

Map Unit Properties Table: Lassen Volcanic National Park

The units listed occur within Lassen Volcanic National Park. Refer to "lavo_geology.pdf" on the attached CD for a list and geologic description of all units in the GRI GIS data set. A geologic map graphic (map 1, in pocket) is a simplified geologic map of the park using the listed units. Precise ages and age estimates in "Geologic History" column are from Clynne and Muffler (2010) or as compiled in Nathenson et al. (2012) for Lassen volcanic center eruptions less than 100,000 years ago.

Age	Map Unit (Symbol) <i>GIS Data</i>	Geologic Map Graphic (Symbol) <i>Map 1 (in pocket)</i>	Geologic Description	Geologic Features and Processes	Geologic Issues	Geologic History
HOLOCENE & PLEISTOCENE	Alluvium (HPEf)	Alluvium (HPEal)	Sand and gravel in modern stream channels.	Glacial Features—includes reworked glacial outwash in some areas. Streams and Waterfalls—includes stream terraces in some areas. Channel gradients at the park are irregular, often alternating along a particular stream from steep in places where the channel is in bedrock to gentle where alluvium has been deposited.	None reported.	Present-Day Geologic Activity—deposited primarily during the Holocene Epoch, but includes some Pleistocene alluvium.
	Colluvium and talus (HPEc)	Slope-movement deposits (HPEsm)	Rubble consisting mainly of talus at the base of cliffs or steep slopes of exposed bedrock, but locally occurs as slopewash or thin, local debris flows.	Volcanic Features—includes flat, generally internally drained areas of windblown ash related to eruption of nearby cinder cones in northern Caribou volcanic field. Does not include debris emplaced while still hot from growing dacite domes in Lassen domefield. Lakes—Soda Lake is bounded by a landslide (Hsh), as well as alluvium (HPEf) and colluvium and talus (HPEc).	Slope Movements—deposits of talus and colluvium (HPEc) may be prone to future movement.	Present-Day Geologic Activity—deposited throughout the Holocene Epoch and is ongoing. Also, deposited in the Pleistocene Epoch in areas beyond the limits of glaciation.
LATE PLEISTOCENE	Talus on Lassen Peak (PEcl)		Rubble covering much of surface of the Lassen Peak dacite dome (PEdl).	Glacial Features—some talus was deposited as "hot blocks" during emplacement of the dome, but much PEcl was deposited later via glacial processes, weathering, and rockfalls during the late Pleistocene Epoch.	Slope Movements—deposits of talus (HPEcl) may be prone to future movement.	Volcanic Center (Lassen)/Present-Day Geologic Activity—deposited primarily at the time of PEdl dome formation, but slope movement is ongoing.
HOLOCENE	Landslide deposits in hydrothermally altered core of Brokeoff Volcano (Hsh)	Slope-movement deposits (HPEsm)	Rubble in small slumps, debris flows, and landslides on slopes underlain by unconsolidated or hydrothermally altered rocks.	Volcanic Features—late in the history of a volcanic center, an acidic hydrothermal system, driven by heat from silicic magma bodies, altered permeable rocks of the composite cone, making them prone to slope movement. Hydrothermal Features—hydrothermal alteration is widespread in and around the thermal areas of the park such as Bumpass Hell, Devils Kitchen, and Sulphur Works. Lakes— Hsh surrounds Forest Lake and Soda Lake.	Slope Movements—much of the hydrothermally altered core of Brokeoff Volcano is unstable and subject to small landslides and debris flows. Some slides are subject to reactivation during spring snowmelt.	Present-Day Geologic Activity—alteration of rocks is indicative of ongoing hydrothermal activity and facilitates weathering of volcano edifices
	Avalanche deposits of Chaos Jumbles (Hsj)		Nonsorted, unconsolidated, nonbedded deposit of coarse to fine rubble with angular blocks as much as 5 m (16 ft) across. Consists almost entirely of pink, oxidized rhyodacite of Chaos Crags, dome C (Hrcc).	Lakes—Manzanita Lake formed when first debris avalanche (in series of three) dammed Manzanita Creek.	Slope Movements—formed by catastrophic collapse of dome C (Hrcc) as three rockfall avalanches were emplaced in quick succession. Very large debris avalanches, including the three that emplaced Chaos Jumbles, are particularly hazardous because of their high speeds.	Present-Day Geologic Activity—radiocarbon age of emplacement of Chaos Jumbles—278 ± 28 years before present (BP)—was obtained from trees drowned by Manzanita Lake.
	Debris-flow deposits from the northeast side of Lassen Peak (Hwh)		Nonsorted, unconsolidated, nonbedded rubble consisting entirely of dacite of Lassen Peak (PEdl). Commonly pink in color, but ranges from pink to gray, reflecting lithology of source dacite on different parts of Lassen Peak dome. Thickness less than 1–6 m (3–20 ft).	None reported.	Slope Movements—one of two significant deposits on Lassen Peak; the other is PEsl . Formed as mudflows from steep, high, northeastern slopes of Lassen Peak.	Present-Day Geologic Activity—deposited approximately 8,000 years ago.
LATE PLEISTOCENE	Avalanche debris from Lassen Peak spread across glacial ice (PEsl)		Nonsorted, unconsolidated, nonbedded rubble with blocks commonly as large as 1–2 m (3–7 ft) across.	Glacial Features—interpreted as debris spread across the surface of a glacier in Hat Creek valley after partial glacial retreat from terminal position during Raker Peak glaciation (see PEtr).	Slope Movements—one of two significant deposits on Lassen Peak; the other is Hwh .	Glaciations—slope movement that occurred during Pleistocene ice ages, less than 27,000 years ago.

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Age	Map Unit (Symbol) <i>GIS Data</i>	Geologic Map Graphic (Symbol) <i>Map 1 (in pocket)</i>	Geologic Description	Geologic Features and Processes	Geologic Issues	Geologic History		
MIDDLE PLEISTOCENE	Avalanche deposit from dacite of hill 8283 (PEs82)	Slope-movement deposits (HPEsm)	Nonsorted, unconsolidated, nonbedded rubble with blocks commonly as large as 1–2 m (3–7 ft) across.	Volcanic Features—consists almost entirely of dacite of hill 8283 (PEd82).	Slope Movements—unconsolidated material; may be prone to future movement.	Although not mentioned in “Geologic History” section, unit was deposited between approximately 261,000 and 199,000 years ago.		
HOLOCENE	Hydrothermally altered rocks in active thermal areas (Hh)	Hydrothermal deposit (Hh)	Typically, light-gray or orange-brown, altered andesite and dacite. Occasionally areas of kaolinite and silica with scattered blocks of intensely altered rock.	Hydrothermal Features—mapped in areas of intense active hydrothermal alteration at Bumpass Hell, Devils Kitchen, and Sulphur Works. Rocks are so intensely altered that their original lithology and stratigraphy are indeterminable.	Volcano Hazards—demonstrates that the Lassen volcanic center is still active. Hydrothermal Hazards—hazards in areas of Hh include first-, second-, and third-degree burns; collapse of thin thermal surface crusts; impacts to infrastructure; and emission of toxic gases. Slope Movements—areas of hydrothermal alteration subject to slope movement.	Present-Day Geologic Activity—hydrothermal alteration is ongoing as active hydrothermal areas change and migrate.		
	Travertine (Hht)		Calcium carbonate deposited by flowing hot water around active hot-spring vents. Form mounds 1–4 m (3–13 ft) in diameter. Deposits around modern but inactive vents are white, sometimes forming multiple terraces each 0.4 m (1.3 ft) high. Older travertine deposits are brown and commonly broken into 0.1 m (0.3 ft) angular blocks.	Hydrothermal Features—deposits occur mostly in Little Hot Springs Valley. Commonly streaked with brightly colored green and orange algae. Glacial Features—deposited after glaciers retreated from the area; travertine deposits are all younger than younger till (PEty).	Hydrothermal Hazards—hazards include first-, second-, and third-degree burns; collapse of thin thermal surface crusts; impacts to infrastructure; and emission of toxic gases.		Present-Day Geologic Activity—currently being deposited.	
	Till or protalus-rampart debris (Hth)	Slope-movement deposits (HPEsm)	Poorly sorted, unconsolidated, nonbedded rock and rock fragments (silt to boulders) of dacite of Lassen Peak (PEdl).	Glacial Features—represents Holocene glacial advance. Forms small moraines or ramparts at approximately 2,400–2,700 m (7,800–9,000 ft) in elevation near southern and eastern base of Lassen Peak.	Slope Movements—unstable and subject to movement.	Glaciations—deposited 12,000–8,000 years ago.		
LATE PLEISTOCENE	Till, younger glaciations (PEty)	Glacial deposits, till (HPEt)	Poorly sorted, unconsolidated, nonbedded rock and rock fragments with boulders commonly as large as 2 m (7 ft) across, consisting of a range of volcanic rock types.	Glacial Features—occurs as sheetlike deposits and large (well-preserved) moraines as low as about 1,800 m (5,900 ft) in elevation. Subdivided into late till of Anklin Meadows (PEtal), till of Anklin Meadows (PEta), and till of Raker Peak (PEtr) in the Lost Creek, Hat Creek, and Manzanita Creek drainages.	The most important remaining geologic mapping problem in the Lassen area is the extension of the detailed glacial stratigraphy from Lost, Hat, and Manzanita Creek valleys to the rest of Lassen Volcanic National Park and beyond.	Glaciations—deposited 25,000–8,000 years ago.		
LATE PLEISTOCENE TO HOLOCENE	Late till of Anklin Meadows (HPEtal)		Poorly sorted, unconsolidated, nonbedded rock and rock fragments with boulders of locally derived dacite as much as 4 m (13 ft) across.	Glacial Features—occurs as small moraines at approximately 2,300–2,700 m (7,600–9,000 ft) in elevation on eastern and southern sides of Lassen Peak. Overlain by debris-flow deposits from the northeast side of Lassen Peak (Hwh). Also found buried beneath pumiceous pyroclastic-flow and fall deposits of rhyodacite of Chaos Crags (Hpc) in Crescent Crater and at approximately 2,300 m (7,600 ft) in elevation in small cirque east of Chaos Crags.			None reported.	Glaciations—deposited around 12,000 years ago.
LATE PLEISTOCENE	Till of Anklin Meadows (PEta)		Poorly sorted, unconsolidated, nonbedded rock and rock fragments from a variety of bedrock sources with boulders commonly as much as 2 m (7 ft) across and occasionally larger.	Glacial Features—dominated by material derived from Lassen Peak and distinguished from till of Raker Peak (PEtr) by the presence of dacite of Lassen Peak (PEdl) in Hat, Lost, and Manzanita Creek drainages. Occurs as sheetlike deposits and large (well-preserved) moraines as low as 1,700 m (5,500 ft) in elevation in Lost Creek, 1,900 m (6,100 ft) in elevation in Hat Creek, and 1,900 m (6,100 ft) in elevation in Manzanita Creek. Lakes—all small glacial lakes in the park lie within the limits of PEta .				

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LATE PLEISTOCENE	Post-max till of Raker Peak consisting of Lassen Peak avalanche debris (PEtr)	Glacial deposits, till (HPEt)	Poorly sorted, unconsolidated, nonbedded rock and rock fragments with boulders as large as 1.5 m (5 ft) across, consisting almost entirely of dacite derived from avalanche debris from Lassen Peak spread across glacial ice (PEsl).	Glacial Features—forms a small moraine at the northeastern base of Raker Peak.	None reported.	Glaciations—deposited approximately 27,000 years ago.
	Till of Raker Peak (PEtr)		Poorly sorted, unconsolidated, nonbedded rock and rock fragments from a variety of bedrock sources with boulders commonly as large as 2 m (7 ft) across and occasionally larger.	Glacial Features—typified by moderately to poorly preserved and eroded moraines. Occurs as sheetlike deposits and subdued moraines preserved beyond the limits of younger till (PEty). Younger part is equivalent in age to till of Badger Mountain (PEtb) as mapped in Hat, Lost, and Manzanita Creek drainages.		Glaciations—deposited between 35,000 and 27,000 years ago.
	Till of Badger Mountain (PEtb)		Poorly sorted, unconsolidated, nonbedded rock and rock fragments from a variety of bedrock sources with boulders commonly as large as 2 m (7 ft) across and occasionally larger.	Glacial Features—occurs as sheets and subdued moraines preserved beyond the limits of younger tills (PEta and PEtr) in the Hat, Lost, and Manzanita Creek drainages. Occurs at 1,700–2,000 m (5,500–6,500 ft) in elevation.		Glaciations—deposited between 70,000 and 60,000 years ago.
	Outwash gravel, younger glaciations (PEoy)	Glacial deposits, outwash (PEo)	Moderately sorted, unconsolidated gravel and sand, commonly containing boulders as much as 2 m (7 ft) across consisting of same rock types as the correlative PEty.	Glacial Features—occurs as partial valley fills, thick sheets, or alluvial fans in drainages. Equivalent to outwash gravel of Anklin Meadows (PEoa) and outwash gravel of Raker Peak (PEor) in Hat Creek and to part of outwash gravel, undivided (PEou), in Manzanita Creek and Battle Creek meadows. Probably includes older outwash in some areas.	The most important remaining geologic mapping problem in the Lassen area is the extension of the detailed glacial stratigraphy from Lost, Hat, and Manzanita Creek valleys to the rest of Lassen Volcanic National Park and beyond.	Glaciations—deposited 35,000–8,000 years ago.
	Outwash gravel, undivided (PEou)		Moderately sorted, unconsolidated gravel and sand, commonly containing boulders as much as 2 m (7 ft) across consisting of the same rock types as correlative PEty and PEto. Undivided outwash gravel corresponding to units PEty and PEto.	Glacial Features—occurs as partial valley fills and thick sheets in valleys of South Fork Battle Creek and Manzanita Creek where outwash gravels are not divided.		Glaciations—deposited more than 130,000 years ago to 8,000 years ago.
	Outwash gravel of Raker Peak (PEor)		Moderately sorted, unconsolidated gravel and sand, commonly containing boulders as much as 2 m (7 ft) across consisting of the same rock types as correlative till of Raker Peak (PEtr). PEor is distinguished from outwash gravel of Anklin Meadows (PEoa) by the absence of clasts derived from Lassen Peak (PEdl). Equivalent to PEtr.	Glacial Features—occurs as partial valley fill, thick sheets, or alluvial fans in Hat Creek drainage. Obscured by thin pyroclastic-flow and associated fluid debris-flow deposits from the 22 May 1915 eruption of Lassen Peak (Hpw2). Collectively PEor and PEoa are equivalent to PEoy, and make up part of PEou in other drainages.	None reported.	Glaciations—deposited 35,000–27,000 years ago.
HOLOCENE	Diatomite (Hd)	Diatomite (Hd)	Deposits of diatomite in ancient Butte Lake. Many other diatomite deposits in Butte Lake area are too small to show at map scale (1:50,000).	Volcanic Features—"bulldozed" by lava flows. Disturbed sediment located peripheral to Cinder Cone lava flows for about 2 km (1.2 mi) west from present shores of Butte Lake, as kipukas in Fantastic Lava Beds flows from Cinder Cone, and on eastern shore of Butte Lake. Lakes—Hd around base of the Fantastic Lava Beds flows (Hmf1 and Hmf2) indicates that Butte Lake was considerably larger before the eruption of Cinder Cone in 1666 CE.	None reported.	Recent Volcanic Activity—pattern of deposits indicates that a much larger lake existed prior to the eruption of Cinder Cone.

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HOLOCENE	1917 CE, phreatic deposit, May–June (Hp17)	Lassen volcanic center, Twin Lakes sequence, younger (HPE-Lty)	Poorly sorted, partly indurated, thin to thick beds of lithic ash, lapilli, and blocks deposited in 1917. Matrix is generally very fine, indurated, and pale-yellowish-brown ash. Thins abruptly from several meters on crater rim (northern edge of Lassen Peak summit) to a few centimeters at edge of deposit.	Volcanic Features—tephra (ash). Consists mainly of material derived from dacite dome of Lassen Peak (PEdl). Ejected in steam-blast eruptions from crater in the northwestern part of the Lassen Peak summit.	Volcano Hazards—steam explosions from Lassen volcanic center.	Recent Volcanic Activity—deposited mainly during May and June 1917.
	1915 CE, viscous debris-flow deposits, 22 May (Hw2)	Slope-movement deposits (HPEsm)	Nonsorted, unconsolidated, nonbedded debris-flow deposits with lapilli and blocks, greater than 1 m (3 ft) and rarely to 2 m (7 ft) across, in a sandy to silty matrix. Generally lobate with scarp-like margins as high as 2 m (7ft). Thickness ranges from a few decimeters to about 3 m (10 ft).	Volcanic Features—dominated by banded and light-colored pumice of the 22 May 1915 eruption but also contains fragments of Hd9 , Hd4 , and PEdl . Lakes—created Hat Lake, adjacent to Devastated Area, in 1915.	Volcano Hazards/Slope Movements—formed by debris flows from steep upper slopes of Lassen Peak after major pumice eruption of 22 May 1915. The two largest debris flows occur in lower Devastated Area and upper Manzanita Creek.	Recent Volcanic Activity—deposited 22 May 1915.
	1915 CE, pumice-fall deposit, 22 May (Hp2)	Lassen volcanic center, Twin Lakes sequence, younger (HPE-Lty)	Well-sorted, unconsolidated, thick-to-thin beds of dacitic (precise SiO ₂ content not provided; see table 1 for general range) pumice. Mapped on northern and eastern sides of Lassen Peak, where thickness generally exceeds 2 m (7 ft).	Volcanic Features—tephra (pumice). Consists of blocks, lapilli, and ash.	Volcano Hazards—tephra erupted from Lassen Peak on afternoon of 22 May 1915.	
	1915 CE, pyroclastic-flows and debris-flows, 22 May (Hpw2)		Nonsorted, unconsolidated, nonbedded material with lapilli and blocks of Hd9 , Hd4 , and PEdl as large as 3 m (10 ft) in a sandy to silty matrix. Blocks of banded pumice with dark-gray andesitic (59.7%–61.0% SiO ₂) and light-gray to nearly white dacitic (64.2%–66.8% SiO ₂). Layers are conspicuous and diagnostic. Contains abundant fragments of wood, some charred, including numerous decayed logs lying in positions pointing downslope away from summit of Lassen Peak.	Volcanic Features—pyroclastic flows. Consists of pyroclastic-flow and associated debris-flow deposits erupted on the afternoon of 22 May 1915 that grade into each other in middle Devastated Area.	Volcano Hazards—pyroclastic flows are extremely hazardous due to their high speeds and temperatures. Slope Movements—debris flows. Exposed in the middle to lower Devastated Area on northeastern side of Lassen Peak and in drainages of Lost Creek and Hat Creek to near Old Station.	
	1915 CE, dacite flow, 19–20 May (Hd9)		Dacite (64%–65% SiO ₂) erupted from vent at summit of Lassen Peak that was reopened by phreatic explosion on evening of 19 May 1915. Lava filled crater and flowed through notch on western side of summit and approximately 300 m (1,000 ft) down western flank. Another similar flow on northeastern flank was removed during pyroclastic eruption of 22 May 1915.	Volcanic Features—lava flows. Was still fluid enough on 22 May, two days after the eruption, to partially slump back into the crater created by pyroclastic eruption (Hpw2). Has uneroded, spiny aa surface with 5–10 m (16–33 ft) of relief.	Volcano Hazards—lava flows are one type of hazard at Lassen volcanic center; other hazards are pyroclastic flows, tephra, lahars, and construction of lava domes.	
	1915 CE, avalanche and debris-flows, 19–20 May (Hsw9)		Composite unit. <u>Avalanche deposit</u> —composed of nonsorted, unconsolidated, nonbedded debris from Hd4 , PEdl , Hpc , and much wood debris. <u>Debris-flow deposits</u> —composed of nonsorted, unconsolidated, generally nonbedded sand to boulders as much as 3 m (10 ft) in diameter of fragments of Hd4 , PEdl , Hpc , and logs derived from underlying avalanche deposit of 19–20 May 1915 or adjacent areas of forest. Debris-flow was deposited immediately following avalanche.	Volcanic Features—avalanche deposit occurs in Devastated Area on northeastern side of Lassen Peak and across low divide northeast of Emigrant Pass in Hat Creek drainage. Debris-flow deposit occurs in Devastated Area on northeastern side of Lassen Peak and down Lost Creek drainage to a few kilometers east of Twin Bridges. Glacial Features—avalanche deposit originated in cirque at the top of the eastern face of Lassen Peak.	Volcano Hazards— Hp9 , which was thrown onto the snow-covered upper flanks and summit of Lassen Peak, initiated avalanche of snow and rock (Hsw9). Slope Movements—debris flows. Near margins, numerous standing trees predating deposits are scarred from collisions with boulders and logs carried in debris flows. Piles of boulders and logs behind large trees or boulders are common along margins of deposit.	Recent Volcanic Activity—deposited late in the evening of 19 May 1915 and early morning of 20 May 1915.
	1915 CE, pyroclastic deposit, 19 May (Hp9)		Nonsorted, unconsolidated, nonbedded deposit of blocks to fine lithic ash, consisting entirely of dense clasts of Hd4 and PEdl . Ranges from a layer approximately 4 m (13 ft) thick to a field of discontinuous blocks.	Volcanic Features—pyroclastic flow. Preserved only in Lassen Peak summit area.	Volcano Hazards—ejected by phreatic explosion that opened summit crater through dacite dome (Hd4).	Recent Volcanic Activity—emplaced late in evening of 19 May 1915.
	1915 CE, dacite dome, 14–19 May (Hd4)		Dacite (64%–65% SiO ₂) that forms remnants of a small dome at summit of Lassen Peak.	Volcanic Features—lava dome. The dome filled the crater excavated by phreatic explosions that began on 30 May 1914, and was partially disrupted by single large phreatic explosion on evening of 19 May 1915.	Volcano Hazards—construction of lava domes is one type of hazard at Lassen volcanic center; other hazards include pyroclastic flows, tephra, lahars, and lava flows.	Recent Volcanic Activity—emplaced between about 14 May and evening of 19 May 1915.

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HOLOCENE	Basaltic andesites of Cinder Cone, Fantastic Lava Beds, flow 2 (Hmf2) Cinders (Hmfci)	Lassen volcanic center, Twin Lakes sequence, younger (HPE-Lty)	Thin to thick, block-lava flow of basaltic andesite (55.1%–56.2% SiO ₂) erupted from southern base of Cinder Cone. Hmfci consists of cinders related to the explosion of Hmf2 .	Volcanic Features—lava flows and cinder cone. Lakes—lava flowed in a channel across Hmf1 and entered Butte Lake.	Volcano Hazards—this cinder cone sequence is part of Lassen volcanic center (vs. regional volcanism).	Recent Volcanic Activity—deposited during a single volcanic episode in 1666 CE.
	Basaltic andesites of Cinder Cone, Fantastic Lava Beds, flow 1 (Hmf1)		Block-lava flow as thick as 20 m (70 ft) of basaltic andesite (56.4%–57.3% SiO ₂). Erupted from southern base of Cinder Cone. Comprises Cinder Cone and a ring of dense agglutinate bombs as large as 3 m (10 ft) across at base of Cinder Cone.	Volcanic Features—lava flows. Lava flowed south over Painted Dunes flows toward Snag Lake then veered north to Butte Lake and now crops out in the area between Cinder Cone and Butte Lake. Lakes—small outcrop on eastern shore of Butte Lake demonstrates that Hmf1 lava underlies much of the lake basin.		
	Basaltic andesites of Cinder Cone, Painted Dunes, flow 2 (Hmp2)		Andesitic (57.1%–59.7% SiO ₂) block-lava flow as much as 40 m (130 ft) thick. Erupted from earlier cone at base of Cinder Cone.	Volcanic Features—lava flows and tephra. Poorly preserved ash from Cinder Cone on this flow. Occurs primarily south of base of Cinder Cone to shore of Snag Lake. Ash-covered kipukas in area of Fantastic Lava Beds flows near Butte Lake indicate that Hmp2 is more extensive than present outcrop area and was partially buried by Fantastic Lava Beds flows (Hmf1 and Hmf2). Lakes—Lava flowed south from base of remnant cone over Painted Dunes flow 1 (Hmp1) toward Snag Lake then veered north toward Butte Lake.		
	Basaltic andesites of Cinder Cone, Painted Dunes, flow 1 (Hmp1) Cinders (Hmpci)		Basaltic andesite (54.1%–56.1% SiO ₂). Erupted from remnant cone at southern base of Cinder Cone. Thickness up to 40 m (130 ft). Hmpci consists of cinders related to the explosion of Hmp1 .	Volcanic Features—lava flows, tephra, and cinder cone. Covered by Painted Dunes ash deposit that characterizes Painted Dunes area of the park. Ash-covered kipukas in area south of continuous outcrop indicate that flow is more extensive and was partially buried by younger flows (Hmp2 , Hmf1 , and Hmf2). Lakes—created Snag Lake. Lava flowed south toward [what is now] Snag Lake then veered north toward Butte Lake.		
	Basaltic andesites of Cinder Cone, Painted Dunes, Old Bench flow (Hmo)		Basaltic andesite (53.5%–54.1% SiO ₂) lava flows. Erupted from remnant cone at the eastern base of Cinder Cone. Thickness up to 10 m (33 ft).	Volcanic Features—lava flows and tephra. Almost completely covered with a several-meter-thick deposit of weakly oxidized ash from later eruptions of Cinder Cone; only a few pinnacles of Hmo lava extend through the ash. Flow was more extensive than shown on the map and is mostly buried by Painted Dunes and Fantastic Lava Beds flows.		
LATE PLEISTOCENE	Andesite of Hat Mountain (PEah) Cinders (PEahci)		Andesite (58.0%–61.6% SiO ₂) lava flows. Vent is marked by breached cone of agglutinated cinder and spatter. Thickness generally 100 m (330 ft). PEahci consists of cinder and agglutinate cones.	Volcanic Features—lava flows and cinder cone. Glacial Features—entire edifice has been glaciated; original block surface of lava flows was removed by erosion.	Volcano Hazards—hazards at Lassen volcanic center include pyroclastic flows, tephra, lahars, lava flows, and the construction of lava domes.	Recent Volcanic Activity—emplaced 40,000 years ago.
	Andesite of Eagle Peak (PEae)		Heterogeneous unit formed by mixing of rhyodacite of Eagle Peak (PEre) and andesite magmas. Variable lithology (61%–68% SiO ₂).	Hydrothermal Features—poorly exposed in small area of mostly oxidized and altered rock between Ski Heil Peak and Eagle Peak.		Volcanic Center (Lassen)—emplaced 65,900 years ago.
	Basaltic andesite of Fairfield Peak (PEmfp) Cinders (PEmfpici)		Basaltic andesite (54.4% SiO ₂). Erupted from vent marked by agglutinate cone of Fairfield Peak. PEmfpici consists of cinder and agglutinate cones.	Volcanic Features—short stubby lava flow and cinder cone. Cone is composed of scoria, cinders, and blocks of vesicular lava armored by agglutinated surface. Glacial Features—original block surface of flow has been removed by glacial erosion. Till, younger glaciation (PEty) buries part of PEmfp .		Volcanic Center (Lassen)—emplaced 82,000 years ago.

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LATE PLEISTOCENE	Andesite of Crater Butte (PEac)	Lassen volcanic center, Twin Lakes sequence, younger (HPE-Lty)	Andesite (60.4%–60.5% SiO ₂) lava flow. Erupted from vent marked by agglutinate cone. Thickness as much as 150 m (490 ft).	Volcanic Features—lava flows and cinder cone.	Volcano Hazards—hazards at Lassen volcanic center include pyroclastic flows, tephra, lahars, lava flows, and the construction of lava domes.	Volcanic Center (Lassen)—emplaced 93,000 years ago.	
	Cinders (PEacci)		PEacci consists of cinder and agglutinate cones.	Glacial Features—original block surface of flow has been removed by glacial erosion.			
MIDDLE PLEISTOCENE	Andesite and basaltic andesite of Cluster Lakes (PEacl)	Lassen volcanic center, Twin Lakes sequence, older (HPE-Lto)	Andesite (56.6%–57.9% SiO ₂) of two lava flows, one near vent and another in Box Canyon. Erupted from vent marked by agglutinate cone (PEaclci).	Volcanic Features—lava flows and cinder cone.		Volcanic Center (Lassen)—estimated age, 300,000–250,000 years ago.	
	Cinders (PEaclci)		PEaclci consists of cinder and agglutinate cones.	Glacial Features—original block surfaces have been removed by glacial erosion.			
	Andesite of Raker Peak (PEarp)		Andesite (57.4%–58.7% SiO ₂) lava flows.	Volcanic Features—lava flows, also forms a lava cone with agglutinate scoria at vent. Raker Peak (2,281 m; 7,483 ft) was the vent for the andesite of Raker Peak.			Glacial Features—nearly entire unit, except the northern distal portions of lava flows and summit area, has been glaciated.
Cinders (PEarpci)	PEarpci consists of cinder and agglutinate cones.						
HOLOCENE	Rhyodacite of Chaos Crags, talus, emplaced hot from domes B–F (Hcc)	Lassen volcanic center, Eagle Peak sequence (HPE-Le)	Laterally sorted deposits of nonbedded blocks from Chaos Crags domes B–F (PErcb , PErcc , PErcd , PErce , and PErcf). Deposited at the base of domes.	Volcanic Features—initially talus was emplaced while lava was still hot.	Volcano Hazards—hazards at Lassen volcanic center include pyroclastic flows, tephra, lahars, lava flows, and the construction of lava domes.	Volcanic Center (Lassen)—emplaced 1,050 years ago.	
	Rhyodacite of Chaos Crags, dome F (Hrcf)		Rhyodacite (67%–68% SiO ₂) lava dome. Erupted into the scar created by partial collapse of dome E (Hrce) and covered its vent.	Volcanic Features—lava dome. Part of Chaos Crags, which consists of six rhyodacitic lava domes (Hrca – Hrcf) and associated pyroclastic deposits.			
	Rhyodacite of Chaos Crags, lithic pyroclastic-flow deposit from partial collapse of dome E (Hpce)		Nonsorted, unconsolidated, nonbedded deposit of fine rubble to blocks commonly as large as 2 m (7 ft) across, a few as large as 10 m (30 ft) across. Deposit on eastern side of Chaos Crags. Consists entirely of fragments from dome E (Hrce).	Volcanic Features—pyroclastic flow. Emplaced while lava was still hot. Formed by partial collapse of dome E (Hrce) before emplacement of dome F (Hrcf) in resulting avalanche scar.			Volcano Hazards—pyroclastic flows are extremely hazardous due to their high speeds and temperatures.
	Rhyodacite of Chaos Crags, dome E (Hrce)		Rhyodacite (67%–68% SiO ₂) lava dome. Erupted from a vent now covered by the dome.	Volcanic Features—lava dome. Partial collapse of dome E produced a pyroclastic flow (Hrpe).			Volcano Hazards—hazards at Lassen volcanic center include pyroclastic flows, tephra, lahars, lava flows, and the construction of lava domes.
	Rhyodacite of Chaos Crags, lithic pyroclastic-flow deposit from partial collapse of dome D (Hpcd)		Nonsorted, unconsolidated, nonbedded deposit of fine rubble to blocks as large as about 2 m (7 ft), a few to 10 m (33 ft). Consists of material derived from dome B (Hrcb) and dome D (Hrcd).	Volcanic Features—pyroclastic flow. Emplaced hot. Formed by partial collapse of dome D (Hrcd). Resultant avalanche swept across surface and incorporated pumiceous blocks from underlying dome B (Hrcb). Blocks derived from dome D (Hrcb) were either still hot from emplacement of the dome or were reheated in the hot deposit.			
	Rhyodacite of Chaos Crags, dome D (Hrcd)		Rhyodacite (69% SiO ₂) lava dome. Erupted from a vent now covered by the dome.	Volcanic Features—lava dome. Dome D has the highest elevation of the six Chaos Crags lava domes. Partial collapse of dome D produced a hot lithic pyroclastic flow (Hpcd).			

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Age	Map Unit (Symbol) GIS Data	Geologic Map Graphic (Symbol) Map 1 (in pocket)	Geologic Description	Geologic Features and Processes	Geologic Issues	Geologic History
HOLOCENE	Rhyodacite of Chaos Crag, dome C (Hrcc)	Lassen volcanic center, Eagle Peak sequence (HPE-Le)	Dacite (68% SiO ₂) lava dome. Erupted from a vent now covered by the dome.	Volcanic Features—lava dome. Rocks from Brokeoff Volcano (PEad) at summit of dome C indicate dome grew as a solid plug.	Volcano Hazards—hazards at Lassen volcanic center include pyroclastic flows, tephra, lahars, lava flows, and the construction of lava domes. Slope Movements—nearly vertical, northwest-facing cliff of dome C breakaway scar of Chaos Jumbles avalanche deposits (Hsj) exposes strongly oxidized pink dacite of dome C's interior.	Volcanic Center (Lassen)—emplaced 1,050 years ago. Chaos Jumbles (Hsj), which is composed primarily of Hrcc , was deposited 278 ± 28 years BP.
	Rhyodacite of Chaos Crag, dome B (Hrcb)		Rhyodacite (69.5%–70% SiO ₂) lava dome. Erupted from and partially filled and buried the tuff cone of upper pyroclastic flow of unit Hpc .	Volcanic Features—relatively flat-topped lava dome. Lava flowed sluggishly north.	Volcano Hazards—pyroclastic flows are extremely hazardous due to their high speeds and temperatures.	Volcanic Center (Lassen)—emplaced 1,050 years ago.
	Rhyodacite of Chaos Crag, pumiceous pyroclastic-flow and fall deposits (Hpc)		Includes three pumiceous pyroclastic flows, a coignimbrite (fallout tephra deposited from a pyroclastic flow) of nearly white rhyodacite pumice, and two tuff cones.	Volcanic Features—pyroclastic flow and tephra. Eruption of Hpc destroyed dome A (Hrca); blocks of dome A are common in proximal exposures of the upper pyroclastic flow of Hpc .	Volcano Hazards—hazards at Lassen volcanic center include pyroclastic flows, tephra, lahars, lava flows, and the construction of lava domes. In Manzanita Creek, upper pyroclastic flow transformed into a lahar and flowed nearly to the site of McCumber Reservoir.	
	Rhyodacite of Chaos Crag, dome A (Hrca)		Rhyodacite (69.5%–70% SiO ₂) lava dome. Erupted into and partially filled tuff cone from which the lower and middle pyroclastic flows (Hpc) erupted.	Volcanic Features—lava dome mostly destroyed by the eruption of upper pyroclastic flow of Hpc and only a remnant of the original dome remains. Fragments of dome A are abundant in the upper pyroclastic flow (Hpc) within 1–2 km (0.6–1.2 mi) of the vent.	Volcano Hazards—hazards at Lassen volcanic center include pyroclastic flows, tephra, lahars, lava flows, and the construction of lava domes.	
LATE PLEISTOCENE	Dacite of Lassen Peak, lithic pyroclastic-flow deposit from partial collapse of dome (PEpfl)		Poorly sorted, unconsolidated, nonbedded volcanic ash to blocks as large as 3 m (10 ft) across, consisting of dacite (68.0% SiO ₂) that is lithologically identical to the dacite dome of Lassen Peak (PEdl). Thickness ranges from feather edge to as much as 50 m (160 ft).	Volcanic Features—pyroclastic flow. Formed by hot, dome-collapse, pyroclastic flows during emplacement of Lassen Peak dacite dome (PEdl). Forms sheet at northeastern base of Lassen Peak, incised by upper Lost Creek. Also exposed in the north-facing toe of Survivors Hill and present in subsurface at Emigrant Pass (north of the Devastated Area parking lot).	Volcano Hazards—pyroclastic flows are extremely hazardous due to their high speeds and temperatures.	
	Dacite of Lassen Peak, dome (PEdl)		Large dacite dome, 2 km ³ (0.5 mi ³), covers its vent. Composition ranges from approximately 70% SiO ₂ in northeast-projecting ridge to approximately 63.5% SiO ₂ in spine low on northwestern side above upper Manzanita Creek, but bulk of dome is 66%–68% SiO ₂ .	Volcanic Features—world's largest lava dome.	Volcano Hazards—hazards at Lassen volcanic center include pyroclastic flows, tephra, lahars, lava flows, and the construction of lava domes.	Volcanic Center (Lassen)—emplaced 27,000 years ago.
	Rhyodacite of Kings Creek, flows (PErk)		Thick rhyodacite (69.1%–70.3% SiO ₂) lava flows that erupted from vent (small, poorly preserved tuff cone) at the eastern end of [what is now] the Lassen Peak parking lot.	Volcanic Features—lava flows. Glacial Features—although glaciated, flow morphology is well preserved.		Volcanic Center (Lassen)—emplaced 35,000 years ago.
	Rhyodacite of Kings Creek, pumiceous pyroclastic-flow deposits (PEpk)		Poorly sorted, unconsolidated volcanic ash, with pumice blocks to approximately 1 m (3 ft) across. Pumice is light gray to white, glassy, coarsely pumiceous, and weathers to pale yellow. Pumice consists of rhyodacite (69.1%–70.6% SiO ₂) lithologically identical to PErk .	Volcanic Features—pyroclastic flows and tephra (pumice). Tuff cone just east of Lassen Peak parking lot marks the vent. Glacial Features—original extent of PEpk was markedly reduced by glacial erosion.		

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Age	Map Unit (Symbol) GIS Data	Geologic Map Graphic (Symbol) Map 1 (in pocket)	Geologic Description	Geologic Features and Processes	Geologic Issues	Geologic History
LATE PLEISTOCENE	Rhyodacite of Sunflower Flat, domes (PErsf)	Lassen volcanic center, Eagle Peak sequence (HPE-Le)	Overlapping complex of eight rhyodacite (68.3%–70.0% SiO ₂) domes.	Volcanic Features—lava domes. Erupted in a linear array north of Chaos Crags. Glacial Features—overlain by lateral moraines of till of Anklin Meadows (PEta) on northern flank.	Volcano Hazards—hazards at Lassen volcanic center include pyroclastic flows, tephra, lahars, lava flows, and the construction of lava domes.	Volcanic Center (Lassen)—emplaced 41,000 years ago.
	Rhyodacite of Sunflower Flat, pumiceous pyroclastic-flow deposits (PEpsf)		Poorly to moderately sorted, unconsolidated, volcanic ash with pumice blocks (rhyodacite, 69.0%–69.3% SiO ₂) as large as 50 cm (20 in) across.	Volcanic Features—pyroclastic flows. Occurs as pyroclastic flows from Sunflower Flat to Lost Creek and as proximal fall deposits (not mapped separately) forming a pumice crater southeast of Sunflower Flat.	Volcano Hazards—pyroclastic flows are extremely hazardous due to their high speeds and temperatures.	
	Rhyodacite of Krummholz (PEkr)		Rhyodacite (68.3%–69.3% SiO ₂) flow. Small dome marks the vent.	Volcanic Features—lava dome and lava flows. Mostly obscured by thick blanket of pumice from Chaos Crags eruption (Hpc). Glacial Features—dome and flow are glaciated.	Volcano Hazards—hazards at Lassen volcanic center include pyroclastic flows, tephra, lahars, lava flows, and the construction of lava domes.	Volcanic Center (Lassen)—emplaced 43,000 years ago.
	Rhyodacite of section 27 (PEr27)		Rhyodacite (69.7%–69.8% SiO ₂) lava flows on the northern flank of Lassen Peak. Vent was probably in the area now occupied by Lassen Peak.	Volcanic Features—lava flows. Glacial Features—flows are slightly to moderately glaciated, and original flow morphology and pumiceous carapace (outer "shell" or covering) are preserved in some places.		Volcanic Center (Lassen)—emplaced 50,000 years ago.
	Rhyodacite of Eagle Peak, dome and flow (PEre)		Rhyodacite (71.0%–71.6% SiO ₂) lava flow with summit dome that overlies its vent.	Volcanic Features—lava dome and lava flows. Glacial Features—although glaciated, flow morphology is well preserved.		Volcanic Center (Lassen)—emplaced 66,000 years ago.
	Rhyodacite of Eagle Peak, pumiceous pyroclastic-flow deposits (PEpe)		Rhyodacite (70.9% SiO ₂) pumice pyroclastic flow; similar in composition to PEre . Contains white, poorly sorted, matrix-supported, unconsolidated ash, lapilli, and pumice blocks. Erupted from a vent now covered by dome and lava flow (PEre). Most extensive area of outcrop is west of Manzanita Lake, where deposit occurs as a single approximately 2-m- (7-ft-) thick bed.	Volcanic Features—pyroclastic flows. Immediately preceded eruption of and is the same age as the associated dome and lava flow (PEre). Glacial Features—preserved only beyond limits of late Pleistocene glaciation.	Volcano Hazards—pyroclastic flows are extremely hazardous due to their high speeds and temperatures.	Volcanic Center (Lassen)—emplaced 66,000 years ago.
MIDDLE PLEISTOCENE	Rhyodacite of Dersch Meadows (PErd)	Lassen volcanic center, Bumpass sequence (PE-Lb)	Thick rhyodacite (69.4% SiO ₂) lava flow. Vent location unknown but probably east of Paradise Meadows.	Volcanic Features—lava flow. Glacial Features—five discrete outcrop areas are separated by extensive cover of till (PEty and PEta). Pumiceous upper surface of flow has been removed by glacial erosion.	Volcano Hazards—hazards at Lassen volcanic center include pyroclastic flows, tephra, lahars, lava flows, and the construction of lava domes.	Volcanic Center (Lassen)—193,000 ± 11,000 years ago. Last unit of Bumpass sequence to be emplaced.
	Dacite of Reading Peak (PEdr)		Complex of dacite (64.9%–68.9% SiO ₂) lava domes. Lithology and composition of dacite is slightly variable.	Volcanic Features—lava domes. Dome complex rivaled Lassen Peak in volume at the time of emplacement. Glacial Features—extensively glaciated. Includes protalus ramparts and small moraines on north-facing upper slopes of domes.		Volcanic Center (Lassen)—212,000 ± 5,000 years ago.

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Age	Map Unit (Symbol) GIS Data	Geologic Map Graphic (Symbol) Map 1 (in pocket)	Geologic Description	Geologic Features and Processes	Geologic Issues	Geologic History
MIDDLE PLEISTOCENE	Dacite of Bumpass Mountain (PEdb) Explosion breccia (PEdbbr)	Lassen volcanic center, Bumpass sequence (PE-Lb)	Dacite (64.1%–64.4% SiO ₂) dome and lava flow. Thickness greater than 100 m (300 ft). PEdbbr is explosion breccia related to PEdb .	Volcanic Features—lava dome and lava flows. Lava flow emerged from beneath the dome at Bumpass Mountain and flowed southeast for several kilometers, covering approximately 12 km ² (5 mi ²). Remnants of a fragmental deposit related to dacite of Bumpass Mountain (PEdb) are preserved in area south and west of Bumpass Mountain. Hydrothermal Features—the Bumpass Hell thermal area occupies the area of the Bumpass Mountain vent. Glacial Features—extensively glaciated; original glassy carapace of dome completely stripped. Glacial erosion greatly reduced original extent of lava flow.	Volcano Hazards—hazards at Lassen volcanic center include pyroclastic flows, tephra, lahars, lava flows, and the construction of lava domes. Also, phreatic (steam) eruption that deposited PEdbbr .	Volcanic Center (Lassen)—232,000 ± 8,000 years ago.
	Dacite of Crescent Crater (PEdc)		Lithologically and compositionally zoned unit composed of dacite (65.6% SiO ₂) dome and thick rhyodacite (68.9% SiO ₂) lava flow. Dome covers the vent.	Volcanic Features—lava dome and lava flows. Glacial Features—depression at the summit is a cirque that exposes interior of dome.	Volcano Hazards—hazards at Lassen volcanic center include pyroclastic flows, tephra, lahars, lava flows, and the construction of lava domes.	Volcanic Center (Lassen)—236,000 ± 1,000 years ago.
	Dacite of Ski Heil Peak (PEds)		Dacite (64.2%–66.5% SiO ₂) dome that covers its vent.	Volcanic Features—lava dome. Summit area of dome is covered by pumiceous pyroclastic-flow deposits (PEpe) of Eagle Peak. Glacial Features—extensively glaciated.	Volcano Hazards—hazards at Lassen volcanic center include pyroclastic flows, tephra, lahars, lava flows, and the construction of lava domes.	Volcanic Center (Lassen)—244,000 ± 10,000 years ago.
	Dacite of Mount Helen (PEdh)		Large dacite (65.5% SiO ₂) dome forming Mount Helen. Vent was beneath Mount Helen on steep flank of Brokeoff Volcano.	Volcanic Features—lava dome and lava flows. Some lava flowed eastward towards Kings Creek Meadows to produce short, thick lava flow. Glacial Features—extensively glaciated.	Volcano Hazards—hazards at Lassen volcanic center include pyroclastic flows, tephra, lahars, lava flows, and the construction of lava domes.	Volcanic Center (Lassen)—249,000 ± 12,000 years ago.
	Dacite under Mount Helen (PEduh)		Dacite (64.2% SiO ₂) that forms small remnant of dome on northern flank of Mount Helen.	Volcanic Features—lava dome. Dacite of Mount Helen (PEdh) buried much of PEduh . Glacial Features—extensively glaciated. Only a small area of the interior of the dome remains.	Volcano Hazards—hazards at Lassen volcanic center include pyroclastic flows, tephra, lahars, lava flows, and the construction of lava domes.	Volcanic Center (Lassen)—estimated age, 260,000–250,000 years ago.
	Dacite of Summit Creek (PEdsc)		Thick flow and associated fragmental deposits of dacite (65.0% SiO ₂) exposed in Kings Creek drainage. Location of source vent is unknown but is probably located near Reading Peak.	Volcanic Features—lava flows. Glacial Features—source vent is probably buried beneath glacial deposits or younger dacites. Flow was extensively glaciated; its original form is poorly preserved.		
	Dacite of Lassen Peak parking lot (PEdpl)		Dacite (63.7% SiO ₂) lava dome.	Volcanic Features—lava dome. Glacial Features—extensively glaciated.		

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MIDDLE PLEISTOCENE	Dacite of Vulcans Castle (PEdv)	Lassen volcanic center, Bumpass sequence (PE-Lb)	Dacite (65.6%–66.5% SiO ₂) lava dome.	Volcanic Features—lava dome. Glacial Features—highly sculpted by glacial erosion and slope movements.	Volcano Hazards—hazards at Lassen volcanic center include pyroclastic flows, tephra, lahars, lava flows, and the construction of lava domes. Slope Movements—lava dome susceptible to slope movement.	Volcanic Center (Lassen)—estimated age, 260,000–250,000 years ago, but could be slightly older.
	Dacite of hill 8283 (PEd82)		Dacite (65.7%–66.4% SiO ₂) dome and lava flow. Hill 8283 marks vent.	Volcanic Features—lava dome and lava flows. Lava flowed 3.5 km (2.2 mi) north toward Lost Creek. Glacial Features—flow is heavily glaciated. Carapace is entirely stripped. Dome is also heavily glaciated, but remnants of its pumiceous carapace are preserved.	Volcano Hazards—hazards at Lassen volcanic center include pyroclastic flows, tephra, lahars, lava flows, and the construction of lava domes.	Volcanic Center (Lassen)—261,000 ± 5,000 years ago.
	Dacite of upper Manzanita Creek (PEdmz)		Dacite (66.0%–67.0% SiO ₂) dome.	Volcanic Features—lava dome. Glacial Features—dome is heavily glaciated. Streams and Waterfalls—glacial and fluvial erosion along Manzanita Creek cut the single dome into several remnants.		Volcanic Center (Lassen)—estimated age, 280,000–265,000 years ago.
	Rhyodacite of Manzanita Chute (PErmz)		Rhyodacite (69.3% SiO ₂) lava flow and dome. Erupted from vent beneath summit dome.	Volcanic Features—lava dome and lava flows. Lava flowed downhill (northwest) about 3 km (2 mi). Glacial Features—although unit is older than several glacial advances, flow is unglaciated and has well-preserved flow morphology such as well-defined crescentic flow ridges and a pumiceous carapace.		Volcanic Center (Lassen)—297,000 ± 1,000 years ago.
	Rhyodacite of Mount Conard (PErmc)		Rhyodacite (69.1%–71.0% SiO ₂) lava flows on northern, western, and southeastern flanks of Mount Conard, including remnant of lava flow at Terrace Lake.	Volcanic Features—lava flows. Appear to have flowed southward from a yet-to-be-identified vent that was high on eastern flank of Brokeoff Volcano.		Volcanic Center (Lassen)—298,000 ± 9,000 years ago. Lava flows are associated with early part of the Bumpass sequence.
	Rhyodacite of Loomis Peak (PElrm)		Thick rhyodacite (68.6% SiO ₂) lava flow, which erupted from vent located at approximately Loomis Peak and flowed northwest.	Volcanic Features—lava flows. One of the oldest units of Lassen domefield. Glacial Features—extensive glacial erosion of flow margins.		Volcanic Center (Lassen)—estimated age, 300,000 years ago.
MIDDLE PLEISTOCENE	Andesite of Mount Diller (PEamd)	Lassen volcanic center, Brokeoff Volcano, Diller sequence (PE-Lvd)	Andesite (61.2%–63.0% SiO ₂) lava flows erupted from vent high on northern flank of Brokeoff Volcano. Vent is not preserved. Thickness of flow is 300–400 m (1,000–1,300 ft) on ridge oriented northwest from Mount Diller.	Volcanic Features—remnant of composite volcano and lava flows. Youngest lava of the Diller sequence. Forms the uppermost slopes of Brokeoff Volcano on its western, northern, and northeastern flanks. Hydrothermal Features—flows bordering core of Brokeoff Volcano are hydrothermally altered to varying degrees.		Volcano Hazards—none at present; part of extinct Brokeoff Volcano. Slope Movements—hydrothermally altered core of Brokeoff Volcano is prone to landslides.
	Andesites of Diller sequence, undivided (PEad)		Andesite (60%–63% SiO ₂) lava flows.	Volcanic Features—lava flows. Outcrops occur on northern and western sides of Lassen domefield. Glacial Features and Processes—younger glacial and volcanic deposits obscure vents and extent of these lava flows.	Volcanic Center (Lassen)—estimated age, 470,000–400,000 years ago.	

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MIDDLE PLEISTOCENE	Andesite of Digger Creek (PEadc)	Lassen volcanic center, Brokeoff Volcano, Diller sequence (PE-Lvd)	Andesite (61.3%–61.9% SiO ₂) lava flows erupted from vent that is not preserved but was higher on western flank of Brokeoff Volcano than hill 8198. Thickness 30–60 m (100–200 ft).	Volcanic Features—lava flows. Forms the upper slopes of Brokeoff Volcano on its western flank. Lava flowed west and was diverted around dome of Red Rock Mountain. Glacial Features—typical outcrops are glaciated cliffs.	Volcano Hazards—none at present; part of extinct Brokeoff Volcano. Slope Movements—hydrothermally altered core of Brokeoff Volcano is prone to landslides.	Volcanic Center (Lassen)—451,000 ± 10,000 years ago.
	Andesite of Manzanita Creek (PEamz) Cinders (PEamzci)		Andesite (62.6% SiO ₂) block-lava flow. Erupted from vent marked by small cinder cone south of Manzanita Lake that consists of PEamzci . PEamzci consists of cinder and agglutinate cones.	Volcanic Features—cinder cone and lava flows. Eroded cinder cone is built of andesite scoria. Lava flowed from cone west for 8 km (5 mi). Glacial Features—lava flow is unglaciated and retains considerable original flow morphology.		Volcanic Center (Lassen)—estimated age, 450,000–425,000 years ago.
	Andesite of Glassburner Meadows (PEag)		Andesite (61.4%–61.7% SiO ₂) lava flows erupted from unpreserved vent on southern flank of Brokeoff Volcano. Thickness 30–60 m (100–200 ft).	Volcanic Features—lava flows. Forms uppermost slopes of Brokeoff Volcano on part of its southern flank. Glacial Features—lava flow was glaciated, and typical outcrops are small cliffs exposing flow interiors.		Volcanic Center (Lassen)—not dated, but probably similar in age to andesite of Digger Creek (PEadc , 451,000 ± 10,000 years ago).
	Andesite of Bluff Falls quarry (PEabf)		Andesite (59.0%–59.1% SiO ₂) lava flows erupted from unpreserved vent on southern flank of Brokeoff Volcano. Thickness 30–60 m (100–200 ft).	Volcanic Features—lava flows. Glacial Features—typical outcrops are glacially eroded cliffs that expose flow interiors.		Volcanic Center (Lassen)—467,000 ± 10,000 years ago.
	Andesite of Rice Creek (PEar)		Andesite (62.4%–63.0% SiO ₂) lava flows erupted from unpreserved vent on eastern flank of Brokeoff Volcano. Thickness 30–60 m (100–200 ft).	Volcanic Features—lava flows. Unit is oldest of Diller sequence lavas. Glacial Features—typical outcrops are glacially eroded cliffs that expose flow interiors. Streams and Waterfalls—Kings Creek Falls spills over PEar bedrock.		Volcanic Center (Lassen)—two different samples yielded K-Ar ages of 485,000 ± 12,000 and 477,000 ± 14,000 years ago.
MIDDLE PLEISTOCENE	Dacite of Twin Meadows (PEdt)	Lassen volcanic center, Brokeoff Volcano, Mill Canyon sequence (PE-Lvm)	Dacite (66.1%–68.0% SiO ₂) lava flows. Vent area not preserved. Thickness generally 100 m (330 ft), but as much as 200 m (660 ft).	Volcanic Features—lava flows. Flows cap Mill Canyon sequence and form the most important widespread stratigraphic marker of Brokeoff Volcano. Flows occur high on southwestern flank of Brokeoff Mountain and form most of upper part of the mountain.	Volcano Hazards—none at present; part of extinct Brokeoff Volcano. Slope Movements—hydrothermally altered core of Brokeoff Volcano is prone to landslides. Flows in area below Mount Diller and Pilot Pinnacle are strongly altered, as are flows near Cold Boiling Lake.	Volcanic Center (Lassen)—470,000 ± 10,000 years ago.
	Andesites of Mill Canyon (PEamc)		Variety of basaltic andesite and andesite lava flows and sparse dacite lava flows (55%–65% SiO ₂). Overwhelming majority of lavas contains 57%–61% SiO ₂ , and the average of 40 samples of Mill Canyon sequence andesites is 58.5% SiO ₂ . These flows and associated fragmental deposits erupted from central vents that cannot be located precisely.	Volcanic Features—primarily lava flows, but includes tephra fallout and lithic pyroclastic flow deposits. Forms older part of Brokeoff Volcano. Hydrothermal Features—core of Brokeoff Volcano is variably hydrothermally altered and "fresh" rock is rare. In areas of intense active hydrothermal alteration, rocks are so extensively altered that their original lithology is difficult to determine; typically, these are light-gray or orange-brown, altered andesite, but locally there are areas of kaolinite and silica with scattered blocks of intensely altered rock. Streams and Waterfalls—Mill Creek Falls spills over PEamc bedrock.		Volcano Hazards—lahar deposits are common in Mount Conard area. Pyroclastic flows are extremely hazardous due to their high speeds and temperatures. Slope Movements—hydrothermally altered core of Brokeoff Volcano is prone to landslides.

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Age	Map Unit (Symbol) GIS Data	Geologic Map Graphic (Symbol) Map 1 (in pocket)	Geologic Description	Geologic Features and Processes	Geologic Issues	Geologic History
MIDDLE PLEISTOCENE	Rhyolite of Raker Peak (PErr)	Lassen volcanic center, Rockland caldera complex (PE-Lr)	Rhyolite (73.5% SiO ₂) of a steep-sided lava dome. Erupted from an underlying vent. Chemically very similar to Rockland tephra (PEpr), which does not occur within the park.	Volcanic Features—lava dome, but much older than Lassen domefield and categorized as part of the Rockland caldera complex. May represent a pre-caldera leak of the Rockland magma chamber. Glacial Features—glacial erosion along southern margin of dome exposed prominent columnar joints, and dome has been stripped of pumiceous and blocky carapace.	Volcano Hazards—part of caldera-forming explosion in Lassen volcanic center.	Volcanic Center (Lassen)—K-Ar dating established an age of 588,000 ± 69 years ago, but PErr is probably older than the Rockland tephra (PEpr), which was deposited 609,000 years ago.
	Dacite of Bench Lake (PEdbl)		Several small dacite (65.7% SiO ₂) domes related to Rockland caldera complex. Lithology of domes is slightly variable.	Volcanic Features—lava domes. Glacial Features—domes are poorly exposed under glacial deposits (PEty) and younger rocks in Kings Creek. Original pumiceous carapaces or hot talus covers were completely removed by glacial erosion, exposing dome interiors.	Volcano Hazards—part of caldera-forming explosion in Lassen volcanic center.	Volcanic Center (Lassen)—679,000 ± 14,000 years ago.
EARLY PLEISTOCENE	Dacite of Flatiron Ridge (PEdfr)		Dacite (65.9% SiO ₂) lava flow. Erupted from vent now buried by younger domes of Lassen volcanic center. Thickness greater than 100 m (300 ft).	Volcanic Features—lava flows. Glacial Features—original carapace of flow completely stripped by glacial erosion. Covered by glacial till (PEty).	Volcano Hazards—part of caldera-forming explosion in Lassen volcanic center.	Volcanic Center (Lassen)—812,000 ± 6,000 years ago.
	Dacite of Panther Creek (PEdp)	Small group of dacite (65.3% SiO ₂) domes exposed around and south of Devils Kitchen. Largest of domes erupted from vent centered under hill 7139.	Volcanic Features—lava domes. Underlies rocks of Brokeoff Volcano and overlies hydrothermally altered rocks of Dittmar volcanic center. Glacial Features—domes were eroded by glaciers so that original pumiceous carapaces or hot talus covers were completely removed and interiors of domes are exposed. Hydrothermal Features—at Devils Kitchen, rocks are strongly altered.	Volcano Hazards—part of caldera-forming explosion in Lassen volcanic center. Slope Movements—hydrothermally altered core of Brokeoff Volcano is prone to landslides.	Volcanic Center (Lassen)—K-Ar age of sample from hill 7139 is 827,000 ± 18,000 years ago.	
LATE PLEISTOCENE	Andesites of Maidu volcanic center, stage 1, undivided (PLam)	Not depicted. Note: Underlies park headquarters near Mineral, California.	Variety of basaltic andesite, andesite, and dacite lava flows forming the older part of Maidu volcanic center. Analyzed samples range in composition from 55%–65% SiO ₂ ; most are andesite. Flows and associated fragmental deposits erupted from central vents that cannot be precisely located.	Volcanic Features—lava flows.	None reported.	Volcanic Center (Maidu)—best estimate for the age is 2.375 million–2.150 million years ago.
EARLY PLEISTOCENE	Rhyolites of Dittmar volcanic center, stage 3 (PErd3)	Dittmar volcanic center (PEPL-D)	Isolated erosional remnants or buried lava domes and flows of rhyolite and rhyodacite (70.9%–75.0% SiO ₂) on northern flank of Dittmar volcanic center. Includes rocks on Pilot Mountain, in Summit Creek and Grassy Swale, and just east of Hidden Lake.	Volcanic Features—lava domes and lava flows, part of composite volcano of Dittmar volcanic center. Glacial Features—rocks related to PErd3 have been more abundant prior to glaciation, and similar rocks undoubtedly lie buried beneath younger rocks of Lassen volcanic center and in the Caribou volcanic field.	None reported.	Volcanic Center (Dittmar)—K-Ar age of rhyolite lava flow exposed in Summit Creek is 1.273 million ± 7,000 years ago.
	Andesites of Dittmar volcanic center, stage 2, undivided (PEad2)		Andesite (58%–63% SiO ₂) and sparse dacite (63%–64% SiO ₂) lava flows that covered the flanks of the volcano. Erupted from vents probably located on upper slopes or at the summit of volcano and not preserved. Thickness 30–60 m (100–200 ft). Flows exposed in southern face of upper part of Saddle Mountain are generally thinner, 10–20 m (30–70 ft).	Volcanic Features—lava flows and remnant of composite volcano. These flows dip radially away from core area of Dittmar volcanic center, which was centered just southwest of Saddle Mountain. Glacial Features—typical outcrops consist of glacially eroded cliffs that expose flow interiors. Lakes—Juniper Lake developed in this lava flow.	None reported.	Volcanic Center (Dittmar)—K-Ar age of one sample is 1.398 million ± 42,000 years ago.
LATE PLEISTOCENE TO EARLY PLEISTOCENE	Andesites of Dittmar volcanic center, stage 1, undivided (PEPLad)		Early part of Dittmar composite cone. Composed of lithologically diverse, generally thin, basaltic andesite to andesite lava flows and fragmental deposits and sparse rhyodacite pyroclastic deposits. Flows range in composition from 55.7% to 68% SiO ₂ , but the majority are 55.7%–58.4% SiO ₂ .	Volcanic Features—composite volcano, lava flows, pyroclastic flows, and tephra (fallout of lithic pyroclastic flow deposits). A rhyodacite (68.4% SiO ₂) ash flow is exposed on northern flank of Kelly Mountain. Hydrothermal Features—hydrothermal alteration and poor exposure limit recognition of some deposits.	Volcano Hazards—lahar deposits were common during the volcano's history. Pyroclastic flows are extremely hazardous due to their high speeds and temperatures.	Volcanic Center (Dittmar)—K-Ar ages of three samples are 1.650 million ± 35,000; 1.785 million ± 35,000; and 2.315 million ± 29,000 years ago, and indicate a long eruptive history for early phase of this volcanic center.

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Age	Map Unit (Symbol) GIS Data	Geologic Map Graphic (Symbol) Map 1 (in pocket)	Geologic Description	Geologic Features and Processes	Geologic Issues	Geologic History	
MIDDLE PLEISTOCENE	Basaltic andesite of Little Bunchgrass Meadow, cinders (PEmbgci)	Regional volcanic rocks north and west of Lassen volcanic center (PE-Rnw)	Cinder and agglutinate cones composed of basaltic andesite (54.2% SiO ₂) of Little Bunchgrass Meadow (PEmbg). Only cinders (PEmbgci) from this eruption occur within the park.	Volcanic Features—cinder cone.	Volcano Hazards—hazards from regional volcanoes include construction of cinder cones, production of lava flows, and emission of tephra.	Regional Volcanism—143,000 ± 6,000 years ago.	
	Tholeiitic basalt of Nobles Trail (PEbn)		Basaltic (48.0% SiO ₂) lava flow in Hat Creek northeast of Raker Peak. Location of vent is unknown, but is probably buried beneath younger lava flows of andesite of Hat Mountain (PEah) at the center of the park.	Volcanic Features—lava flow. Consists of multiple flow units of tube-fed pahoehoe. Glacial Features—weakly glaciated but well preserved.		Regional Volcanism—estimated age, 250,000–200,000 years ago.	
	Andesite and basaltic andesite of Prospect Peak (PEap) Andesite and basaltic andesite of Prospect Peak, cinders (PEapci)		Block-lava flows that forms Prospect Peak shield volcano. Three types of lava flows erupted to build Prospect Peak: one basaltic andesite and two types of andesite (53%–58% SiO ₂). Earlier andesite lavas form bulk of edifice and the area beyond northern flank of volcano, north of Hat Creek fault. Late-stage andesite lava flows that erupted from summit crater cover some flanks of the volcano. PEapci consists of cinder and agglutinate cones.	Volcanic Features—shield volcano and cinder cones. Shield is capped by cinder cone composed of PEapci with several flank vents near summit. Summit crater contains pumice from Chaos Crags eruption (1,050 years ago). Glacial Features—lower flanks on southern and western sides of volcano are buried by till and moraines.		Regional Volcanism—K-Ar age of sample of andesite is 247,000 ± 56,000 years ago. Volcano was probably active for at most a few thousand years.	
	Andesites of West Prospect Peak (PEawp)		Lava flows of two types of andesite (59.3%–61.2% SiO ₂) that form a steep-sided cone.	Volcanic Features—cinder cone and lava flows. Glacial Features—small cirque occupies northwestern flank just below the summit.		Regional Volcanism—estimated age, 400,000–300,000 years ago.	
	Basalt of Badger Flat (PEbbf) Cinders (PEbbfci)		Basalt (51.3%–52.2% SiO ₂) lava flow and cinder cone. Thickness approximately 10 m (30 ft). PEbbfci consists of cinder and agglutinate cones.	Volcanic Features—cinder cone and lava flows. Glacial Features—flow and cone were glaciated, and much till (PEty) was deposited on flow. At distal end of flow, original flow surface is preserved.		Regional Volcanism—slightly older but close in age to PEawp (400,000–300,000 years ago).	
	Andesite of Table Mountain (PEat)		Andesite (61.4% SiO ₂) lava flows that form a small shield volcano. Vent area is poorly preserved.	Volcanic Features—shield volcano and lava flows. Flow tops are conspicuously rubbly. Glacial Features—edifice was not glaciated.		Volcano Hazards—hazards from regional volcanoes include construction of cinder cones, production of lava flows, and emission of tephra. Seismic Activity—several faults oriented north–northwest slightly offset the volcano edifice.	Regional Volcanism—probably similar in age to andesites of Badger Mountain (PEabm , 708,000 ± 21,000 years ago).
	Andesites of Badger Mountain (PEabm)		Andesite (two types, 56.7%–62.7% SiO ₂) lava flows that formed a small shield volcano. Vent area is poorly preserved. Thickness up to 10 m (30 ft).	Volcanic Features—shield volcano and lava flows. Glacial Features—shield is glaciated on northwestern margin. Overlain by avalanche debris from Lassen Peak spread across glacial ice (PEsl).		Volcano Hazards—hazards from regional volcanoes include construction of cinder cones, production of lava flows, and emission of tephra. Seismic Activity—shield is cut by normal faults.	Regional Volcanism—K-Ar age of 708,000 ± 21,000 years ago for upper flow; entire volcano is probably about that age.

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Age	Map Unit (Symbol) GIS Data	Geologic Map Graphic (Symbol) Map 1 (in pocket)	Geologic Description	Geologic Features and Processes	Geologic Issues	Geologic History
EARLY PLEISTOCENE	Andesite of Butte Lake (PEabl)	Regional volcanic rocks north and west of Lassen volcanic center (PE-Rnw)	Andesite (60.5% SiO ₂) lava flow. Vent location unknown.	Volcanic Features—lava flows. Glacial Features—lava flows heavily glaciated and mostly buried by till (PEty).	Volcano Hazards—hazards from regional volcanoes include construction of cinder cones, production of lava flows, and emission of tephra. Seismic Activity—lava flows are exposed in upthrown fault scarp east of Butte Lake.	Regional Volcanism—estimated age, 1 million–900,000 years ago.
	Andesite of section 22 (PEa22)		Andesite (59.9% SiO ₂) lava flows. Vent location unknown.	Volcanic Features—lava flows. Glacial Features—heavily glaciated; surface features of flow are not preserved. Mostly buried by till (PEty).	Volcano Hazards—hazards from regional volcanoes include construction of cinder cones, production of lava flows, and emission of tephra. Seismic Activity—exposed in downthrown fault block just east of flows from Cinder Cone. Outcrops are probably small fault blocks.	
MIDDLE PLEISTOCENE	Basalts and basaltic andesites of Sifford Mountain (PEbsm) Cinders (PEbsmci)	Regional volcanic rocks south and east of Lassen volcanic center (PE-Rse)	Variety of lithologically distinct basalt and basaltic andesite (51.5%–57.4% SiO ₂) block-lava flows that form the small shield volcano of Sifford Mountain. Eroded scoria cone at summit marks vent. PEbsmci consists of cinder and agglutinate cones of this eruption.	Volcanic Features—shield volcano and lava flows. Sifford Mountain is youngest regional shield volcano south of Lassen volcanic center and marks southern limit of young regional volcanism in Cascade arc. Glacial Features—Sifford Mountain shield is weakly glaciated and little eroded. More PEbsm may be present under till (PEty) east of Domingo Spring.	Volcano Hazards—hazards from regional volcanoes include construction of cinder cones, production of lava flows, and emission of tephra. Seismic Activity—basalt of Sifford Mountain is exposed in fault scarp along Hot Springs Creek. Several young faults with little displacement cut edifice. Faults near Boiling Springs Lake and along Hot Springs Creek offset late Wisconsinan glacial deposits (not visible at map scale, but would be PEty).	Regional Volcanism— ⁴⁰ Ar/ ³⁹ Ar ages are 172,000 ± 23,000 and 167,000 ± 4,000 years ago. Entire shield volcano was probably emplaced within span of a few thousand years.
	Andesite and basalt of Mount Harknes (PEamh) Cinders (PEamhci)		Older basalt (51.8% SiO ₂) and younger andesite (57.9% SiO ₂) erupted from Mount Harkness shield volcano. PEamhci consists of cinders.	Volcanic Features—shield volcano and lava flows. Andesite lava flows represent some of the youngest regional volcanism in southern Lassen Volcanic National Park. Glacial Features—a small cirque on the northern side of Mount Harkness exposes vent complex. Andesite lavas cascaded over glacial cliffs of Warner Valley and partly filled valley bottom. Blocky-jointed andesite lava on northeastern margin of mountain indicates confinement of flowing lava by ice. Basalt lava flows are best exposed on glacially eroded northern flank of volcano above Juniper Lake. Lakes— PEamh partly surrounds Juniper Lake.	Volcano Hazards—hazards from regional volcanoes include construction of cinder cones, production of lava flows, and emission of tephra.	Regional Volcanism—188,000 ± 32,000 years ago.
	Basaltic andesite of Huckleberry Lake (PEmhl) Cinders (PEmhlci)		Basaltic andesite (53.1%–54.0% SiO ₂) lava flows. Erupted from vent high on southern flank of Brokeoff Volcano. Vent is marked by small plug intruded into a cinder cone. PEmhl consists of cinder and agglutinate cones from this eruption.	Volcanic Features—cinder cone, lava dome, and lava flows. Flows covered at least 18 km ² (7 mi ²) of the southern flank of Brokeoff Volcano. However, this regional mafic lava is unrelated to the Lassen volcanic center magmatic system, and its presence on the flank of Brokeoff Volcano marks the end of a viable Brokeoff Volcano magmatic system. Glacial Features—flows heavily glaciated. Most of the cinder cone (intruded by small lava dome) was removed by glacial erosion.	Volcano Hazards—hazards from regional volcanoes include construction of cinder cones, production of lava flows, and emission of tephra.	Regional Volcanism—estimated age, 300,000 years ago.

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Age	Map Unit (Symbol) GIS Data	Geologic Map Graphic (Symbol) Map 1 (in pocket)	Geologic Description	Geologic Features and Processes	Geologic Issues	Geologic History	
LATE PLEISTOCENE	Basaltic andesite of Red Cinder Cone (PEmrc) Cinders (PEmrcci)	Regional volcanic rocks of the Caribou volcanic field (PE-Rc)	Basaltic andesite (53.1% SiO ₂) block-lava flows. Erupted from northerly of a pair of vents collectively called Red Cinder Cone, 1 km (0.6 mi) northwest of Red Cinder. PEmrcci consists of cinder and agglutinate cones from this eruption.	Volcanic Features—cinder cones and lava flows. Glacial Features—flows only slightly eroded by glaciers.	Volcano Hazards—volcanic activity contemporaneous with Lassen volcanic center. Red Cinder chain of volcanoes is likely location of future eruption.	Regional Volcanism—estimated age, 25,000–20,000 years ago.	
	Basalt of Red Cinder Cone (PEbrc) Cinders (PEbrcci)		Basalt (52.1% SiO ₂) lava flow. Erupted from the more southern vent in a pair of vents collectively called Red Cinder Cone. PEbrcci consists of cinder and agglutinate cones from this eruption.	Volcanic Features—cinder cone and lava flow. Most of the cinder cone built over the vent was destroyed by eruption of lava flow and by glaciation. Glacial Features—flow is short and thick and may have been confined by glacial ice. Lava flow was only slightly eroded by glaciers, but cinder cone was destroyed of eruption by lava flows and glaciation.			
	Basaltic andesite of Red Cinder (PEmrr) Cinders (PEmrcci)		Basaltic andesite (53.3% SiO ₂) block-lava flows and large cinder cone. PEmrrci consists of cinder and agglutinate cones from this eruption.	Volcanic Features—lava flows and large cinder cone. Red Cinder is the largest cone in the Red Cinder chain. Flows and cinders occur within the park; cone is to the east. Glacial Features—lava flow was glaciated, but surface morphology is mostly preserved. Older than last glacial maximum.			
	Basalt of hill 8030 (PEbr80)			Basalt (52.1%–52.3% SiO ₂) lava flows. Erupted from vent marked by cinder cone 1 km (0.6 mi) southeast of Red Cinder at hill 8030.	Volcanic Features—cinder cone and lava flows. Glacial Features—glaciated but not deeply eroded, though not much of the original surface morphology is preserved. Older than last glacial maximum.	Volcano Hazards—volcanic activity contemporaneous with Lassen volcanic center. Red Cinder chain of volcanoes is likely location of future eruption. Seismic Activity—flows are offset by small N10°W faults along discontinuous fault zone between Lake Almanor and Hat Creek grabens.	Regional Volcanism—estimated age, 40,000–25,000 years ago.
	Basalt of Cameron Meadow (PEbrm)			Basalt lava flows. Precise SiO ₂ content not provided (see table 1 for general range). Erupted from vent to the east now buried by younger lavas.	Volcanic Features—lava flows. Glacial Features—glaciated lava flow.		
	Basalt of Ash Butte (PEbra) Cinders (PEbraci)			Basalt (52.0% SiO ₂) lava flow. Erupted from Ash Butte cinder cone at north-northwest end of Red Cinder chain. PEbra consists of cinder and agglutinate cones from this eruption.	Volcanic Features—cinder cone and lava flows. Flow is short and thick. Rubbly surface of flow and shape of cone are well preserved, although cone is sufficiently eroded to expose agglutinated core in some places. Cinders are generally oxidized. Part of cone was rafted away by lava flow. Glacial Features—glaciated but generally free of thick till deposits. Older than last glacial maximum.	Volcano Hazards—volcanic activity contemporaneous with Lassen volcanic center. Red Cinder chain of volcanoes is likely location of future eruption.	Regional Volcanism—estimated age, 70,000–40,000 years ago.
	Basalt of hill 2283 (PEbr22) Cinders (PEbr22ci)		Basalt (52.5% SiO ₂) lava flow. Erupted from well-preserved cinder cone at hill 2283. Thickness as much as 20 m (70 ft). PEbr22 consists of cinder and agglutinate cones.	Volcanic Features—cinder cone and lava flow. Cone is composed of agglutinated cinders that are mostly oxidized. Glacial Features—glaciated, but cone shape is well preserved. Flows extensively buried by till (PEty) and poorly exposed.			
	Basalt of section 25 (PEbr25)			Basalt (52.9% SiO ₂) lava flow. Vent is cinder cone that forms hill 7711 at north-northwest end of Red Cinder chain. PEbr25 consists of cinder and agglutinate cones.	Volcanic Features—cinder cone and lava flow. Glacial Features—cone and lava flow are weakly glaciated; surface of lava flow and conical shape of cone are fairly well preserved.		

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Age	Map Unit (Symbol) GIS Data	Geologic Map Graphic (Symbol) Map 1 (in pocket)	Geologic Description	Geologic Features and Processes	Geologic Issues	Geologic History	
LATE PLEISTOCENE	Andesite of Red Cinder (PEarr)	Regional volcanic rocks of the Caribou volcanic field (PE-Rc)	Andesite (59.6%–60.3% SiO ₂) block-lava flows. Erupted from vent now buried by younger lavas of basaltic andesite of Red Cinder (PEmrr).	Volcanic Features—lava flows. Comprises largest-volume unit of the Red Cinder chain. Glacial Features—lava flows were glaciated but are not significantly eroded.	Volcano Hazards—volcanic activity contemporaneous with Lassen volcanic center. Red Cinder chain of volcanoes is likely location of future eruption.	Regional Volcanism—69,000 ± 20,000 years ago.	
	Basalt east of Ash Butte (PEbre)		Basalt lava flow. Precise SiO ₂ content not provided (see table 1 for general range). Erupted from cinder cone 500 m (1,600 ft) east of Ash Butte. Thickness 20–30 m (70–100 ft).	Volcanic Features—cinder cone and lava flow. Cinders are generally oxidized. Glacial Features—lava flow glaciated and partially covered by thick deposits of till (PEty). Cone is sufficiently eroded to expose agglutinated core.		Regional Volcanism—estimated age, 100,000–70,000 years ago.	
	Cinders (PEbreCI)		PEbreCI consists of cinder and agglutinate cones from this eruption.				
	Basalt of Widow Lake (PEbrw)			Basalt (52.1% SiO ₂) lava flows at north-northwest end of Red Cinder chain. Erupted from two cinder cones 0.5 km (0.3 mi) northeast of Widow Lake. Thickness as much as 10 m (33 ft). A third cone of PEbrw occurs approximately 0.75 km (0.5 mi) southwest of Widow Lake.	Volcanic Features—cinder cones and lava flows. Cones aligned west-northwest and composed of agglutinated, mostly oxidized cinders. Glacial Feature—two cones, 0.5 km (0.3 mi) northeast of Widow Lake, and associated lava flows were glaciated and extensively buried by till (PEty). Third cone completely buried by till (PEty). Lithology of third cone known from outcrop 300 m (1,000 ft) farther west.		Regional Volcanism—estimated age, 100,000 years ago.
	Basaltic andesites of Long Lake, unit 3 (PEmrg3)			Basaltic andesite (53.2% SiO ₂) lava flow. Erupted from poorly preserved cinder cone that forms hill 7602, 5 km (3 mi) west-northwest of Posey Lake.	Volcanic Features—cinder cone and lava flow. Glacial Features—flow was heavily glaciated and is partly buried by till (PEty); surface features not preserved.	Volcano Hazards—volcanic activity contemporaneous with Lassen volcanic center, and still active. Seismic Activity—flow offset by two small faults along discontinuous fault zone between Lake Almanor and Hat Creek grabens.	Regional Volcanism—precise age unknown, but younger than basaltic andesite of Black Cinder Rock (PEmb ; 667,000 ± 24,000 years ago).
	Basaltic andesites of Long Lake, unit 2 (PEmrg2)			Basaltic andesite (55.5%–56.3% SiO ₂) lava flow. Lithology is somewhat variable. Erupted from poorly preserved vent at hill 7603 north-northwest of Posey Lake.	Volcanic Features—lava flow. Glacial Features—flow was heavily glaciated and is partly buried by till (PEty); surface features not preserved.	Volcano Hazards—volcanic activity contemporaneous with Lassen volcanic center, and still active. Seismic Activity—flow offset by one of two small faults along discontinuous fault zone between Lake Almanor and Hat Creek grabens.	Regional Volcanism—precise age unknown, but immediately underlies (is older than) unit PEmrg3 .
	Basaltic andesite of Black Butte, unit 1, cinders (PEmdb1ci)			Consists of cinders and agglutinate cones associated with basaltic andesites of Black Butte, unit 1 (PEmbd1), which is composed of basaltic andesite (55.8%–56.1% SiO ₂). Some areas of lava flow are covered by PEmdb1ci .	Volcanic Features—cinders. Associated cinder cone, 0.5 km (0.3 mi) west of Black Butte, was partially destroyed when lava flows were extruded from its base. Glacial Features—the majority of the lava flow related to PEmbd1ci is beyond the limits of glaciation, but part of the flow is buried by till (PEty).		Regional Volcanism—estimated age, 70,000–50,000 years ago.
MIDDLE PLEISTOCENE	Basalt of Lost Spring (PEbsl)		Basalt (52.7%–53.0% SiO ₂) lava flow and cinder cone. Exposed near Duck Lake, north of Butte Lake. Vent is 1 km (0.6 mi) southeast of Duck Lake.	Volcanic Features—cinder cone and lava flow. Glacial Features—heavily glaciated lava flow; surface features not preserved; mostly buried by till (PEty). Cinder cone, located on edge of glaciated area, is partially eroded and buried by till (PEty).	Volcano Hazards—volcanic activity contemporaneous with Lassen volcanic center, and still active.	Regional Volcanism—302,000 ± 7,000 years ago.	
	Basalt of Duck Lake (PEbsd)		Basalt lava flow. Precise SiO ₂ content not provided (see table 1 for general range). Exposed around Duck Lake, in northern Caribou volcanic field.	Volcanic Features—lava flow. Glacial Features—heavily glaciated and mostly buried by till (PEty); surface features not preserved.		Regional Volcanism—estimated age, 300,000 years ago.	

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Age	Map Unit (Symbol) GIS Data	Geologic Map Graphic (Symbol) Map 1 (in pocket)	Geologic Description	Geologic Features and Processes	Geologic Issues	Geologic History
MIDDLE PLEISTOCENE	Basalts of Sunrise Peak, unit 2 (PEbss2) Cinders (PEbss2ci)	Regional volcanic rocks of the Caribou volcanic field (PE-Rc)	Basalt (52.3% SiO ₂) lava flows and agglutinated scoria cone. PEbss2ci consists of cinder and agglutinate cones.	Volcanic Features—scoria cone and lava flows. Glacial Features—overlies unit PEbss1 , but is otherwise completely surrounded by till (PEty).	Volcano Hazards—volcanic activity contemporaneous with Lassen volcanic center, and still active.	Regional Volcanism—age is slightly younger than PEbss1 (393,000 ± 4,000 years ago).
	Basalts of Sunrise Peak, unit 1 (PEbss1)		Basalt (51.4% SiO ₂) lava flows and agglutinated scoria cone.	Volcanic Features—lava flows and scoria cone. Glacial Features—surrounded by till (PEty).		
	Basalt of Bathtub Lake (PEbsb)		Basalt lava flows. Precise SiO ₂ content not provided (see table 1 for general range). Occur in Butte Creek, north of Butte Lake. Lithologies of several flows are somewhat variable. Vent locations unknown.	Volcanic Features—lava flows. Outcrops of flows are partly buried by ash from Cinder Cone eruption (Fantastic Lava Beds flows, Hmf1 and Hmf2) and discontinuous. Glacial Features—heavily glaciated; surface features are not preserved. Vents were probably removed by glaciation. Outcrops of flows are discontinuous and are mostly buried by till (PEty), as well as ash from Cinder Cone eruption.	Volcano Hazards—volcanic activity contemporaneous with Lassen volcanic center, and still active. Seismic Activity—cut by small faults extending southeast from Hat Creek Fault.	Regional Volcanism—estimated age, 400,000 years ago.
	Basalt of Island Lake (PEbii)		Basalt (52.7% SiO ₂) lava flow. Erupted from eroded vent at hill 7470, 2.2 km (1.4 mi) north-northeast of Bonte Peak.	Volcanic Features—lava flow. Glacial Features—heavily glaciated and partially buried by till (PEty). Surface features not preserved; only cores of flow preserved in outcrops.	Volcano Hazards—volcanic activity contemporaneous with Lassen volcanic center, and still active.	Regional Volcanism—estimated age, 350,000–300,000 years ago.
	Basalt of East Lake (PEbie)		Basalt (52.9% SiO ₂) lava flows. Erupted from poorly preserved vent at hill 7321, 1 km (0.6 mi) northeast of Bonte Peak.	Volcanic Features—lava flows. Glacial Features—lava flows were heavily glaciated. Typically only flow cores remain; till (PEty) obscures much of southern part.	Volcano Hazards—volcanic activity contemporaneous with Lassen volcanic center, and still active. Seismic Activity—on eastern boundary of flow, faulted against much older basaltic andesite of Black Cinder Rock (PEmb).	Regional Volcanism—331,000 ± 45,000 years ago.
MIDDLE PLEISTOCENE	Older basalts and basaltic andesites south of Caribou volcanic field (PEboc)	Older regional volcanic rocks of the Caribou area (PEPL-Ro)	Basalt and basaltic andesite (52.3%–52.7% SiO ₂) lava flows. In general, these older basalts and basaltic andesites have compositions and lithologies similar to younger lavas in the Caribou volcanic field. Vent locations unknown, but probably somewhere northwest of flow near Bailey Creek. Affinities of these flows to other units are unknown.	Volcanic Features—lava flows. Scattered throughout southern Caribou volcanic field and exposed in 60 small outcrops, mostly in the Red Cinder 7.5-minute quadrangle. Glacial Features—heavily glaciated; flow morphologies are subdued or absent. Typically, only small areas of flow crop out beneath thick cover of till (PEto or PEty).	Volcano Hazards—none at present; these volcanoes were active more than 650,000 years ago.	Regional Volcanism—estimated age, 725,000–600,000 years ago. These lava flows are older than Caribou volcanic field.
	Basaltic andesite of Jakey Lake (PEmj)		Basaltic andesite lava flow. Precise SiO ₂ content not provided (see table 1 for general range). Erupted from vent at hill 7741, 2.6 km (1.6 mi) northeast of Juniper Lake in southern Caribou volcanic field.	Volcanic Features—lava flow. Glacial Features—heavily glaciated; surface features not preserved. Partially buried by till (PEty).		
	Basaltic andesite of Black Cinder Rock (PEmb)		Basaltic andesite (54.2%–55.0% SiO ₂) lava flows. Lithology of lava flows is slightly variable. Erupted from vent marked by scoria cone at Black Cinder Rock and at least one other vent.	Volcanic Features—scoria cone and lava flows. Located south of Caribou volcanic field. Glacial Features—heavily glaciated; typically only flow cores remain and crop out.	Volcano Hazards—none at present; these volcanoes were active more than 650,000 years ago. Seismic Activity—edifice of Black Cinder Rock (vent/scoria cone) was cut by faults of the discontinuous fault zone between Lake Almanor and Hat Creek grabens.	Regional Volcanism—667,000 ± 24,000 years ago.

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Age	Map Unit (Symbol) <i>GIS Data</i>	Geologic Map Graphic (Symbol) <i>Map 1 (in pocket)</i>	Geologic Description	Geologic Features and Processes	Geologic Issues	Geologic History
MIDDLE PLEISTOCENE	Basaltic andesites and basalt of Snag Lake (PEmsn)	Older regional volcanic rocks of the Caribou area (PEPL-Ro)	Basaltic andesite and basalt lava flows. Precise SiO ₂ content not provided (see table 1 for general range). Vent locations unknown. Rocks probably are not directly related but are combined because of similar lithology and age.	<p>Volcanic Features—lava flows. Occur in five isolated areas near Juniper and Snag lakes, southwest of Caribou volcanic field.</p> <p>Glacial Features—heavily glaciated; typically only flow cores remain and crop out. Outcrops have thick cover of till (PEty).</p>	Volcano Hazards—none at present; these volcanoes were active more than 650,000 years ago.	Regional Volcanism—estimated age, 725,000–675,000 years ago.
EARLY PLEISTOCENE	Basalt of Bonte Peak (PEbnt)		Basalt (51.6%–53.1% SiO ₂) lava flows. Vent was probably near summit of Bonte Peak.	<p>Volcanic Features—lava flows. Located south of Caribou volcanic field.</p> <p>Glacial Features—heavily glaciated; typically only flow cores remain and crop out. Flanks of Bonte Peak (location of vent) were oversteepened by glacial erosion. Till (PEty) buries much of the lava flow away from the Bonte Peak summit.</p>	Seismic Activity—faulting along the discontinuous fault zone between Lake Almanor and Hat Creek grabens may cut lavas, but relations are obscured by glacial erosion and till deposits.	Regional Volcanism—estimated age, 700,000–675,000 years ago.