

Two theories thus have appeared which propose to account for the origin of lava tubes. The first of these, by Wentworth and MacDonald (1953) has been cited frequently in the past few years by several workers in lava tube research. The Wentworth-MacDonald theory is held by Hatheway (1971b) to constitute a valid explanation for formation of lava tubes less than about one kilometer in length. The theory calls for roofing by spatter and agglutination from lava flowing in open channels.

For the longer lava tubes, a compatible theory was developed by Ollier and Brown (1965) from basic observations of Nichols (1936). This concept has been modified to suit close field observations (Hatheway, 1971) and is herein proposed as a likely mode of formation for almost all lava tubes greater than about one kilometer in length.

The importance of a discussion of the two theories is that field observations of active basaltic eruptions, and those made on quiescent Holocene lava fields, suggest that the two theories are quite compatible; each explaining tube formation under a respective length criterion.

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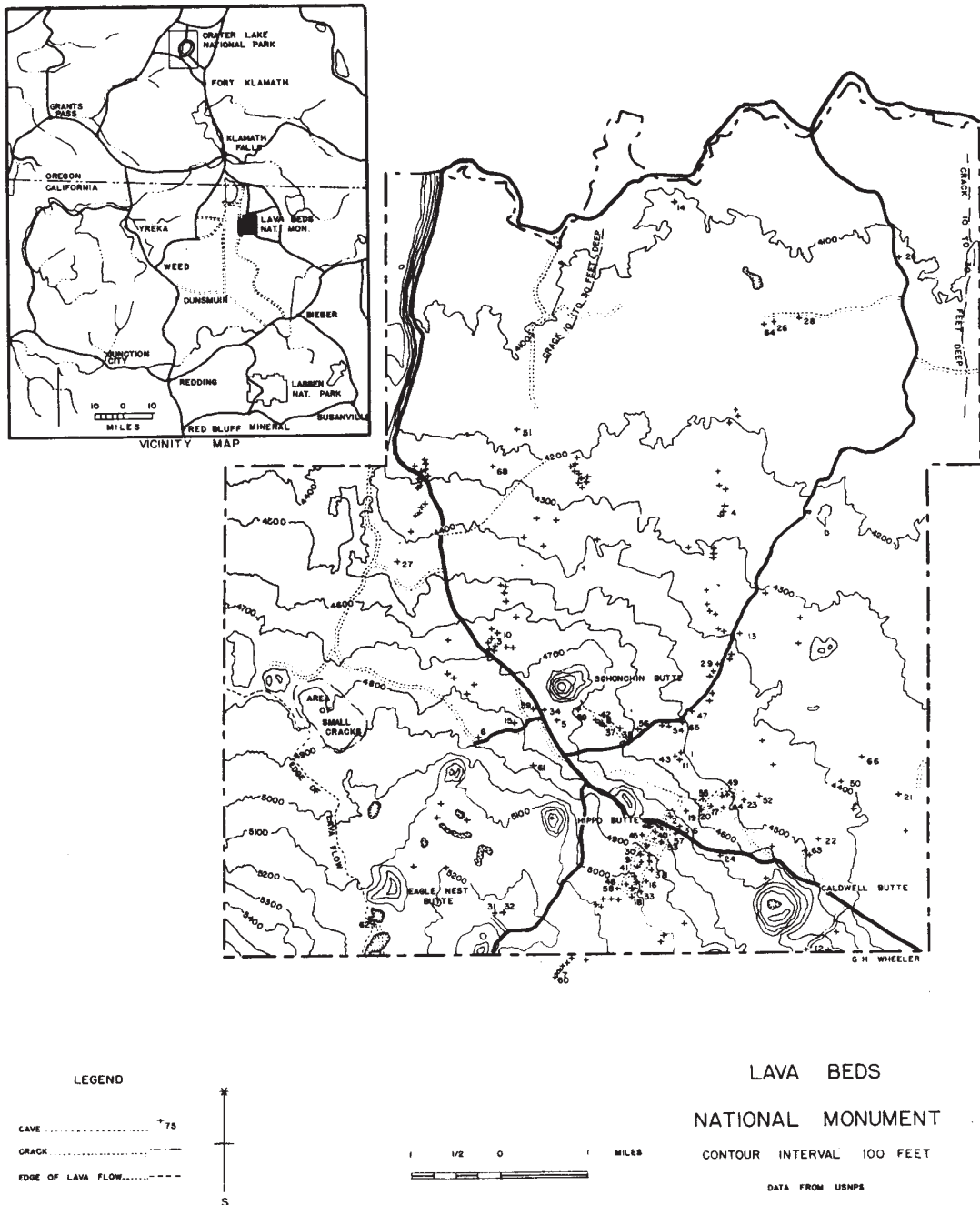
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GEOLOGY OF LAVA TUBES IN LAVA BEDS NATIONAL MONUMENT, CALIFORNIA

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READ IN ABSTRACT

Lava-tube systems in Lava Beds National Monument are among several that occur in young basalt flows which flank the Medicine Lake Highlands volcano. Mammoth Crater was the source for one tube system (including Heppe, Sentinel, and Dragonhead caves). This system includes both a major tributary and numerous distributary tubes. The large tributary (now collapsed) formed where lava ponded to one side of the main tube before draining it into subsurface. More typically the main channel fed numerous distributary conduits. Complexly branching distributary tubes at the monument headquarters are unusually well drained, evidently the result of a high gradient. The main channel in this area of high gradient (Crystal and Sentinel Caves) is narrow and deep and evidently carried a high rate of flow as suggested by evidence of high-velocity gas streaming above the lava river. Modoc Crater was the source of another lava large tube, whose uncollapsed segments include Bearpaw, Skull, Frozen River, Fossil, and Fern caves. This was a single channel throughout most of its 15-km length. Unusual features of this tube are a low gradient (less than 0.3° at the downstream end), and a series of collapsed blisters that form non-explosive craters with high outward-topped rims. Like the Mammoth Crater tube, this tube generally is deeper than wide, is multistoried, has a thick roof, and is enclosed in several flow units. These complexities, which are typical of large tubes, originated by such mechanisms as successive lava overflow and levee building before the roof completely formed, non-uniform accretion on the tube walls, and local erosion into underlying materials. Except for small features in the tube lining, most layering exposed by tube collapse is believed to represent superposed flow units and not shear layers within the flow.



Map of Lava Beds National Monument

Major caves of Lava Beds National Monument

1. Angleworm, 2. Arch, 3. Balcony, 4. Bat, 5. Beaconlight, 6. Bearpaw, 7. Berthas Cupboard, 8. Big Painted, 9. Blue Grotto, 10. Boulevard, 11. Bowers, 12. Caldwell Ice, 13. Captain Jacks Ice, 14. Captain Jacks, 15. Castle, 16. Catacombs, 17. Chest, 18. Compound Bridge, 19. Coopers, 20. Cox Ice, 21. Craig, 22. Crawfish, 23. Dragon Head, 24. Dynamite, 25. Fern, 26. Flat Arch, 27. Fleener Chimneys, 28. Fossil, 29. Frozen River, 30. Garden Bridge 31. Heppe, 32. Heppe Chimney, 33. Hercules Leg, 34. Igloo, 35. Incline Cavern, 36. Indian Well, 37. Irish Bridge, 38. Juniper, 39. Kirk White's, 40. Labyrinth no. 1, 41. Labyrinth no. 2, 42. Little Painted, 43. Lost Pinnacle, 44. Mahogany, 45. Maze, 46. Mushpot, 47. North Bend, 48. Ovis Bridge, 49. Post Office, 50. Rock, 51. Ross Chimneys, 52. Schonchin, 53. Sentinel, 54. Ship Cavern, 55. Silver, 56. Skull, 57. Stinking, 58. Sunshine, 59. Symbol Bridge, 60. Tecnor, 61. Trapper, 62. Upper Ice, 63. Valentine, 64. Wedding Cake, 65. White Lace, 66. Wild Cat, 67. Winemas Chimneys, 68. Wright Chimneys.