

# Geologic Overview of Newberry Volcano

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Newberry Volcano is located 25 mi (40 km) south of Bend and 35 mi (56 km) east of the crest of the Cascade Range (Figure 1). Newberry is a shield shaped composite volcano, about 40 mi (64 km) north-south and 25 mi (40 km) east-west. During its more than half million year history of activity, including multiple caldera collapses and subsequent caldera-filling volcanism, Newberry has erupted often, including several times in the Holocene. Although it only rises about 3,600 ft (1100 m) above the surrounding area, it covers an area in excess of 500 mi<sup>2</sup> (1300 km<sup>2</sup>) and has a volume of over 110 mi<sup>3</sup> (460 km<sup>3</sup>). The erupted volume is probably substantially greater than this, because lava flows from Newberry extend more than 40 mi (65 km) beyond the base of the volcano (Figure 1).

The elongate shape of Newberry is the result of the distribution of vents and lava flows of basalt, basaltic andesite, and minor andesite along the length of the volcano. Dacitic to rhyolitic volcanism is concentrated in the central high portion of the volcano. The gentle slopes of the lower flanks steepen abruptly at about 6000 ft (1000 m) due to the accumulation of stubby silicic lava flows and domes. Pyroclastic flow deposits related to caldera forming eruptions are most widely exposed on the west and northeast flanks. Similar deposits likely covered the other flanks but have been buried by younger basaltic andesite eruptions.

Basalt flows from vents on (or beneath) Newberry form a broad plain to the north between Bend and Redmond covering another 270 mi<sup>2</sup> (700 km<sup>2</sup>). These flows have repeatedly flowed into the canyons of the Deschutes and Crooked Rivers and followed them northward as intracanyon flows. Work by Donnelly-Nolan and others (this guidebook) is just beginning to unravel the geologic story of this part of Newberry's history.

The summit caldera of Newberry is approximately 5 mi (8 km) east-west and 4 mi (6.4 km) north-south and has an area of 17 mi<sup>2</sup> (44 km<sup>2</sup>). The major ash-flow tuffs on the west and northeast flanks and a caldera with several walls nested inside each other indicate multiple caldera forming events. The two largest ash-flow tuffs each have an estimated volume in excess of 2.5 mi<sup>3</sup> (10 km<sup>3</sup>) (MacLeod and others, 1995). In addition, work by Kuehn and Foit (this guidebook) has shown that there are a number of additional large volume air-fall deposits on the flanks. The Tepee Draw tuff (northeast flank) has been dated at about 500,000 years old and the basaltic andesite

lapilli tuff (west flank) has an estimated age of 200,000 to 400,000 years old (MacLeod and others, 1995).

Water from Paulina Lake spills over the low west wall of the caldera. Elsewhere, the caldera walls are 500 to 1600 ft (150 to 490 m) high. The caldera was initially deeper by at least 1600 ft (490 m) but has been filling with pyroclastic rocks, flows, domes and lacustrine deposits during late Pleistocene and Holocene time. East and Paulina Lakes cover about 20% of the caldera. During the Pleistocene a single large lake probably filled the caldera. As episodic eruptions and wall collapses slowly filled the caldera, the lake became smaller and shallower. Eventually, the caldera was partitioned into two smaller lake basins, probably following the eruption of the Little Crater tuff cone. Evidence suggests that for awhile, a stream flowed from the new and higher standing East Lake to Paulina Lake until it was blocked by the eruptions of the South Obsidian Flow (12,000 years ago) and the Central Pumice Cone (7,200 years ago).

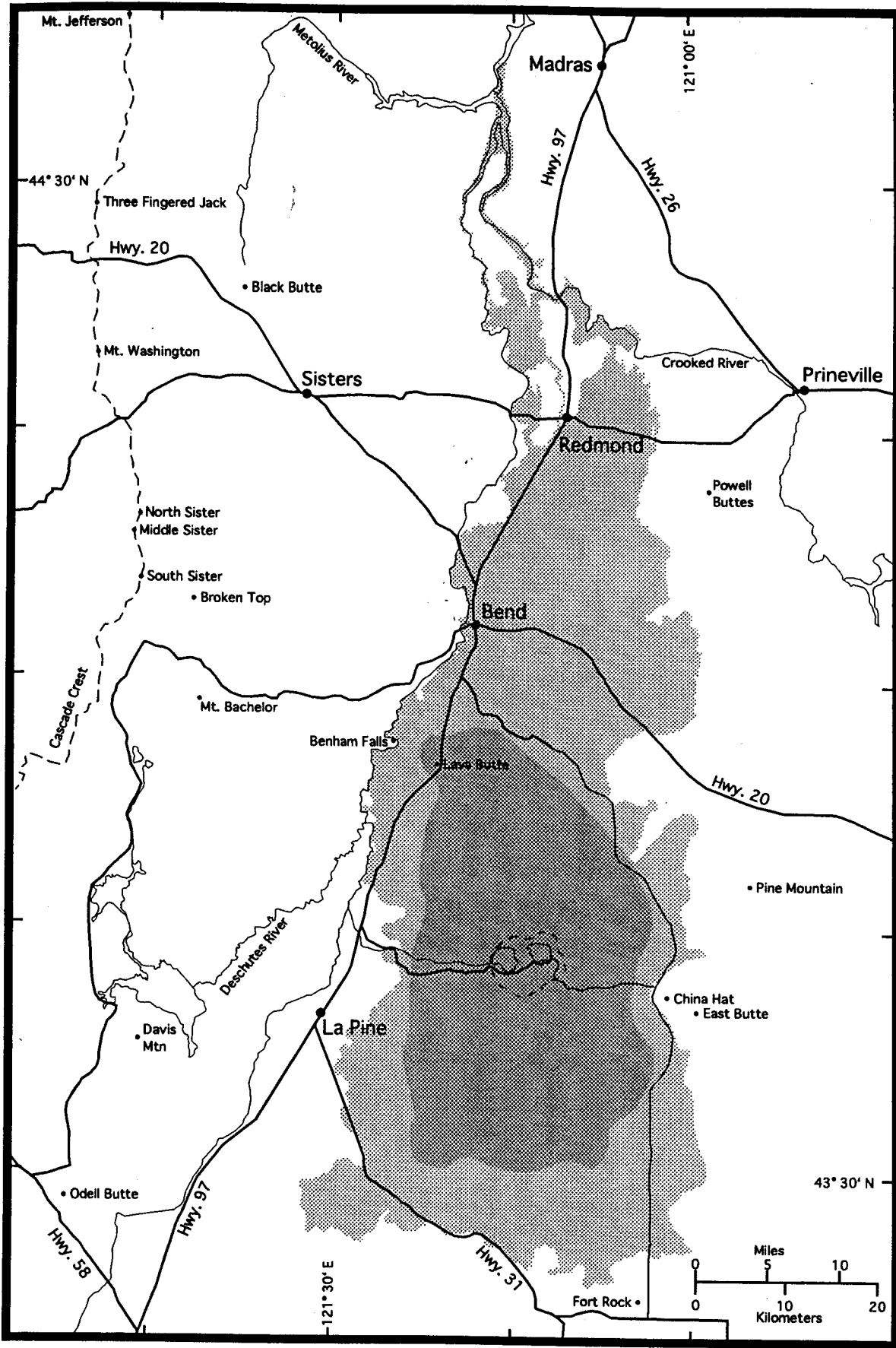
During the late Pleistocene and Holocene six eruptive episodes are notable; four rhyolitic (east half of the caldera) and two basaltic (on the flanks). Future studies will likely expand this list.

**South Obsidian Eruptive Episode:** An estimated 12,000 calendar yrs ago, an obsidian dome and related obsidian flow were erupted from a vent along a caldera ring fractures in the southeast part of the caldera.

**East Rim Eruptive Episode:** About 11,200 calendar yrs ago (10,000 C14 yrs B.P.), mafic cinders, scoria, spatter, and lava flows were erupted from a fissure on the east rim of the caldera.

**Interlake Eruptive Episode:** A series of rhyolitic eruptions began in the caldera approximately 7,300 calendar yrs ago (6,200 C14 yrs B.P.). These eruptions produced a widespread phreatomagmatic pumiceous tephra deposit (East Lake tephra), obsidian flows (Interlake Flow, Crater Flow, and Game Hut Flow), a large pumice cone (Central Pumice Cone), and several small pumice cones. This eruptive episode probably lasted for about 200 years.

**Northwest Rift Eruptive Episode:** About 7,000 calendar yrs ago (6,100 C14 yrs B.P.), basaltic andesite lavas were erupted from extensive fissure vents on the northwest and south flanks of Newberry. Spatter and cinders also erupted from a fissure on the north caldera wall (East Lake Fissure). More than a dozen lava flows and associated cinder and spatter cones were



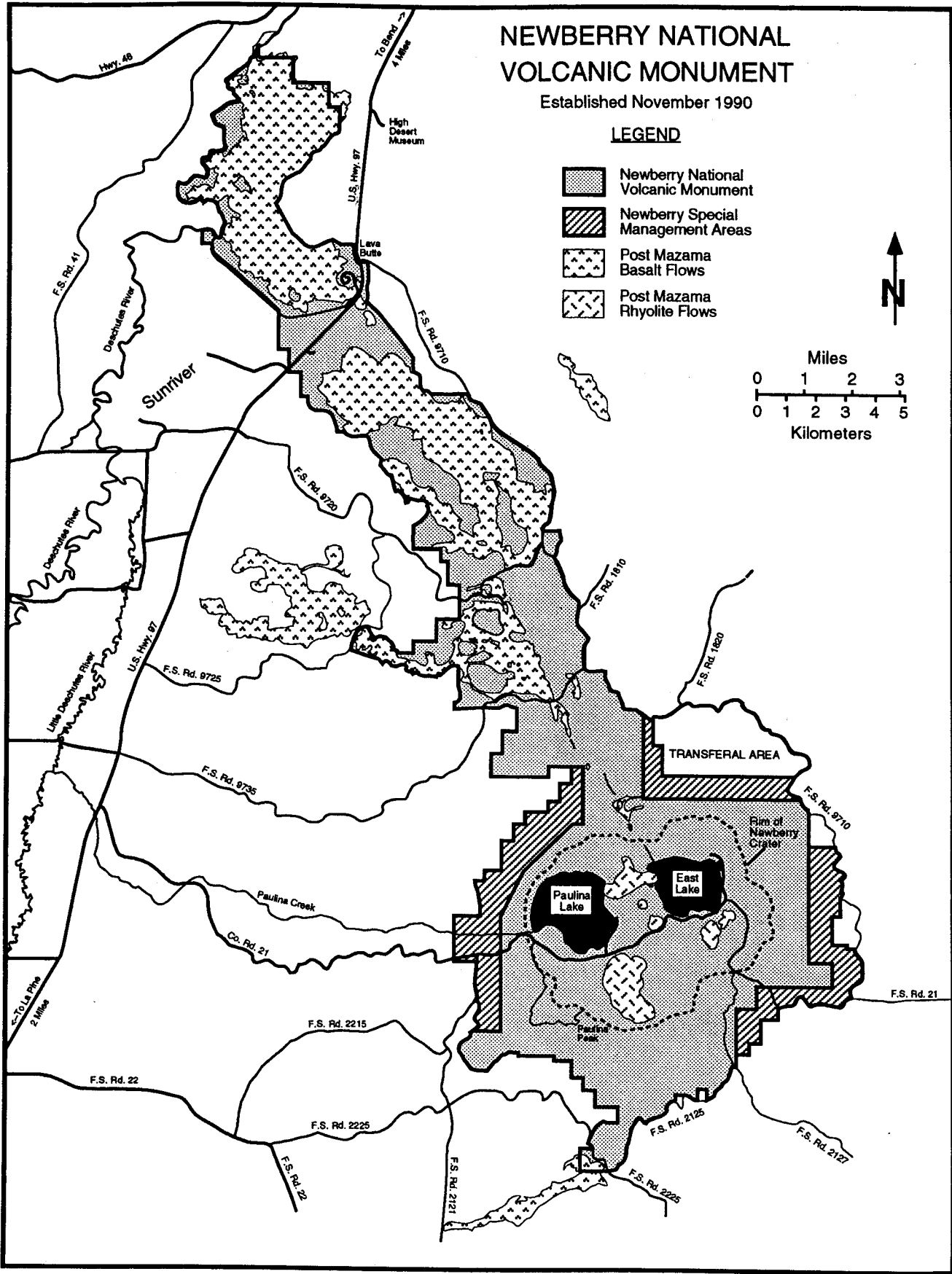
**Figure 1. Newberry Volcano (dark gray) and extent of its lava flows (light gray).**

formed. The lava flows were up to 6 mi (9 km) long and were more voluminous at lower elevations. This eruptive episode probably lasted for less than 50 years.

**East Lake Eruptive Episode:** About 3,500 yrs ago, obsidian flows and associated pumice deposits in the caldera erupted from caldera ring fractures.

**Big Obsidian Eruptive Episode:** About 1,460 calendar yrs ago, a 3-part sequence of rhyolitic eruptions began from a common vent at the base of the south caldera wall. These produced an

air-fall tephra (Newberry Pumice), ash-flows (Paulina Lake ashflows), and the Big Obsidian Flow. The initial Plinian eruption (1,580 C14 yrs B.P.) produced the Newberry pumice fall deposit, which blanketed the east flank of the volcano and areas to the east. About 250 yrs later the Paulina Lake ash flow (1,310 C14 yrs B.P.) spread from near the south caldera wall to Paulina Lake. The final phase of the eruption produced the Big Obsidian Flow which covers 1.1 mi<sup>2</sup> (2.8 km<sup>2</sup>).



**Figure 3. Newberry National Volcanic Monument.**