Lava Tube Systems of Lava Beds National Monument

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Abstract

Nine major lava tube systems have their origin in, or pass through, Lava Beds National Monument. Six of the ten are in the Pleistocene Basalt of Mammoth Crater, two are in younger basalts, and one is in an apparently contemporaneous basalt. Some parts of four of the systems, those with popular caves, have been studied at some length. The nature of the other five is not well known because they are remote, not served by roads or trails, in areas that are vegetated by mountain mahogany, and extremely difficult to traverse. Only three monument-wide studies of the monument's lava tube systems exist, and they are cursory at best.

Overall Assessments

Only three overall assessments of lava tube systems inside Lava Beds national Monument exist. They are Lewis and Anderson (1936), Hatheway (1969), and Donnelly-Nolan (1987). Nolan's geologic map clearly shows most of the systems, identifying them as either lava tubes or lava tube caves. All three, while not detailed, roughly agree on the number of systems, about nine. Lewis and Anderson show about 12 or 13 possible systems, but it is important to note that their study was completed before high-resolution aerial photographs were available.

Six of the ten systems are in the Pleistocene Basalt of Mammoth Crater, one in the Holocene Basaltic Andesite of Valentine Cave, one in the Pleistocene Basalt of Caldwell Ice Caves, and one in the Pleistocene Basalt of the Castles. The largely tube-fed Mammoth Crater Basalt, which covers roughly two-thirds of the monument, and roughly an equal area outside it, was erupted from a series of vents along a now-buried southern extension of the Gillem Fault. It should be no surprise, therefore, that most of caves inside the monument are segments of lava tube systems formed within it.

The Mammoth Crater "distribution center," an area bounded by Bearpaw Butte on the north, Hippo Butte on the east, Mammoth Crater on the south, and the Callahan Lava Flow on the west, is complex. Waters (1990) contends that this area was a large lava lake, and that the lava tube systems assigned to Modoc Crater, Bearpaw Butte, and Bat. Butte had their source in this lake. Although this theory is at odds with that of Donnelly-Nolan and others, the existence of such a lake should not be dismissed. The Bat Butte and Bearpaw Butte systems could be branches of the Modoc Crater system, which could have originated in the lava lake (above). However, it is more likely they originated at their respective vents along the Gillem fault south of Fleener Chimneys.

In addition to the nine systems described here, there are several minor alignments of two or three caves each. Their volume and location indicate that they are probably branches of the major systems, but since the basalt of Mammoth Crater erupted from several different vents, the possibility that they could be systems in their own right cannot be discounted.

Detailed below are the nine major systems. The average slope length is based on the traverse length. A comparison of the map length and traverse length provides a very rough approximation of each system's sinuosity.

1. Modoc Crater System

Pleistocene Basalt of Mammoth Crater.
Map length: 41,400 feet, 7.8 miles.
Traverse length: 56,500 feet, 10.7 miles.
Average slope: 0.92 degrees.

Traceable from the east side of Bearpaw Butte to Fern Cave near the south shore of old Tule Lake,

the Modoc Crater System is the longest in the monument. It is extensively segmented and many of its segments were developed for tourists during the 1920s and 1930s. Only five of the individual caves are presently maintained for tourist use. About 15 others are abandoned as developed sites, and about two-thirds of those are within a wilderness area set aside in the 1970s.

The system is characterized by a mature, multilevel master tube ranging to 120 feet below the surface, most of which is now collapsed. Though there are no known branches of significance, it is likely that some exist in the five-mile-diameter delta at the distal end of the system. The master tube lies alongside the older Schonchin Butte lava flow for about six miles. Most of the open segments display considerable erosion down into unconsolidated pre-flow strata. Erosion is especially obvious in the lower level of Skull Cave. Several segments are glacieres, most notable of which are Merrill, Skull, and Frozen River caves.

Just southwest of Schonchin Butte there is a rare example of an eruption that rose through the path of an older lava tube. About one mile northeast of Bearpaw Butte, the system's master tube impinged against Schonchin Butte, then veered sharply eastward. Just up-tube from this bend, perched atop the lava tube like a monstrous hornito, stands one of the "Castles." The Castles are two prominent spatter vents on the southwest flank of Schonchin Butte – two of numerous other vents, mostly to the north, that erupted a high-alumina basalt through the Mammoth Crater Basalt (Nolan). There is a cave, consisting of a complex open vertical conduit, that is entered through this spatter vent (West Castle Cave), that has been mistaken for a lava tube. It is not part of the Modoc Crater System, and what effect the younger eruption had on remaining cavernous parts of the master tube, if any, is not known.

The Modoc Crater System and various sections of it are also known as: Bear Foot Rift, Bearpaw Butte System, Bearpaw-Merrill-Skull line of breakdowns, Bearpaw-Skull lava tube system, Bearpaw-Skull-Fossil system, Bearpaw-Skull line of breakdowns, Bearpaw-Skull line of lava tubes, Bearpaw-Skull System, Bearpaw Tubes, Cave Loop-Post Office Distributary Tube, Heppe-Modoc Lava Tube, Heppe-Modoc Lava Tube System, Heppe-Modoc System, Mammoth Bearpaw collapse trench, Mammoth Bearpaw lava-tube drainage system, Merrill Ice-Skull Cave lava tube, Merrill-Skull System, Merrill-Skull Trench, Merrill-Skull Trench System, Merrill Trench, Modoc Crater Tube, Modoc Lava Tube, Modoc System, and Skull Cave Rift.

2. Headquarters System

Pleistocene, Basalt of Mammoth Crater.
Map length: 26,600 feet, 5.04 miles.
Traverse length: 34,300 feet, 6.5 miles
(master tube only).
Average slope: 1.78 degrees
(master tube only, first quarter of a mile is steep).
(The above data are based on the assumption that Craig Cave is a segment of the system.)

Traceable from the north side of Mammoth Crater to (possibly) Craig Cave, the system is characterized by a mature master tube and prominent dendritic development in a mile-long section of overflows known as the Cave Loop area. Uncollapsed segments of the multilevel master tube range to 150 feet below the surface and, like the Modoc Crater System, part of the extraordinary depth resulted from erosion into unconsolidated pre-flow surfaces.

There are three major branches in Cave Loop area, and possibly a major branch about half a mile from the source at Mammoth Crater. Angleworm-Lost Pinnacle Cave and The Bowers (Cave), located about midway between the Indian Well campground and Skull Cave, appear to be segments of yet another branch of this system.

The Headquarters System and various sections of it are also known as: Big Rift, Blue Grotto System, Catacombs Lava Tube System, Catacombs Rift, Catacombs System, Cave Loop-Labyrinth System, Cave Loop Lava Rift, Cave Loop Line of Lava Tubes, Cave Loop-Post Office Trench, Cave Loop-Post Office Distributary Tube, Cave Loop Road Lava Tube System, Cave Loop-Sentinel System, Cave Loop System, Cave Loop to Post Office Series of Caves, Craig System, Headquarters Flow, Headquarters Flow System, Headquarters Lava Flow, Heppe-Cave Loop Road-Post Office-Craig System, Heppe-Catacombs Flow, Heppe-Modoc System, Heppe Rift – "three bridges in the Heppe Rift," Heppe System, Indian Well-Doc Yock System, Labyrinth Cave System, Labyrinth Caves System, Labyrinth Cave System Trench, Labyrinth Lava-Tube System, Labyrinth System, Lava tube system of the Cave Loop area, Mammoth Crater-Headquarters System, Mammoth Crater-Heppe

Trench, Mammoth Crater Lava Tube, Mammoth Crater-Post Office Cave line of breakdowns, Mammoth Crater System, Mammoth Crater Tube, Mammoth Crater Tube I, Mammoth Cave Lava Flow, Mammoth-Heppe System, Mammoth-Heppe-Natural Bridge Lava-Tube Cave System, Mammoth-Sentinel-Labyrinth System, Paradise Alleys-Catacombs Lava-Tube System, Paradise Alleys-Ovis System, Post Office Trench, and Post Office System.

3. Tickner-Valentine System

Holocene Basaltic Andesite of Valentine Cave.
Map length: 17,200 feet, 3.26 miles.
Traverse length: 18,480 feet, 3.5 miles.
Average slope: 2.23 degrees.

The system and various sections of it are also known as Tickner-Berthas System, Tickner Cave Tube, Valentine Cave Lava Flow, Valentine Cave Tube, Valentine Channel, Valentine Distributary, Valentine Flow, Valentine System, Valentine Trench, and West Valentine Distributary Trench.

The system formed in the Basaltic Andesite of Valentine Cave, branched to flow around both sides of Caldwell Butte, but does not include Caldwell Caves. Traceable from Tickner and Berthas Cupboard Caves, about a quarter of a mile south (outside) of the monument and about one mile east of Mammoth Crater, around the northwest side of Caldwell Butte to Valentine Cave where the flow spreads north and east. Tickner and Berthas Cupboard Caves, or parts of them, appear to be part of the vent structure – or rift tubes. There are several lava tube segments beyond Valentine, but none can be positively ascribed to this system.

4. Bearpaw Butte System

Pleistocene, Basalt of Mammoth Crater.
Map length: 7,400 feet, 1.4 miles.
Traverse length: 11,800 feet, 2.1 miles
(includes both branches).
Average slope: 1.7 degrees.

Traceable from the north flank of Bearpaw Butte north-northeast, for about 1.36 miles, where it is buried by the younger Basalt of the Castles, the system branches about one mile from Bearpaw Butte. Balcony and Boulevard caves are segments of the left, or northwest branch. The relatively small cross section of the latter caves suggests that this system did not continue far beyond the point where it is covered by Basalt of the Castles.

The system is also known as: Balcony-Boulevard System, Bearpaw Butte Tube, Bearpaw System, Castle Basalt System, East Bat Butte Trench, [System] North of Bearpaw Butte.

5. Caldwell System

Pleistocene Basalt of Caldwell Ice Caves.
Map length: 5,500 feet, 1.04 miles.
Traverse length: 6,300 feet, 1.2 miles.
Average slope: 2.9 degrees.

The Basalt of Caldwell Ice Caves cannot be distinguished from the Basalt of Mammoth Crater by hand specimen or remnant paleomagnetism, but differs chemically. The lava tube system is traceable from about a quarter of a mile outside the monument, south of Caldwell Butte, northeast about 1.2 miles to the main monument road, where it is buried by the Basalt of Valentine Cave. Although relatively voluminous at the point of burial, its host flow does not reappear from beneath the Basalt of Valentine Cave within the monument, suggesting that it could not extend much more than a mile.

Also known as Caldwell Ice Caves System, Caldwells Rift, Caldwell Trench, and Ice Caves Tube

6. Bat Butte System

Pleistocene Basalt of Mammoth Crater.
Map length: 15,300 feet, 2.9 miles.
Traverse length: 18,700 feet, 3.5 miles.
Average slope: 1.78 degrees.

This system is traceable from the vent area around and on the north side of Bat Butte to about one mile past Black Crater where its western side is overlain by Holocene basalt of the Devils Homestead flow. A half-mile-long section of the system south of Fleener Chimneys is marked only by some extraordinary tumuli. The distal part of the system has the appearance of being much older than others in the Mammoth Crater Basalt.

This system is also known as Bat Butte System, Fleener System, Fleener Trench, and "Rift North of Bear Foot," and is sometimes confused with the Fleener Trench, a major channel that developed in the younger Devils Homestead lava flow, adjacent to Fleener Chimneys.

7. Mammoth Crater II

Pleistocene Basalt of Mammoth Crater.
Map length: 1.5 miles.

Traverse length: 9,500 feet, 1.8 miles.
Average slope: 1.2 degrees.

First identified and named by Hatheway (1969), this system begins near the pit craters on the north flank of Mammoth Crater and trends northwest between Bearpaw Butte and Eagle Nest Butte. There are no named caves in this system.

8. Upper Ice System

Pleistocene Basalt of Mammoth Crater.
Map length: 4,500 feet, 0.8 miles.
Traverse length: 5,300 feet, 1.0 miles.
Average slope: 1.3 degrees.

Traceable for one mile, from the west flank of Mammoth Crater to south side of Eagle Nest Butte (Cinder Cone) where it is buried by the Callahan Flow, this alignment is mostly collapse trench and the only named cave is Upper Ice Cave.

9. Hardin Butte System

Pleistocene Basalt of the Castles.
Map length: approximately 0.5 miles.
Traverse length: approximately 0.5 miles.
Average slope: Unknown.

The Hardin Butte system apparently formed in Basalt of the Castles, South of Hardin Butte, in an area where the Castles Basalt intermittently covers the andesite of Schonchin Butte. Very little is known about this system. It was first identified by Hatheway in 1969. Donnely (1987) found only surface tubes in this flow. The possibility of a northern extension of this system is raised in the notes of J. D. Howard, an early cave explorer: "There are nine natural bridges northeast of 'Sand Butte,'" now known as Hardin Butte.

References

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