,670±150 years. Rock is hypocrystalline, nonporphyritic, medium grained, and consists of euhedral olivine (about Fa_{50}), tabular to lath-like plagioclase (An_{40-50}), an equant opaque mineral, and intergranular to subophitic blades of clinopyroxene intergrown with a feathery to needle-like opaque mineral. Opaque-charged, brown glass is also present

ff3 — **Bottleneck Lake pahoehoe and a'a basalt flows (Holocene to latest Pleistocene)**—Chiefly surface- and tube(?)-fed, medium-dark-gray (N4) pahoehoe basalt flows. Flows contain areas of a'a that consist of broken plates of pahoehoe where flows collapsed or flowed over steep slopes. Units exposed in two isolated locations; flows west of Bear Park are correlated with main part of unit on the basis of similarities in field, petrographic, and paleomagnetic characteristics. Only distal parts of flows are exposed, source vent is unknown. The oldest age from 4 radiocarbon analyses on both pretreated and untreated samples of carbon-bearing material from sediment buried by flow is 11,000±100 years. Rock is hypocrystalline and diktytaxitic containing rare phenocrysts of euhedral olivine (about Fa_{50}) and an equant opaque mineral, each as much as 0.8 mm in longest dimension. The phenocrysts are set in an intergranular matrix of plagioclase (An_{40-50}) laths, olivine granules, subophitic clinopyroxene that is interlayered with a feathery opaque mineral, and brown, opaque-charged glass. All minerals in the matrix are <0.3 mm

Lava flows and related cinder-cone deposits of eruptive-period G

fg1 — **Sunset pahoehoe and a'a basalt-hawaiite flows (latest Pleistocene)**—Chiefly surface- and tube(?)-fed, hummocky, medium-dark-gray (N4) pahoehoe basalt flows. Flows in main part of unit are covered by a thin (<2 m) layer of olive, orange, and brown lapilli as far as 3 km northeast from the source vent at Sunset Cone cinder cone (cg1). Southeasternmost flow is from a low source vent southeast of Sunset Cone cinder cone and is correlated with the main part of the units on the basis of similarity in paleomagnetic data. A'a lava occurs where pahoehoe flows collapsed or moved over steep slopes. Pressure ridges, pressure plateaus, and collapse depressions are common morphologic features on the surface of these flows and indicate high-volume, short-duration eruptions. Age of flow, on the basis of a single radiocarbon analysis of charcoal excavated from beneath the flow, is 12,010±150 years. Rock is hypocrystalline and porphyritic containing microphenocrysts of euhedral olivine (about Fa_{35-40}), plagioclase (An_{45}) laths, and an equant, skeletal opaque mineral, all 0.2–0.8 mm in longest dimension. The microphenocrysts are set in an intergranular matrix of the same minerals plus blades and patches of spindly clinopyroxene, and opaque-charged, brown glass

fg2 — **Carey pahoehoe and a'a basalt-hawaiite flows (latest Pleistocene)**—Chiefly surface- and tube(?)-fed, hummocky, medium-dark-gray (N4) pahoehoe basalt-hawaiite flows. Flow contains conspicuous ridges, plateaus, collapse pits, and depressions of various sizes, which are characteristic of high-volume, short-duration eruptions. Isolated exposures about 1–5 km west of Big Cinder Butte cinder cone (cc1) are correlated with main unit farther west on the basis of similarity in paleomagnetic directions. Carey flows are believed to have been erupted simultaneously with Sunset flows (fg1) on the basis of similarities in field, petrographic, paleomagnetic, and chemical characteristics. Sunset Cone cinder cone (cg1) is believed to be source vent for flows of unit. Rock is hypocrystalline, medium to fine grained (mostly <0.2 mm), diktytaxitic, and microporphyritic. In typical samples, larger crystals of euhedral olivine (about Fa_{35-40}), laths of plagioclase (An_{40-50}), and an equant, skeletal opaque mineral are all as large as 0.8 mm. The phenocrysts are set in a matrix of the same minerals plus a feathery, bladed opaque mineral; blades and patches of spindly, subophitic clinopyroxene; and granules of an equant opaque mineral, all 0.05–0.2 mm; and strongly opaque-charged, brown glass

cg1 — **Sunset Cone basaltic cinder cone (latest Pleistocene)**—Black, brown, and red cinders, agglutinated spatter, lapilli, coarse ash, and interlayered, thin lava flows. Cone is a complex of eight nested cones that indicate a complicated eruptive history. Flanks of cone are mantled by fine tephra. Cone is 140 m high and 1.5 km in diameter. Cone is known source vent for Sunset flow (fg1), including flow to northwest of Sunset flow and the probable source vent for the Carey flow (fg2). Sunset flow vented from northeast base of cone; flow northwest of Sunset Cone vented from obscure, tephra-covered vents. Vent to southeast of Sunset Cone is a low lava cone covered by black lapilli from Sunset Cone

fg3 — **Lava Creek a'a and pahoehoe basalt flows (latest Pleistocene)**—Chiefly surface- and channel-fed, dark-gray (N3), blocky a'a basalt flows. Unit also includes lesser amounts of thin, spattery, pahoehoe basalt flows near vents. The narrow section of main flow, at base of steep slopes east of Black Cap, has long, deep, leveed channels. Squeeze-outs having filamented, glassy crusts are common along flow margins. Large exposure to east consists of two distinct lobes; the southern lobe overlaps the northern lobe. Both lobes contain flow ridges that are perpendicular to and convex toward the direction of flow movement. Flow ridges have wavelengths as large as 100 m and amplitudes up to 5 m. Lobes also contain longitudinal furrows and cracks that are roughly parallel to direction of flow movement. Vents are small cones and craters (cg2) alined along an extension of the Great Rift volcanic rift zone in the Pioneer Mountains. Vent areas are mantled by lapilli, blocks of pahoehoe, and thin flows. The oldest of two radiocarbon analyses of pretreated samples of carbon-bearing material from sediment buried by flows is 12,760±150 years. Rock is hypocrystalline, partly diktytaxitic, and microporphyritic to porphyritic. In porphyritic rocks, single euhedral crystals and clots of several crystals of olivine (about Fa_{40-45}), euhedral laths of plagioclase (An_{45-55}), and an equant, partly skeletal opaque mineral are all 0.2–1.2 mm in longest dimension. The matrix is typically a granular aggregate of olivine, an equant opaque mineral, a feathery to bladed, opaque mineral, and rare blades of clinopyroxene, all less than 0.1 mm, and plagioclase laths that are 0.1–0.2 mm, and opaque-charged, brown glass. Inclusions of dacitic volcanic rocks are common in hand specimens and thin sections

cg2 — **Lava Creek basaltic cinder cones (latest Pleistocene)**—Chiefly black cinders, agglutinated spatter, bombs, lapilli, coarse ash, and interlayered, thin lava flows. The surfaces of cones are locally mantled by red and brown cinders and ash. Some bombs have cores of felsic volcanic rocks. Southernmost, largest cone (Black Cap) was source vent for main flow that extends north into valley of Dry Fork Creek. A small crater that lacks an associated flow is 1 km northwest of Black Cap cinder cone

Lava flows and related cinder-cone deposits of eruptive-period H

fh1 — **Kimama pahoehoe basalt flow (latest Pleistocene)**—Surface-fed, medium-dark-gray (N4), hummocky, pahoehoe basalt flow. Flow is covered by thin, discontinuous mantle of loess and eolian sand. Only distal part of flow exposed. Source vent is unknown. The oldest of two radiocarbon ages from pretreated samples of carbon-bearing material from sediment buried by flow is 15,100±160 years. Rock is hypocrystalline, diktytaxitic, and microporphyritic. Microphenocrysts are rare euhedral crystals of olivine (about Fa_{45}) and an equant, skeletal opaque mineral that are both as much as 1 mm in longest dimension. The microphenocrysts are set in a matrix of plagioclase (An_{45-55}) laths, olivine granules, blades of clinopyroxene, and an equant opaque mineral, all less than 0.2 mm, and brown glass charged with a feathery to bladed opaque mineral and an equant opaque mineral

fh2 — **Bear Den Lake pahoehoe basalt flows (latest Pleistocene)**—Surface-fed, medium-dark-gray (N4), pahoehoe basalt flows. Flows are covered by a thin, discontinuous mantle of loess and eolian sand. Flows occur as two main exposures and nearby isolated patches that are surrounded by younger flows. All exposures are correlated with one another by similarity in field and petrographic characteristics. Source vent is unknown. Rock is hypocrystalline and porphyritic to aphyric. Porphyritic varieties contain euhedral single crystals of olivine (about Fa_{45}), clots of several crystals of olivine, an equant opaque mineral, and laths of plagioclase (An_{45-55}), each as long as 1 mm. The phenocrysts are set in a matrix of these same minerals plus ophitic, light-brown clinopyroxene, blades and bundles of clinopyroxene, an equant opaque mineral, all less than 0.2 mm, plus opaque-charged, brown glass

fh3 — **Baseline pahoehoe basalt flows (latest Pleistocene)**—Surface- and tube(?)-fed, medium-dark-gray (N4), hummocky, pahoehoe basalt flows. Both exposures are covered by a thin, discontinuous mantle of loess and eolian sand. Source vent is unknown. Rock is hypocrystalline, partly diktytaxitic, and porphyritic containing phenocrysts of euhedral, partly skeletal olivine (about Fa_{50}) and an equant, skeletal opaque mineral that are both 0.2–1.0 mm in longest dimension. The phenocrysts are set in a matrix of the same minerals plus plagioclase (about An_{40}) laths, granules and blades of clinopyroxene, an acicular to bladed opaque mineral, all <0.2 mm, plus opaque-charged, brown glass

fh4 — **Little Prairie pahoehoe and a'a basalt flows (latest Pleistocene)**—Surface- and tube-fed, medium-dark-gray (N4) pahoehoe basalt flows. Flows are covered by low shrubs and grass. Unit is mantled by a thin blanket of tephra on its western margin and by fine tephra and loess on eastern margin. Eastern and southern margin of unit represent older a'a lobes of main unit. Source vent is unknown. Rock is hypocrystalline, diktytaxitic, intergranular and aphyric. Consists of skeletal, euhedral olivine (about Fa_{50}), plagioclase (about An_{40}) laths, intergranular blades and patches of clinopyroxene, an equant opaque mineral, and an acicular to bladed opaque mineral, all <0.4 mm, and opaque-charged, brown glass

fh5 — **No name pahoehoe basalt flow (latest Pleistocene)**—Surface- and tube-fed, medium-dark-gray (N4), pahoehoe basalt flow. Flow is covered by a thin, discontinuous mantle of loess and eolian sand. Unit is possibly correlative with Little Prairie flow (fh4) on the basis of similarities in rock type, paleomagnetic data, and distribution of units with respect to the Great Rift. Source vent is unknown. Unit not studied petrographically

fh6 — **Lost Kipuka pahoehoe basalt flow (latest Pleistocene)**—Surface-fed, medium-dark-gray (N4) pahoehoe basalt flow. Flow is covered by low shrubs and grass and a thin discontinuous mantle of loess and eolian sand. Unit is possibly correlative with Little Prairie flow (fh4) on the basis of similarities in rock types, paleomagnetic data, and distribution of units with respect to the Great Rift. Source vent is unknown. Rock is hypocrystalline, intergranular, diktytaxitic, and aphyric. Consists of euhedral, mostly equant crystals of olivine (about Fa_{50}), plagioclase (about An_{40}) laths, blades and subophitic patches of clinopyroxene, an acicular to feathery opaque mineral, and an equant, partly skeletal opaque mineral, all <0.4 mm, and opaque-charged, brown glass

fh7 — **Crescent Butte pahoehoe basalt flow (latest Pleistocene)**—Small, surface-fed, medium-dark-gray (N4), pahoehoe basalt flow that vented from crater in Crescent Butte cinder cone (ch1). Flow is vegetated and thinly mantled by colluvium. Unit not studied petrographically

ch1 — **Crescent Butte basaltic cinder cone (latest Pleistocene)**—Black, brown, and red cinders, agglutinated spatter, lapilli, coarse ash, and interlayered, thin lava flows. Cone has a single crater. Western flank of cone is mantled by tephra from Trench Mortar Flat eruptive fissures (ea2). Cone is 120 m high and 1 km in diameter. Cone is source vent for the Crescent Butte flow (fh7)

fh8 — **Brown flow basalt pahoehoe flow (latest Pleistocene)**—Surface- and tube(?)-fed, medium-dark-gray (N4) pahoehoe basalt flow. Exposed as distal parts of a larger flow that is covered by Rangefire (fb6) and Minidoka (fb4) flows. Flow is cut by many noneruptive fissures. Flow not studied petrographically

CINDER CONES OF THE CRATERS OF THE MOON LAVA FIELD

c — **Basaltic cinder cones (Holocene and latest Pleistocene)**—A group of cinder cones that have no identifiable, associated lava flows. Cones of unit consist of black, brown, and red cinders, agglutinated spatter, lapilli, and coarse ash. Age of cones encompasses nearly the entire time span of the Craters of the Moon lava field. Unit includes Paisley Cone, Inferno Cone, Half Cone, Echo Crater, Split Butte, and other unnamed cinder cones

LAVA FLOWS AND RELATED CINDER CONE AND ERUPTIVE FISSURE DEPOSITS OF THE SNAKE RIVER GROUP

fsr — **Pahoehoe and a'a basalt flows, near-vent tephra deposits, cinder cones, lava cones, and shield volcanoes (Pleistocene)**—Typically brownish-gray (NYR4/1) to dark-gray (N3), slightly weathered pahoehoe and a'a basalt flows. Unit locally covered by discontinuous deposits of loess and eolian sand (unmapped). Individual flows and flow units are mapped but not distinguished from one another by separate colors in order to emphasize the individual flows of the Craters of the Moon, Kings Bowl, and Wapi lava fields. Rock is typically hypocrystalline, diktytaxitic, and porphyritic to aphyric. Crystals of olivine and plagioclase are typically as large as 1–2 mm. Plagioclase, olivine, clinopyroxene, an equant opaque mineral, and a bladed opaque mineral constitute the matrix and have a size range of 0.1–1.0 mm. Brown glass is charged with tiny crystals of opaque minerals

esr — **Eruptive-fissure deposits of the Snake River Group (Pleistocene)**—Eruptive fissures and associated spatter ramparts, cinder mounds, and tephra mantled furrows. Deposits masked by tephra and thin (<1 m) sheets and patches of eolian sand

BEDROCK

pQr — **Bedrock, undivided (pre-Quaternary)**—Unit includes sedimentary, volcanic, and plutonic rocks of mountains north of the Snake River Plain. Unit ranges in age from middle Tertiary to Paleozoic. See Skipp and Hait (1977) for a more detailed map and description of bedrock units in area of this map

[1]Because all map units except unit pQr are Quaternary, the letter "Q" has been omitted from their symbols

MAP SYMBOLS

Contact—Dashed where approximately located, particularly between lava flows that are veneered by thin deposits of eolian sand and loess. Letters Y and O denote younger and older flows along contact. Dash-dot contact separates flows erupted from the same vent
Flow line—Linear flow features and lava tubes; arrow shows flow direction. Open circles on flow lines are locations of skylights in lava tubes
Lava channel—Arrow shows direction of flow within lava channel
Crater—Outline of crater rim on volcanic vent, barbs point toward central depression. Barbs not shown on smaller craters
Small cone—Small lava cone, cinder cone, or spatter cone
Rootless vent—Secondary source of lava not directly related to conduit to deep magma reservoir; most are openings in lava tubes
Lava pond—Basalt-filled depression surrounded by levees, shown by hachured line
Nonerruptive fissures—Fractures in rock through which lava has not erupted. Width generally less than 1 m
Fault—Ball and bar on downthrown side
W-4385 **Sample locality**—Charcoal or carbon-bearing sediment sample locality for radiocarbon analysis. Number or name refers to laboratory number

CORRELATION OF MAP UNITS

ERUPTIVE PERIOD	RADIOCARBON AGE[1]	FLOW NAME	LAVA FLOWS	CINDER CONES	CONE NAME	ERUPTIVE-FISSURE DEPOSITS	ALLUVIUM	BEDROCK	
A	n.d.	Broken Top	fa1	ca1	Broken Top		al		HOLOCENE
	2076±45	Blue Dragon	fa2	ca2	Big Craters	ea1			
	2205±25	Trench Mortar Flat	fa3	ca3	The Watchman	ea2			
	n.d.	North Crater	fa4	ca4	North Crater				
	2400±300	Big Craters	fa5			ea3			
	2222±100	Kings Bowl (fa6)	fa6			ea4			
	2270±50	Wapi (fa7)	fa7						
	n.d.	Serrate (fa8)	fa8						
	n.d.	Devils Orchard (fa9)	fa9						
	n.d.	Highway (fa10)	fa10 (Age relations among units unknown)						
B	n.d.	Vermillion Chasm	fb1			eb1			
	4300±60	Deadhorse	fb2			eb2			
	3660±60[2]	Devils Cauldron	fb3						
	3590±70[2]	Minidoka	fb4						
	n.d.	Larkspur Park	fb5						
	4510±100	Rangefire	fb6						
	n.d.	Black Top Butte	fb7	cb1	Black Top Butte				
C	n.d.	Indian Wells North	fc1						
	n.d.	Indian Wells South	fc2						
	6020±160	Sawtooth (fc3)	fc3	cc1	Big Cinder Butte				
	n.d.	Big Cinder Butte northwest (fc4)	fc4						
	n.d.	South Echo	fc5			ec1			
	n.d.	Sheep Trail Butte	fc6	cc2	Sheep Trail Butte				
	n.d.	Fissure Butte	fc7	c, cc3	Fissure Butte	ec2	al		
	n.d.	The Sentinel	fc8	cc4	The Sentinel				
D	n.d.	Silent Cone	fd1	cd1	Silent				
	6600±60	Carey Kipuka	fd2						
	6500±60	Little Park	fd3						
	n.d.	Little Laidlaw Park	fd4						
E	7360±60	Grassy	fe1	ce1	Grassy				
	7470±80	Laidlaw Lake	fe2						
	7840±140	Lava Point	fe3						
F	10,240±120	Pronghorn	ff1						
	11,000±100	Heifer Reservoir	ff2						
	10,670±150	Bottleneck Lake	ff3						PLEISTOCENE
G	12,010±150	Sunset (fg1)	fg1	cg1	Sunset				
		Carey (fg2)	fg2						
	12,760±150	Lava Creek	fg3	cg2	Lava Creek				
H	15,100±160	Kimama	fh1						
	n.d.	Bear Den Lake	fh2						
	n.d.	Baseline	fh3						
	n.d.	Little Prairie	fh4 (Age relations among all units in eruptive period H are unknown)						
	n.d.	No name	fh5						
	n.d.	Lost kipuka	fh6						
	n.d.	Crescent Butte	fh7	ch1	Crescent Butte				
	n.d.	Brown	fh8						
		Lava flows of the Snake River Group	fsr			esr			
								pQr	PRE-QUATERNARY

[1]See Kuntz, Spiker, and others (1986) for discussion and details of radiocarbon ages. n.d., not dated.
[2]Ages probably too young: See Kuntz, Spiker, and others (1986) for discussion.

Base from U.S. Geological Survey Arco, 1979; Craters of the Moon, 1978; and Lake Walcott, 1979
Contours on Arco and Lake Walcott as of 1987

APPROXIMATE MEAN DECLINATION, 1988

SCALE 1:100 000

CONTOUR INTERVALS 20 AND 50 METERS
NATIONAL GEODETIC VERTICAL DATUM OF 1929

Geology mapped in 1978–80

INTERIOR—GEOLOGICAL SURVEY, RESTON, VA 1988

GEOLOGIC MAP OF THE CRATERS OF THE MOON, KINGS BOWL, AND WAPI LAVA FIELDS, AND THE GREAT RIFT VOLCANIC RIFT ZONE, SOUTH-CENTRAL IDAHO

By
Mel A. Kuntz, Duane E. Champion, Richard H. Lefebvre, and
Harry R. Covington
1988

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