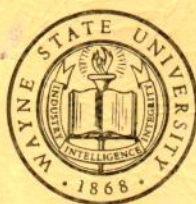


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STRUCTURES AND ORIGIN
OF
VOLCANIC ROCKS
Montana-Wyoming-Idaho



WAYNE STATE UNIVERSITY
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July 15 - August 3, 1965

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GUIDEBOOK

STRUCTURES AND ORIGIN OF VOLCANIC ROCKS

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River that ample water continued to be supplied to induce steam explosions throughout the duration of the eruption. For this reason, broad tuff cones have been developed rather than the more common cinder cones or lava cones elsewhere on the plains.

Buttes Between Idaho Falls and Arco

Three buttes in the lava fields between Arco and Idaho Falls form prominent land marks. Big Southern Butte, about five miles in diameter rises nearly 2500 feet above the Snake River Plains and lies 21 miles southeast of Arco. This butte is composed of basaltic and rhyolitic flows of different texture. The main mass is a light colored porphyritic rock with quartz phenocrysts. The material is glassy and pumaceous and apparently accumulated as explosion debris on the summit of a volcano. No crater is present today probably as the result of erosion. This butte is the remains of an eroded rhyolitic volcano or endogenous dome apparently older than the surrounding basalt flows.

The Twin Buttes rise above the lava plain 15 miles northeast of Big Southern Butte. They are four miles apart. The eastern Twin Butte, locally known as "East Butte," rises 1100 feet above the plain. It is light colored in strong contrast to the dark lava fields. It is composed of trachyte, pumice, and obsidian, dipping about 30° to the south. This butte probably has a similar origin to that of Southern Butte--that is, it is the remains of a volcanic vent or dome. West Twin Butte, or Middle Butte, rises nearly as high as the east twin. It is composed almost entirely of basalt, with a steep dip to the south. The most plausible theory to account for this tilted block of basalt rising above the general basalt field is that it belongs to the Pliocene period of rhyolitic and basaltic eruptions which are buried by the Pleistocene basalts (Stearns, et al., 1938).

Craters of the Moon National Monument

The youngest lavas on the Snake River Plain are exposed in Craters of the Moon National Monument. The flows and structures of the monument have been mapped in detail by Stearns (Stearns, Crandall and Steward, 1938; Stearns, 1963) and by John G. Murtaugh (unpublished master's thesis, University of Dayton, 1960).

^{Idaho 1961}
These Recent lava fields are striking features of the landscape and are of much interest to tourists. Their special value to the geologist is that they indicate the characteristics of the older similar rocks that underlie much of the Snake River Plain.

Almost all of the vents in the area are situated in a strip of land slightly less than two miles wide at the north and only one mile wide at the southern end. It extends southeastward from the foot of the mountains for a distance of about thirteen miles and is known as the Great Rift Zone.

It is studded with 55 cones that have given rise to lava flows by fourteen fissures and numerous spatter cones (Stearns, Crandall, and Steward, 1938). The fissure zone dies out in several gaping cracks, although about five miles southeast and outside of the monument is a large black cinder cone which may belong to the Great Rift Zone.

Within the rift zone are twenty-seven distinct cinder cones and many remnants of older partly buried cones. These rise from 50 to 600 feet high with one, Big Cinder Butte, rising to 800 feet above the adjacent lava flows. Most of these cones are asymmetrical, showing a pronounced elongation towards the northeast and suggesting the direction of prevailing winds.

Many of the characteristic features of basaltic shield volcanoes and plateaus are illustrated in the monument. These features are summarized in Table 12 (Wentworth and Macdonald, 1953). The various types of primary vents or cones may be seen not only within the monument but throughout the Snake River Plain, as previously described. The only type of rootless vent which is easy to identify here are the Hornitoes. Pahoehoe and aa types of lava are both represented, although perhaps the pahoehoe is slightly in abundance. There is every gradation between these two types.

Most of the cinder cones contain craters and many of them are breached on one side. Lava flows have come out from the breached side of the cinder cones or have issued from fissures without cinder cone development. In the latter case, small lava cones have been built up. Some of the cones are compound cinder-spatter cones because of the character of the fire fountains throwing large clots of lava which have landed as fluid bombs on the rim of the developing cone. The Big Craters easily visited from the main monument road are almost identical in size and shape to the cinder-spatter cones and craters developed in the 1960 Kapoho eruption of Kilauea Volcano.

Lava tunnels are common in the Monument, and several of these are open to the tourist. These represent the channel ways through which lava rivers feeding large pahoehoe flows coursed during the emplacement of the flows. As extrusion of lava ceased, lava drained out of these underground rivers, leaving the open tunnel. The floor of the tunnels represents the solidified top of lava that remained in the river. Lava stalactites may be seen hanging from the walls and ceilings of these tunnels.

Various types of bombs may be found in the park. Most common are spindle, ribbon, and breadcrust bombs. Spindle bombs are football-shaped with tapered projections formed when a clot of lava was thrown into the air. The ribbon bombs are the long ends of tapered projections of the spindle type. Breadcrust bombs are light-weight and more porous than the other types. These were formed from masses of lava containing much gas which crusted over in flight while the interior was still swelling with gas formation. As the interior continued to swell, the crust was fractured or checkered to give the breadcrust appearance. Fluid bombs, or spatter, are not as recognizable since such material has tended to weld together in the walls of the cinder-spatter cones. Occasionally, however, rounded,

flattened masses of such spatter look something like pancakes; these are occasionally found separate from underlying material. Such bombs are known as the Hawaiian type. Occasionally large pieces of very porous pumice or scoria have fallen as bombs but without any special crust or shape. These can be called pumice or scoria bombs respectively. In most volcanoes the vast number of clots of lava thrown into the air which fall as so-called bombs have no distinct shape or form and do not fit into any of the names discussed above. These might be called simply irregular-shaped bombs, and are typical of more viscous lavas.

Craters of the Moon basalt is an olivine basalt abnormally rich in magnetite. Feldspar occurs in microliths and small phenocrysts and ranges from calcic andesine to sodic labradorite. The groundmass is glassy and is rendered opaque by magnetite. The groundmass usually makes up at least 50% of the rock.

The age of the last flows at Craters of the Moon has recently been placed at about 1400 years based on the number of tree rings in an old tree growing on the youngest flow. Stearns, et al., (1938) believed that the flows were between 500 and 1000 years old as the tree rings had not been counted at that time. Apparently the flows are older than they appear.

HEBGEN LAKE EARTHQUAKE AREA

On August 17, 1959 at about 11:37 P.M., southwestern Montana was shaken by a major earthquake with a magnitude of 7.1. This quake was felt over an area of 600,000 square miles, being noted as far as 550 miles from the epicenter near Hebgen Lake. Several new fault scarps and many smaller ones were formed and a very large area was abruptly dropped and warped. The surficial mantle slumped and slid extensively. Many landslides were initiated as much as 25-30 miles away, in addition to the major landslide in the Madison Valley.

Features formed by the earthquake and its characteristics have been described by many writers in the Billings Geological Society Guidebook (1960), by Fisher (1960) and Witkind et al (1962 and 1964).

New fault scarps are as high as 20 feet. They are mostly in unconsolidated or weakly coherent material, but certainly reflect displacements of the underlying bedrock. Subsidence amount to as much as 22 feet in the lake basin, as proved by re-leveling of bench marks by the Coast and Geodetic Survey and by shoreline measurements around Hebgen Lake. Parts of the basin subsided differentially warping the lake bed. One shore is flooded, another shore has been elevated above water level.

A disastrous landslide was triggered by the earthquake in the canyon of the Madison River, six miles downstream from Hebgen Dam. 37,000,000 cubic yards of broken rock slid into the canyon, burying a mile of the river and highway to depths as great as 220 feet. At least 26 people in a campground were buried by the slide. Water ponded by the slide formed