

## Map Unit Properties Table: Lava Beds National Monument

Geologic mapping by Donnelly-Nolan and Champion (1987), as modified by Donnelly-Nolan (2010), delineated these 43 map units in Lava Beds National Monument. A full list and description of units of Medicine Lake volcano is on the attached CD (see labe\_geology.pdf). That document also includes a link to the Correlation of Map Units figure from Donnelly-Nolan (2010). Bold text indicates report sections.

Age	Map Unit (symbol)	Geologic Description	Geologic Features and Processes	Geologic Resource Management Issues	Geologic History
HOLOCENE	Basaltic andesite of Callahan Flow (Hmcf)	Compositionally variable (51.8%–57.8% silica [SiO <sub>2</sub> ]; average [avg.] of 40 [samples] = 55.1%), blocky lava flow consisting of basalt, basaltic andesite, and andesite. Estimated area: 24 km <sup>2</sup> (9 mi <sup>2</sup> ). Estimated volume: 0.33 km <sup>3</sup> (0.08 mi <sup>3</sup> ).	<b>Volcanic Features</b> —youngest lava flow in Lava Beds National Monument. Erupted from Cinder Butte and adjacent smaller vents 7 km (4 mi) from northern terminus of flow. <b>Paleontological Resources</b> —contains tree molds.	<b>Volcano Hazards</b> —the most likely future eruption at Medicine Lake volcano would be a small effusive eruption of basaltic lava, which could occur anywhere on the volcano. Tephra emitted during a silicic eruption (near the summit) could affect Lava Beds National Monument.	<b>Medicine Lake Volcano History</b> —eruptive stage 5 (approximately 13,000 years ago to present).  Calibrated radiocarbon age: 1,120 years before present (BP).
	Basalt of Black Crater and Ross Chimneys (Hbbr)	Basalt (48.3%–50.6% SiO <sub>2</sub> ; avg. of 21 = 49.5%). Estimated area: 0.45 km <sup>2</sup> (0.17 mi <sup>2</sup> ). Estimated volume: 0.001 km <sup>3</sup> (0.0002 mi <sup>3</sup> ).	<b>Volcanic Features</b> —erupted from numerous north–northeast-oriented spatter cones that form an echelon linear arrays. Black Crater and Ross Chimneys mark vents. <b>Tectonic Features</b> —open ground cracks, which have the same orientation as vents, extend north toward Lava Beds National Monument boundary and may have opened during this eruption. <b>Paleontological Resources</b> —contains tree molds.	<b>Recreational Impacts to Geologic Features</b> —Black Crater and Ross Chimneys are popular visitor attractions and very susceptible to recreational impacts. <b>Volcano Hazards</b> —the most likely future eruption at Medicine Lake volcano would be a small effusive eruption of basaltic lava, which could occur anywhere on the volcano. Tephra emitted during a silicic eruption (near the summit) could affect Lava Beds National Monument.	<b>Medicine Lake Volcano History</b> —eruptive stage 5 (approximately 13,000 years ago to present).  Calibrated radiocarbon age: 3,080 years BP.
HOLOCENE AND PLEISTOCENE	Lake deposits (HPEI)	Fine-grained, water-laid sediments in low, flat areas scattered around Medicine Lake volcano.	<b>Paleontological Resources</b> —includes diatoms, pollen, and ostracodes that inhabited Tule Lake basin over the past 3 million years. <b>Lake Deposits</b> —include deposits from ancient Tule Lake, Tule Lake, and around Medicine Lake in the caldera.	<b>Volcano Hazards</b> —phreatomagmatic eruptions possible if vent were to open under Medicine Lake in the caldera.	<b>Medicine Lake Volcano History</b> —coincides with eruptive stage 5, although history of Tule Lake (and its predecessors?) extends back 3 million years.
LATE PLEISTOCENE	Basalt of Valentine Cave (PEbvc)	Basalt and basaltic andesite (52.9%, 52.9%, 53.4% SiO <sub>2</sub> ; avg. of 3 = 53.0%). Estimated area: 20 km <sup>2</sup> (8 mi <sup>2</sup> ). Estimated volume: 0.2 km <sup>3</sup> (0.05 mi <sup>3</sup> ).	<b>Volcanic Features</b> —lava flow erupted from northwest-oriented linear array of spatter cones at 1,650–1,700 m (5,400–5,600 ft) elevation on northern flank of Medicine Lake volcano, just south of Lava Beds National Monument. Nearly all of the lava was erupted from vents known as Tickner Chimneys, but separate vents uphill and to the southeast produced a very small lava flow. <b>Lava Tubes</b> —contains a lava-tube system. Main flow contains several caves, including Valentine Cave. These are the youngest caves in the monument. <b>Paleontological Resources</b> —contains tree molds. <b>Glacial Outwash</b> —overlies glacial outwash formerly exposed in quarry east of paved monument road, about 0.5 km (0.3 mi) east of Caldwell Butte.	<b>Cave Management</b> —contains much-visited Valentine Cave. <b>Rockfall and Roof Collapse</b> —the monument road traverses parts of PEbvc. Steep slopes prone to rockfall. Rockfall debris may accumulate on road and be a hazard to travelers. PEbvc contains caves. Cave roofs and entrances are prone to collapse. Infrastructure built over caves is susceptible to collapse into the opening below. <b>Volcano Hazards</b> —the most likely future eruption at Medicine Lake volcano would be a small effusive eruption of basaltic lava, which could occur anywhere on the volcano. Tephra emitted during a silicic eruption (near the summit) could affect Lava Beds National Monument.	<b>Medicine Lake Volcano History</b> —eruptive stage 5 (approximately 13,000 years ago to present).  Calibrated radiocarbon age: 12,260 years BP.  <b>Glacial History</b> —early postglacial flow (i.e., erupted soon after ice-age glaciers retreated from the area).

Geologic mapping by Donnelly-Nolan and Champion (1987), as modified by Donnelly-Nolan (2010), delineated these 43 map units in Lava Beds National Monument. A full list and description of units of Medicine Lake volcano is on the attached CD (see labe\_geology.pdf). That document also includes a link to the Correlation of Map Units figure from Donnelly-Nolan (2010). Bold text indicates report sections.

Age	Map Unit (symbol)	Geologic Description	Geologic Features and Processes	Geologic Resource Management Issues	Geologic History
LATE PLEISTOCENE	Basalt of Devils Homestead (PEbdh)	Basalt (51.3%, 51.4% SiO <sub>2</sub> ). Estimated area: 4 km <sup>2</sup> (2 mi <sup>2</sup> ). Estimated volume: 0.04 km <sup>3</sup> (0.01 mi <sup>3</sup> ).	<p><b>Volcanic Features</b>—lava flow erupted from spatter vents known as Fleener Chimneys. Aa lava makes up rugged Devils Homestead lava flow, although much of the lava near the vent is pahoehoe.</p> <p><b>Tectonic Features</b>—vents, located at bend along predominantly north-south-oriented Gillem fault, are aligned approximately N20°–25°E.</p>	<p><b>Recreational Impacts to Geologic Features</b>—Fleener Chimneys is a popular visitor attraction and very susceptible to recreational impacts.</p> <p><b>Rockfall and Roof Collapse</b>—the monument road traverses parts of PEbdh. Steep slopes prone to rockfall. Rockfall debris may accumulate on road and be a hazard to travelers.</p> <p><b>Volcano Hazards</b>—the most likely future eruption at Medicine Lake volcano would be a small effusive eruption of basaltic lava, which could occur anywhere on the volcano. Tephra emitted during a silicic eruption (near the summit) could affect Lava Beds National Monument.</p>	<p><b>Medicine Lake Volcano History</b>—eruptive stage 5 (approximately 13,000 years ago to present).</p> <p>Calibrated radiocarbon age: 12,320 years BP.</p> <p>Age is interpreted as postglacial on the basis of paleomagnetic data and morphologic comparison with other lava flows.</p>
PLEISTOCENE	Gravel (PEg)	Includes boulders as much as 1 m (3 ft) across, but dominant size range is pebbles to small cobbles. Deposited in widely scattered areas on middle to lower flanks of Medicine Lake volcano.	<p><b>Volcanic Features</b>—white pebbles in glacial outwash gravel are pumice that is compositionally identical to the rhyolite of Mount Hoffman (PERmh) outside Lava Beds National Monument.</p> <p><b>Glacial Outwash</b>—only two exposures of PEg occur in the monument.</p>	<p><b>Abandoned Mineral Lands</b>—cinders and gravel extracted from Closed Dump Pit.</p>	<p><b>Glacial History</b>—consists primarily of glacial outwash gravel associated with deglaciation, as well as gravels deposited by a flood that was generated when the dacite tuff of Antelope Well (PEdta; see GRI data on attached CD) erupted onto summit ice cap about 180,000 years ago.</p>
LATE PLEISTOCENE	Basalt of Gold Digger Pass (PEbgd)	Basalt (49.6%–50.7% SiO <sub>2</sub> ; avg. of 8 = 50.4%) on lower northern flank of Medicine Lake volcano. Exposed flow length is approximately 11 km (7 mi).	<p><b>Volcanic Features</b>—flow has youthful, well-preserved morphology similar to the (underlying) basalt of Mammoth Crater (PEbmc). Vent area presumably buried by Callahan Flow (PEmcf) to the south.</p> <p><b>Tectonic Features</b>—broken by northwest- and northeast-oriented faults.</p>	<p><b>Volcano Hazards</b>—the most likely future eruption at Medicine Lake volcano would be a small effusive eruption of basaltic lava, which could occur anywhere on the volcano. Tephra emitted during a silicic eruption (near the summit) could affect Lava Beds National Monument.</p>	<p><b>Medicine Lake Volcano History</b>—eruptive stage 4 (approximately 100,000–13,000 years ago).</p>
	Basalt of The Castles (PEbc)	Basalt (48.6% SiO <sub>2</sub> ). Estimated area: 6.5 km <sup>2</sup> (2.5 mi <sup>2</sup> ), including one small 1.4-km (0.9-mi) × 0.3-km (0.2-mi) area on the eastern side of Schonchin Flow. Estimated volume: less than 0.05 km <sup>3</sup> (0.02 mi <sup>3</sup> ).	<p><b>Volcanic Features</b>—lava extruded from many tens of spatter cones, including The Castles near western base of Schonchin Butte. One major vent is the lava lake west of Semi Crater (PEmsc). PEbc is mostly located west of Schonchin Flow, but one area is located at its northeastern edge.</p> <p><b>Lava Tubes</b>—contains a lava-tube system. Small surface tubes are common, but development of major lava tubes did not occur.</p> <p><b>Tectonic Features</b>—most vents are aligned north-northeast, but some are oriented north-northwest to northwest.</p>	<p><b>Cave Management</b>—contains small caves close to the surface.</p> <p><b>Rockfall and Roof Collapse</b>—the monument road traverses parts of PEbc. Steep slopes prone to rockfall. Rockfall debris may accumulate on road and be a hazard to travelers. PEbc contains caves. Cave roofs and entrances are prone to collapse. Infrastructure built over caves is susceptible to collapse into the opening below.</p> <p><b>Volcano Hazards</b>—the most likely future eruption at Medicine Lake volcano would be a small effusive eruption of basaltic lava, which could occur anywhere on the volcano. Tephra emitted during a silicic eruption (near the summit) could affect Lava Beds National Monument.</p>	<p><b>Medicine Lake Volcano History</b>—eruptive stage 4 (approximately 100,000–13,000 years ago).</p> <p>Degree of spatter-vent breakdown indicates PEbc is not of Holocene age.</p>

Geologic mapping by Donnelly-Nolan and Champion (1987), as modified by Donnelly-Nolan (2010), delineated these 43 map units in Lava Beds National Monument. A full list and description of units of Medicine Lake volcano is on the attached CD (see labe\_geology.pdf). That document also includes a link to the Correlation of Map Units figure from Donnelly-Nolan (2010). Bold text indicates report sections.

Age	Map Unit (symbol)	Geologic Description	Geologic Features and Processes	Geologic Resource Management Issues	Geologic History
LATE PLEISTOCENE	Basalt of Mammoth Crater (PEbmc)	Compositionally variable (48.4%–55.9% SiO <sub>2</sub> ; avg. of 45 = 52.3%) basalt and basaltic andesite; predominantly basalt. Can sometimes be distinguished by reddish patina.	<p><b>Volcanic Features</b>—consists of widespread lava flow, covering 70% of Lava Beds National Monument. Fed by lava tubes as far as 25 km (16 mi) from vent area. Vents include Mammoth Crater, Modoc Crater, and Bat Butte, as well as a spatter rampart on the northern side of Bearpaw Butte and other north- and northwest-aligned pit craters and spatter vents.</p> <p><b>Lava Tubes</b>—contains six lava-tube systems and the majority of caves in the monument.</p> <p><b>Tectonic Features</b>—cut by numerous north–northwest- to north–northeast-oriented faults, including open ground cracks.</p> <p><b>Paleontological Resources</b>—Pleistocene mammal fossils in caves; for example Ovis Cave is known for extirpated bighorn sheep remains.</p> <p><b>Lake Deposits</b>—at its northeastern edge, <b>PEbmc</b> entered ancient Tule Lake and formed pillow lavas and littoral cones of Hospital Rock.</p> <p><b>Glacial Outwash</b>—overlies <b>PEg</b>.</p> <p><b>Geologic Features with Cultural Significance</b>—Captain Jacks Stronghold, Gillems Camp, and Hospital Rock. Modoc used water available in Captain Jacks Ice Cave and Frozen River Cave, which occur in <b>PEbmc</b>.</p>	<p><b>Cave Management</b>—contains all caves along Cave Loop, and all visitor-use caves except Valentine Cave.</p> <p><b>Recreational Impacts to Geologic Features</b>—contains distinctive and often-visited landmarks, such as Captain Jacks Stronghold.</p> <p><b>Abandoned Mineral Lands</b>—contains numerous abandoned mineral land sites: volcanic clasts and soil quarried from West Lyons and East Lyons road pits; cinders and pumice quarried from Sump Pump, Old Shoreline, Brass Cap, and Hospital Rock pits. [Dump] site 14 of Ziegenbein et al. (2006) occurs in <b>PEbmc</b>.</p> <p><b>Rockfall and Roof Collapse</b>—the monument road traverses parts of <b>PEbmc</b>. Steep slopes prone to rockfall. Rockfall debris may accumulate on road and be a hazard to travelers. <b>PEbmc</b> contains caves. Cave roofs and entrances are prone to collapse. Infrastructure built over caves is susceptible to collapse into the opening below.</p> <p><b>Volcano Hazards</b>—the most likely future eruption at Medicine Lake volcano would be a small effusive eruption of basaltic lava, which could occur anywhere on the volcano. Tephra emitted during a silicic eruption (near the summit) could affect Lava Beds National Monument.</p>	<p><b>Medicine Lake Volcano History</b>—eruptive stage 4 (approximately 100,000–13,000 years ago).</p> <p>Argon-40/argon-39 (<sup>40</sup>Ar/<sup>39</sup>Ar) age: 36,000 ± 16,000 years.</p>
	Andesite of Indian Butte (PEaib)	Andesite and basaltic andesite (56.1%–59.5% SiO <sub>2</sub> ; avg. of 11 = 57.6%). Covers significant area on upper northeastern flank of Medicine Lake volcano.	<p><b>Volcanic Features</b>—erupted from Indian Butte, the adjacent cinder cone to the west, and additional cones farther north-northwest.</p>	<p><b>Volcano Hazards</b>—the most likely future eruption at Medicine Lake volcano would be a small effusive eruption of basaltic lava, which could occur anywhere on the volcano. Tephra emitted during a silicic eruption (near the summit) could affect Lava Beds National Monument.</p>	<p><b>Medicine Lake Volcano History</b>—eruptive stage 4 (approximately 100,000–13,000 years ago).</p> <p><sup>40</sup>Ar/<sup>39</sup>Ar age: 22,000 ± 13,000 years.</p>
	Basalt of Caldwell Ice Caves (PEbci)	Basalt (52.8% SiO <sub>2</sub> ). Not distinguished from <b>PEbmc</b> in hand specimen, but lacks the reddish surface patina. Chemically distinguished from <b>PEbmc</b> by lower magnesium oxide and higher titanium dioxide contents.	<p><b>Lava Tubes</b>—contains a lava-tube system. Tube and flow directions indicate buried vent(s) to southwest. Contains the mostly collapsed lava tube of Caldwell Ice Caves near the southeastern corner of Lava Beds National Monument. These are the oldest caves in the monument.</p> <p><b>Geologic Features with Cultural Significance</b>—Modoc used water available in Caldwell Ice Caves.</p>	<p><b>Cave Management</b>—contains Caldwell Ice Caves.</p> <p><b>Rockfall and Roof Collapse</b>—the monument road traverses parts of <b>PEbci</b>. Steep slopes prone to rockfall. Rockfall debris may accumulate on road and be a hazard to travelers. <b>PEbci</b> contains caves. Cave roofs and entrances are prone to collapse. Infrastructure built over caves is susceptible to collapse into the opening below.</p> <p><b>Volcano Hazards</b>—the most likely future eruption at Medicine Lake volcano would be a small effusive eruption of basaltic lava, which could occur anywhere on the volcano. Tephra emitted during a silicic eruption (near the summit) could affect the monument.</p>	<p><b>Medicine Lake Volcano History</b>—eruptive stage 4 (approximately 100,000–13,000 years ago).</p>
LATE? PLEISTOCENE	Basaltic andesite of Three Sisters (PEmts)	Basaltic andesite (54.4% SiO <sub>2</sub> ) in eastern part of Lava Beds National Monument.	<p><b>Volcanic Features</b>—apparently erupted from cluster of small cones at southern part of lava flow.</p> <p><b>Tectonic Features</b>—vents are atypical in that they show no apparent alignment, although cones may lie on intersecting northeasterly and northwesterly alignments.</p>	<p><b>Volcano Hazards</b>—the most likely future eruption at Medicine Lake volcano would be a small effusive eruption of basaltic lava, which could occur anywhere on the volcano. Tephra emitted during a silicic eruption (near the summit) could affect Lava Beds National Monument.</p>	<p><b>Medicine Lake Volcano History</b>—eruptive stage 4 (approximately 100,000–13,000 years ago).</p>

Geologic mapping by Donnelly-Nolan and Champion (1987), as modified by Donnelly-Nolan (2010), delineated these 43 map units in Lava Beds National Monument. A full list and description of units of Medicine Lake volcano is on the attached CD (see labe\_geology.pdf). That document also includes a link to the Correlation of Map Units figure from Donnelly-Nolan (2010). Bold text indicates report sections.

Age	Map Unit (symbol)	Geologic Description	Geologic Features and Processes	Geologic Resource Management Issues	Geologic History
LATE PLEISTOCENE	Andesite of Schonchin Butte (PEasb)	Andesite (56.8%–57.4% SiO <sub>2</sub> ; avg. of 3 = 57.2%), typically dense and glassy. Among the highest SiO <sub>2</sub> contents of units in Lava Beds National Monument. Estimated area: 14 km <sup>2</sup> (5 mi <sup>2</sup> ). Estimated volume: 0.2 km <sup>3</sup> (0.05 mi <sup>3</sup> ).	<b>Volcanic Features</b> —block lava flow (Schonchin Flow) with steep margin, rugged morphology, and little vegetative cover. Also includes tephra erupted from Schonchin Butte, which is a prominent landmark. <b>Geologic Features with Cultural Significance</b> —band of Modoc men, women, and children fled toward the Schonchin Flow when US Army troops cut them off from their water source at Tule Lake.	<b>Recreational Impacts to Geologic Features</b> —popular trail to fire lookout traverses Schonchin Butte. <b>Volcano Hazards</b> —the most likely future eruption at Medicine Lake volcano would be a small effusive eruption of basaltic lava, which could occur anywhere on the volcano. Tephra emitted during a silicic eruption (near the summit) could affect Lava Beds National Monument.	<b>Medicine Lake Volcano History</b> —eruptive stage 4 (approximately 100,000–13,000 years ago). <sup>40</sup> Ar/ <sup>39</sup> Ar age: 65,000 ± 23,000 years.
	Basalt of The Panhandle (PEbpa)	Basalt (49.6%–51.0% SiO <sub>2</sub> ; avg. of 3 = 50.4%). Similar to basalt of Mammoth Crater ( <b>PEbmc</b> ), which overlies it.	<b>Volcanic Features</b> —vent for lava flow is unknown, but presumably located south or southwest of outcrop area. <b>Tectonic Features</b> —cut by open ground crack (Big Crack) that also breaks unit <b>PEbmc</b> . <b>Lake Deposits</b> —shows evidence at its northeastern margin of having flowed into ancient Tule Lake; this and its petrographic and morphologic similarity to overlying unit <b>PEbmc</b> , which also flowed into ancient Tule Lake, make the two units ( <b>PEbpa</b> and <b>PEbmc</b> ) difficult to distinguish in the field.	<b>Volcano Hazards</b> —the most likely future eruption at Medicine Lake volcano would be a small effusive eruption of basaltic lava, which could occur anywhere on the volcano. Tephra emitted during a silicic eruption (near the summit) could affect Lava Beds National Monument.	<b>Medicine Lake Volcano History</b> —eruptive stage 4 (approximately 100,000–13,000 years ago).
	Basaltic andesite of Hippo Butte (PEmhi)	Basaltic andesite (54.4%–56.1% SiO <sub>2</sub> ; avg. of 7 = 55.4%). Commonly has speckled appearance.	<b>Volcanic Features</b> —lava flows erupted from Hippo Butte cinder cone and from smaller cone south of Mammoth Crater.	<b>Rockfall and Roof Collapse</b> —the monument road traverses parts of <b>PEmhi</b> . Steep slopes prone to rockfall. Rockfall debris may accumulate on road and be a hazard to travelers. <b>Volcano Hazards</b> —the most likely future eruption at Medicine Lake volcano would be a small effusive eruption of basaltic lava, which could occur anywhere on the volcano. Tephra emitted during a silicic eruption (near the summit) could affect Lava Beds National Monument.	<b>Medicine Lake Volcano History</b> —eruptive stage 3 (approximately 180,000–100,000 years ago).
	Basaltic andesite of Eagle Nest Butte (PEmen)	Basaltic andesite (52.4%–53.8% SiO <sub>2</sub> ; avg. of 10 = 53.2%).	<b>Volcanic Features</b> —lava flow erupted from Eagle Nest Butte and Bearpaw Butte cinder cones.	<b>Volcano Hazards</b> —the most likely future eruption at Medicine Lake volcano would be a small effusive eruption of basaltic lava, which could occur anywhere on the volcano. Tephra emitted during a silicic eruption (near the summit) could affect Lava Beds National Monument.	<b>Medicine Lake Volcano History</b> —eruptive stage 3 (approximately 180,000–100,000 years ago). <sup>40</sup> Ar/ <sup>39</sup> Ar age: 114,000 ± 10,000 years.
LATE OR MIDDLE PLEISTOCENE	Basaltic andesite spatter vent west-northwest of Bat Butte (PEm1)	Basaltic andesite (53.0% SiO <sub>2</sub> ). Mostly oxidized.	<b>Volcanic Features</b> —single isolated spatter cone (not associated with a flow), approximately 1 km (0.6 mi) west-northwest of Bat Butte.	<b>Volcano Hazards</b> —the most likely future eruption at Medicine Lake volcano would be a small effusive eruption of basaltic lava, which could occur anywhere on the volcano. Tephra emitted during a silicic eruption (near the summit) could affect Lava Beds National Monument.	<b>Medicine Lake Volcano History</b> —eruptive stage 3 (approximately 180,000–100,000 years ago). Cone is broken down and mostly oxidized, suggesting that it is relatively old; however, it is the most recent isolated cone to erupt in Lava Beds National Monument.
MIDDLE PLEISTOCENE	Andesite of Whitney Butte (PEawb)	Andesite (58.4% SiO <sub>2</sub> , among the highest in Lava Beds National Monument). Estimated area: 9 km <sup>2</sup> (3 mi <sup>2</sup> ), some of which is west and north of the monument.	<b>Volcanic Features</b> —lava erupted from Whitney Butte at northern edge of the Callahan Flow ( <b>PEmcf</b> ). Composed of aa. Lava moved north about 6 km (4 mi) from its vent at the Whitney Butte cinder cone. Whitney Butte has two summit craters aligned about N5°W. <b>Tectonic Features</b> —cut by north- and northeast-oriented normal faults whose offsets are more commonly down to the east than to the west. Faulting has revealed flow thicknesses of at least 10 m (30 ft), although flow margins are typically 2–3 m (7–10 ft) high.	<b>Volcano Hazards</b> —the most likely future eruption at Medicine Lake volcano would be a small effusive eruption of basaltic lava, which could occur anywhere on the volcano. Tephra emitted during a silicic eruption (near the summit) could affect Lava Beds National Monument.	<b>Medicine Lake Volcano History</b> —eruptive stage 3 (approximately 180,000–100,000 years ago).

Geologic mapping by Donnelly-Nolan and Champion (1987), as modified by Donnelly-Nolan (2010), delineated these 43 map units in Lava Beds National Monument. A full list and description of units of Medicine Lake volcano is on the attached CD (see labe\_geology.pdf). That document also includes a link to the Correlation of Map Units figure from Donnelly-Nolan (2010). Bold text indicates report sections.

Age	Map Unit (symbol)	Geologic Description	Geologic Features and Processes	Geologic Resource Management Issues	Geologic History
MIDDLE PLEISTOCENE	Basalt northeast of Glass Mountain (PEbng)	Basalt (48.4%–50.8% SiO <sub>2</sub> ; avg. of 6 = 49.4%).	<b>Volcanic Features</b> —primary vent(s) buried by younger lava flows above 1,500 m (4,900 ft) elevation on northeastern flank of Medicine Lake volcano. Two additional satellite vents, which erupted the basalt, are aligned northeast near the southeastern corner of Lava Beds National Monument.	<b>Volcano Hazards</b> —the most likely future eruption at Medicine Lake volcano would be a small effusive eruption of basaltic lava, which could occur anywhere on the volcano. Tephra emitted during a silicic eruption (near the summit) could affect Lava Beds National Monument.	<b>Medicine Lake Volcano History</b> —eruptive stage 3 (approximately 180,000–100,000 years ago).
MIDDLE PLEISTOCENE	Andesite cone west of Crescent Butte (PEa1)	Andesite (57.4% SiO <sub>2</sub> ), mostly red, oxidized cinders and bombs.	<b>Volcanic Features</b> —makes up the isolated cinder cone adjacent to Crescent Butte ( <b>PEm2</b> ) and just northeast of Hippo Butte. Age relationship to Crescent Butte ( <b>PEm2</b> ) is unknown.	<b>Abandoned Mineral Lands</b> —cone has been quarried for cinders and pumice and contains Burn Pit and West Crescent Butte Pit. <b>Rockfall and Roof Collapse</b> —the monument road traverses parts of <b>PEa1</b> . Steep slopes prone to rockfall. Rockfall debris may accumulate on road and be a hazard to travelers. <b>Volcano Hazards</b> —the most likely future eruption at Medicine Lake volcano would be a small effusive eruption of basaltic lava, which could occur anywhere on the volcano. Tephra emitted during a silicic eruption (near the summit) could affect Lava Beds National Monument.	<b>Medicine Lake Volcano History</b> —eruptive stage 3 (approximately 180,000–100,000 years ago).
MIDDLE PLEISTOCENE	Andesite west of Fleener Chimneys (PEawf)	Andesite (60.8% SiO <sub>2</sub> ). Glassy.	<b>Volcanic Features</b> —lava flow with highly irregular, blocky surface. Flow margin is 10–20 m (30–70 ft) high. Vent is buried by younger flows to the south.	<b>Volcano Hazards</b> —the most likely future eruption at Medicine Lake volcano would be a small effusive eruption of basaltic lava, which could occur anywhere on the volcano. Tephra emitted during a silicic eruption (near the summit) could affect Lava Beds National Monument.	<b>Medicine Lake Volcano History</b> —eruptive stage 3 (approximately 180,000–100,000 years ago).  Dacite tuff of Antelope Well ( <b>PEdta</b> ) ash-flow tuff is absent on top of <b>PEawf</b> , but is found immediately to the north, farther from the vent area, indicating that <b>PEawf</b> overlies (and is younger than) the 180,000-year-old marker bed.
	Basaltic andesite of Crescent Butte (PEm2)	Basaltic andesite (54.5% SiO <sub>2</sub> ). Oxidized.	<b>Volcanic Features</b> —makes up isolated Crescent Butte cinder cone. Age relationship to adjacent isolated andesite cinder cone ( <b>PEa1</b> ) is unknown. Located northwest of Lava Beds National Monument visitor center.	<b>Abandoned Mineral Lands</b> —cone has been quarried for cinder and pumice and contains Crescent Butte Pit. <b>Volcano Hazards</b> —the most likely future eruption at Medicine Lake volcano would be a small effusive eruption of basaltic lava, which could occur anywhere on the volcano. Tephra emitted during a silicic eruption (near the summit) could affect Lava Beds National Monument.	<b>Medicine Lake Volcano History</b> —eruptive stage 3 (approximately 180,000–100,000 years ago).
	Basalt north of Whitney Butte (PEbnw)	Basalt (50.7% SiO <sub>2</sub> ).	<b>Volcanic Features</b> —makes up eroded, northeast-oriented set of small spatter cones; no lava flow visible. Underlies, and is nearly surrounded by, andesite of Whitney Butte ( <b>PEawb</b> ).	<b>Volcano Hazards</b> —the most likely future eruption at Medicine Lake volcano would be a small effusive eruption of basaltic lava, which could occur anywhere on the volcano. Tephra emitted during a silicic eruption (near the summit) could affect Lava Beds National Monument.	<b>Medicine Lake Volcano History</b> —eruptive stage 3 (approximately 180,000–100,000 years ago).
	Basaltic andesite of Semi Crater (PEmsc)	Basaltic andesite (55.0%, 55.5% SiO <sub>2</sub> ). Present extent is about 3 km <sup>2</sup> (1 mi <sup>2</sup> ), but was probably at least twice that originally.	<b>Volcanic Features</b> —makes up aa lava flows that were erupted from the partially buried cinder and spatter cone of Semi Crater, which is surrounded on three sides by basalt of The Castles ( <b>PEbc</b> ) and invaded on the east by a tongue of the Schonchin Flow (andesite of Schonchin Butte, <b>PEasb</b> ).  <b>Geologic Features with Cultural Significance</b> —Thomas-Wright Battlefield.	<b>Volcano Hazards</b> —the most likely future eruption at Medicine Lake volcano would be a small effusive eruption of basaltic lava, which could occur anywhere on the volcano. Tephra emitted during a silicic eruption (near the summit) could affect Lava Beds National Monument.	<b>Medicine Lake Volcano History</b> —eruptive stage 3 (approximately 180,000–100,000 years ago).  May be younger than dacite tuff of Antelope Well ( <b>PEdta</b> ), which does not overlie this unit.

Geologic mapping by Donnelly-Nolan and Champion (1987), as modified by Donnelly-Nolan (2010), delineated these 43 map units in Lava Beds National Monument. A full list and description of units of Medicine Lake volcano is on the attached CD (see labe\_geology.pdf). That document also includes a link to the Correlation of Map Units figure from Donnelly-Nolan (2010). Bold text indicates report sections.

Age	Map Unit (symbol)	Geologic Description	Geologic Features and Processes	Geologic Resource Management Issues	Geologic History
MIDDLE PLEISTOCENE	Andesite northeast of Mount Hoffman (PEanh)	Andesite (57.7%, 58.0% SiO <sub>2</sub> ). Glassy. Extends at least 11 km (7 mi) from northeastern edge of rhyolite of Mount Hoffman ( <b>Hrmh</b> ; see GRI data on attached CD), which directly overlies this unit.	<b>Volcanic Features</b> —exposed in three separate areas. Vent is not exposed and presumably is buried to south or southwest. <b>Tectonic Features</b> —cut by two small northeast-oriented faults.	<b>Volcano Hazards</b> —the most likely future eruption at Medicine Lake volcano would be a small effusive eruption of basaltic lava, which could occur anywhere on the volcano. Tephra emitted during a silicic eruption (near the summit) could affect Lava Beds National Monument.	<b>Medicine Lake Volcano History</b> —eruptive stage 3 (approximately 180,000–100,000 years ago).
	Basalt of Canby Bay (PEbcb)	Basalt (50.0% SiO <sub>2</sub> ). Morphologically similar to the overlying basalt of Mammoth Crater ( <b>PEbmc</b> ). Presently covers about 4 km <sup>2</sup> (2 mi <sup>2</sup> ); original extent unknown.	<b>Volcanic Features</b> —vent location is unknown, but presumably buried to the south under younger lava flows.	<b>Abandoned Mineral Lands</b> —quarried for cinder and pumice; contains Shepherd Tank Pits. <b>Volcano Hazards</b> —the most likely future eruption at Medicine Lake volcano would be a small effusive eruption of basaltic lava, which could occur anywhere on the volcano. Tephra emitted during a silicic eruption (near the summit) could affect Lava Beds National Monument.	<b>Medicine Lake Volcano History</b> —eruptive stage 3 (approximately 180,000–100,000 years ago).
	Basalt of Caldwell Butte (PEb4)	Basalt (51.6% SiO <sub>2</sub> ).	<b>Volcanic Features</b> —basalt erupted from Caldwell Butte cinder cone and Caldwell Minor (satellite vent on northern flank of Caldwell Butte), which are isolated cinder cones. Lava flows, if present, are entirely buried by younger lavas.	<b>Abandoned Mineral Lands</b> —cone has been quarried for pumice and contains Caldwell Pit. <b>Rockfall and Roof Collapse</b> —the monument road traverses parts of <b>PEb4</b> . Steep slopes prone to rockfall. Rockfall debris may accumulate on road and be a hazard to travelers. <b>Volcano Hazards</b> —the most likely future eruption at Medicine Lake volcano would be a small effusive eruption of basaltic lava, which could occur anywhere on the volcano. Tephra emitted during a silicic eruption (near the summit) could affect Lava Beds National Monument.	<b>Medicine Lake Volcano History</b> —eruptive stage 3 (approximately 180,000–100,000 years ago).
	Andesite near Devils Homestead (PEadh)	Andesite (56.5%–57.8% SiO <sub>2</sub> ; avg. of 3 = 57.3%). Maximum exposed thickness of three flows is 10 m (30 ft).	<b>Volcanic Features</b> —lava flows exposed at and near the base of Gillem Bluff in the northwestern part of Lava Beds National Monument. Additional small patches of <b>PEadh</b> occur farther north along Gillem fault. Three flows are exposed at and near Devils Homestead Overlook. Vent location is unknown, but presumably buried farther south. <b>Tectonic Features</b> —lava flowed against existing fault scarp and was subsequently uplifted. See also unit <b>PEbgf</b> .	<b>Volcano Hazards</b> —the most likely future eruption at Medicine Lake volcano would be a small effusive eruption of basaltic lava, which could occur anywhere on the volcano. Tephra emitted during a silicic eruption (near the summit) could affect Lava Beds National Monument.	<b>Medicine Lake Volcano History</b> —eruptive stage 3 (approximately 180,000–100,000 years ago).  <sup>40</sup> Ar/ <sup>39</sup> Ar age of uppermost flow: 171,000 ± 4,000 years.
MIDDLE? PLEISTOCENE	Basalt cone southeast of Mammoth Crater (PEb5)	Basalt (52.1% SiO <sub>2</sub> ).	<b>Volcanic Features</b> —isolated cinder cone. Located just southeast of Mammoth Crater, south of the southwestern end of Hidden Valley.	<b>Volcano Hazards</b> —the most likely future eruption at Medicine Lake volcano would be a small effusive eruption of basaltic lava, which could occur anywhere on the volcano. Tephra emitted during a silicic eruption (near the summit) could affect Lava Beds National Monument.	<b>Medicine Lake Volcano History</b> —eruptive stage 3 (approximately 180,000–100,000 years ago).
MIDDLE PLEISTOCENE	Andesite of Island Butte (PEa3)	Andesite (57.5% SiO <sub>2</sub> ).	<b>Volcanic Features</b> —Island Butte is an isolated cinder cone located at the southwestern corner of Lava Beds National Monument. It is entirely surrounded by the Callahan Flow ( <b>PEmcf</b> ).	<b>Volcano Hazards</b> —the most likely future eruption at Medicine Lake volcano would be a small effusive eruption of basaltic lava, which could occur anywhere on the volcano. Tephra emitted during a silicic eruption (near the summit) could affect Lava Beds National Monument.	<b>Medicine Lake Volcano History</b> —eruptive stage 3 (approximately 180,000–100,000 years ago).

Geologic mapping by Donnelly-Nolan and Champion (1987), as modified by Donnelly-Nolan (2010), delineated these 43 map units in Lava Beds National Monument. A full list and description of units of Medicine Lake volcano is on the attached CD (see labe\_geology.pdf). That document also includes a link to the Correlation of Map Units figure from Donnelly-Nolan (2010). Bold text indicates report sections.

Age	Map Unit (symbol)	Geologic Description	Geologic Features and Processes	Geologic Resource Management Issues	Geologic History
MIDDLE PLEISTOCENE	Basalt west of Canby Cross at Gillem fault (PEbgf)	Basalt (51.4% SiO <sub>2</sub> ).	<b>Volcanic Features</b> —exposed in small outcrops at base of Gillem Bluff. <b>Tectonic Features</b> —lava flowed against existing Gillem fault, then was partly covered by andesite near Devils Homestead ( <b>PEadh</b> ); subsequently, both units ( <b>PEbgf</b> and <b>PEadh</b> ) were moved more than 10 m (30 ft) upward along the fault.	<b>Volcano Hazards</b> —the most likely future eruption at Medicine Lake volcano would be a small effusive eruption of basaltic lava, which could occur anywhere on the volcano. Tephra emitted during a silicic eruption (near the summit) could affect Lava Beds National Monument.	<b>Medicine Lake Volcano History</b> —eruptive stage 3 (approximately 180,000–100,000 years ago).  Younger than Pliocene units <b>PLobg</b> and <b>PLomw</b> of Gillem Bluff; underlies unit <b>PEadh</b> . Older than basalt of Mammoth Crater ( <b>PEbmc</b> ), which flowed against upfaulted outcrops of <b>PEbgf</b> .
	Basaltic andesite north of Indian Butte (PEmni)	Basaltic andesite (54.8%, 55.0% SiO <sub>2</sub> ).	<b>Volcanic Features</b> —lava flow exposed in three separate outcrop areas. Also includes vent cone at southern end of the largest exposure.	<b>Volcano Hazards</b> —the most likely future eruption at Medicine Lake volcano would be a small effusive eruption of basaltic lava, which could occur anywhere on the volcano. Tephra emitted during a silicic eruption (near the summit) could affect Lava Beds National Monument.	<b>Medicine Lake Volcano History</b> —eruptive stage 2 (approximately 300,000–180,000 years ago).  May be younger than Caldwell Butte ( <b>PEa4</b> ), but older than surrounding basalt of Caldwell Ice Caves ( <b>PEbci</b> ) and Indian Butte ( <b>PEaib</b> ).
	Basaltic andesite south and southwest of Caldwell Butte (PEmc)	Basaltic andesite (56.1% SiO <sub>2</sub> ).	<b>Volcanic Features</b> —lava flow and small cinder cone at southern boundary of Lava Beds National Monument.	<b>Volcano Hazards</b> —the most likely future eruption at Medicine Lake volcano would be a small effusive eruption of basaltic lava, which could occur anywhere on the volcano. Tephra emitted during a silicic eruption (near the summit) could affect Lava Beds National Monument.	<b>Medicine Lake Volcano History</b> —eruptive stage 2 (approximately 300,000–180,000 years ago).
	Andesite of Red Butte (PEa2)	Andesite (59.1% SiO <sub>2</sub> ). Cone consists of oxidized bombs and cinders.	<b>Volcanic Features</b> —Red Butte cinder cone is an isolated cone (not associated with a flow) southwest of Lava Beds National Monument visitor center.	<b>Rockfall and Roof Collapse</b> —the monument road traverses parts of <b>PEa2</b> . Steep slopes prone to rockfall. Rockfall debris may accumulate on road and be a hazard to travelers.  <b>Volcano Hazards</b> —the most likely future eruption at Medicine Lake volcano would be a small effusive eruption of basaltic lava, which could occur anywhere on the volcano. Tephra emitted during a silicic eruption (near the summit) could affect Lava Beds National Monument.	<b>Medicine Lake Volcano History</b> —eruptive stage 2 (approximately 300,000–180,000 years ago).  Appears morphologically old, with no crater remaining. Underlies (is older than) surrounding basalt of Mammoth Crater ( <b>PEbmc</b> ).
	Basalt of Hardin Butte (PEb1)	Basalt (52.1% SiO <sub>2</sub> ). Cone is oxidized and partially buried.	<b>Volcanic Features</b> —Hardin Butte is the oldest isolated cinder cone in Lava Beds National Monument and is surrounded by the (younger) basalt of The Castles ( <b>PEbc</b> ). Several vents of <b>PEbc</b> are located on lower western flank of Hardin Butte ( <b>PEb1</b> ).	<b>Abandoned Mineral Lands</b> —cone has been quarried for cinder and pumice and contains Hardin Butte Pit.  <b>Volcano Hazards</b> —the most likely future eruption at Medicine Lake volcano would be a small effusive eruption of basaltic lava, which could occur anywhere on the volcano. Tephra emitted during a silicic eruption (near the summit) could affect Lava Beds National Monument.	<b>Medicine Lake Volcano History</b> —eruptive stage 2 (approximately 300,000–180,000 years ago).
	Basalt of Prisoners Rock (PEbp)	Basalt (48.0%–49.5% SiO <sub>2</sub> ; avg. of 5 = 48.6%).	<b>Volcanic Features</b> —lies beyond northeastern margin of contiguous lavas of Medicine Lake volcano. Represents the most northeastern extent of Medicine Lake volcanism. Erupted from north- and northeast-oriented subaerial and subaqueous vents (including Prisoners Rock, The Peninsula, and North Crater) and formed lava flows and spatter vents in addition to tuff cones and ring.  <b>Lake Deposits</b> —tuff rings were significantly eroded on western, northern, and eastern sides by Tule Lake before it was drained for farmland beginning in the early 1900s. Well-exposed wave-cut benches can be seen along western and eastern sides.  <b>Geologic Features with Cultural Significance</b> —makes up Petroglyph Point, on which more than 5,000 petroglyphs are preserved.	<b>Wind Erosion at Petroglyph Point</b> —windblown sand and dust, made available on access road, parking area, and wave-cut benches, may be “sandblasting” the petroglyphs.  <b>Volcano Hazards</b> —the most likely future eruption at Medicine Lake volcano would be a small effusive eruption of basaltic lava, which could occur anywhere on the volcano. Tephra emitted during a silicic eruption (near the summit) could affect Lava Beds National Monument.	<b>Medicine Lake Volcano History</b> —eruptive stage 2 (approximately 300,000–180,000 years ago).  Potassium-Ar age: 273,000 ± 18,000 years.

Geologic mapping by Donnelly-Nolan and Champion (1987), as modified by Donnelly-Nolan (2010), delineated these 43 map units in Lava Beds National Monument. A full list and description of units of Medicine Lake volcano is on the attached CD (see labe\_geology.pdf). That document also includes a link to the Correlation of Map Units figure from Donnelly-Nolan (2010). Bold text indicates report sections.

Age	Map Unit (symbol)	Geologic Description	Geologic Features and Processes	Geologic Resource Management Issues	Geologic History
MIDDLE PLEISTOCENE	Basaltic andesite of Juniper Butte (PEmj)	Basaltic andesite (53.8% SiO <sub>2</sub> ). Individual juvenile clasts are mud coated.	<b>Volcanic Features</b> —eroded palagonite tuff ring in northeastern part of Lava Beds National Monument. <b>PEmj</b> is nearly surrounded by overlying basalt of Mammoth Crater ( <b>PEbmc</b> ); remaining perimeter is overlain by basalt of The Panhandle ( <b>PEbpa</b> ). <b>Lake Deposits</b> —tuff ring probably formed by eruption through ancient Tule Lake.	<b>Volcano Hazards</b> —the most likely future eruption at Medicine Lake volcano would be a small effusive eruption of basaltic lava, which could occur anywhere on the volcano. Tephra emitted during a silicic eruption (near the summit) could affect Lava Beds National Monument.	<b>Medicine Lake Volcano History</b> —eruptive stage 2 (approximately 300,000–180,000 years ago).
	Basalt of Hovey Point (PEbhp)	Basalt (50.9% SiO <sub>2</sub> ).	<b>Volcanic Features</b> —occurs at northern edge of Lava Beds National Monument. Underlies basalt of Canby Bay ( <b>PEbcb</b> ) and basalt of Mammoth Crater ( <b>PEbmc</b> ), both of which are adjacent to <b>PEbhp</b> . Represents oldest eruption of Medicine Lake volcano in the monument. <b>Lake Deposits</b> —appears to have been inundated at some time by ancient Tule Lake.	<b>Rockfall and Roof Collapse</b> —the monument road traverses parts of <b>PEbhp</b> . Steep slopes prone to rockfall. Rockfall debris may accumulate on road and be a hazard to travelers. <b>Volcano Hazards</b> —the most likely future eruption at Medicine Lake volcano would be a small effusive eruption of basaltic lava, which could occur anywhere on the volcano. Tephra emitted during a silicic eruption (near the summit) could affect Lava Beds National Monument.	<b>Medicine Lake Volcano History</b> —eruptive stage 1 (approximately 500,000–300,000 years ago). <sup>40</sup> Ar/ <sup>39</sup> Ar age: 445,000 ± 25,000 years.
EARLY PLEISTOCENE	Older basalt on west side of Gillem fault (PEobp)	Basalt (52.2% SiO <sub>2</sub> ). Has many conspicuous crystals.	<b>Volcanic Features</b> —occurs in three small patches. Overlies Pliocene basalt ( <b>PLobg</b> ) that caps much of Gillem Bluff. Vent location is unknown.	<b>Abandoned Mineral Lands</b> —geologic location of Gillem Bluff Pit is unknown, but may be in <b>PEobp</b> . <b>Rockfall and Roof Collapse</b> —the monument road passes along the base of Gillem Bluff, which is prone to rockfall. Rockfall debris may accumulate on road and be a hazard to travelers.	<b>Pre-Medicine Lake Volcano History</b> —predates Medicine Lake volcano.
PLIOCENE	Older tuff of Gillem Bluff (PLotg)	Dacitic ash-flow tuff, welded and typically reddish. SiO <sub>2</sub> content determined from six pumice lumps (66.9%–69.3% SiO <sub>2</sub> ; avg. of 6 = 68.0%; one whole-rock analysis, 66.9% SiO <sub>2</sub> ).	<b>Volcanic Features</b> —exposed in four closely spaced outcrop areas, each a few meters thick, at top of Gillem Bluff. <b>Tectonic Features</b> —exposed in face of Gillem Bluff; uplifted along Gillem fault.	<b>Abandoned Mineral Lands</b> —geologic location of Gillem Bluff Pit is unknown, but may be in <b>PLotg</b> . <b>Rockfall and Roof Collapse</b> —the monument road passes along the base of Gillem Bluff, which is prone to rockfall. Rockfall debris may accumulate on road and be a hazard to travelers.	<b>Pre-Medicine Lake Volcano History</b> —predates Medicine Lake volcano. <sup>40</sup> Ar/ <sup>39</sup> Ar age: 2.023 million ± 0.020 million years (Donnelly-Nolan and Lanphere 2005).
	Older basaltic andesite of Gillem Bluff (PLomg)	Basaltic andesite (56.9% SiO <sub>2</sub> ).	<b>Volcanic Features</b> —lava flow remnants on Gillem Bluff. <b>Tectonic Features</b> —exposed in face of Gillem Bluff; uplifted along Gillem fault.	<b>Abandoned Mineral Lands</b> —geologic location of Gillem Bluff Pit is unknown, but may be in <b>PLomg</b> . <b>Rockfall and Roof Collapse</b> —the monument road passes along the base of Gillem Bluff, which is prone to rockfall. Rockfall debris may accumulate on road and be a hazard to travelers.	<b>Pre-Medicine Lake Volcano History</b> —predates Medicine Lake volcano.
	Older basalt of Gillem Bluff (PLobg)	Basalt (47.7%, 47.9% SiO <sub>2</sub> ).	<b>Volcanic Features</b> —forms rimrock that caps upthrown fault block at Gillem Bluff. <b>Tectonic Features</b> —exposed in face of Gillem Bluff; uplifted along Gillem fault. <b>Lake Deposits</b> —includes pillow lavas exposed in Gillem Bluff.	<b>Abandoned Mineral Lands</b> —geologic location of Gillem Bluff Pit is unknown, but may be in <b>PLobg</b> . <b>Rockfall and Roof Collapse</b> —The monument road passes along the base of Gillem Bluff, which is prone to rockfall. Rockfall debris may accumulate on road and be a hazard to travelers.	<b>Pre-Medicine Lake Volcano History</b> —predates Medicine Lake volcano. <b>Lake History</b> —lava flowed into ancient Tule Lake.
	Older basaltic andesite in western Lava Beds National Monument (PLomw)	Basaltic andesite (53.7% SiO <sub>2</sub> ). Has speckled appearance.	<b>Volcanic Features</b> —represents the oldest ancient volcano to erupt in the vicinity of Lava Beds National Monument. <b>Tectonic Features</b> —exposed in face of Gillem Bluff; uplifted along Gillem fault.	<b>Abandoned Mineral Lands</b> —geologic location of Gillem Bluff Pit is unknown, but may be in <b>PLomw</b> . <b>Rockfall and Roof Collapse</b> —the monument road passes along the base of Gillem Bluff, which is prone to rockfall. Rockfall debris may accumulate on road and be a hazard to travelers.	<b>Pre-Medicine Lake Volcano History</b> —predates Medicine Lake volcano.