U.S. Department of the Interior
U.S. Geological Survey

WATER-RESOURCES INVESTIGATIONS REPORT 01–4046
Perspective views—SHEET 2 of 2
Gardner, J.V., and others, 2001
Bathymetry and selected perspective views of Crater Lake, Oregon

PERSPECTIVE VIEWS

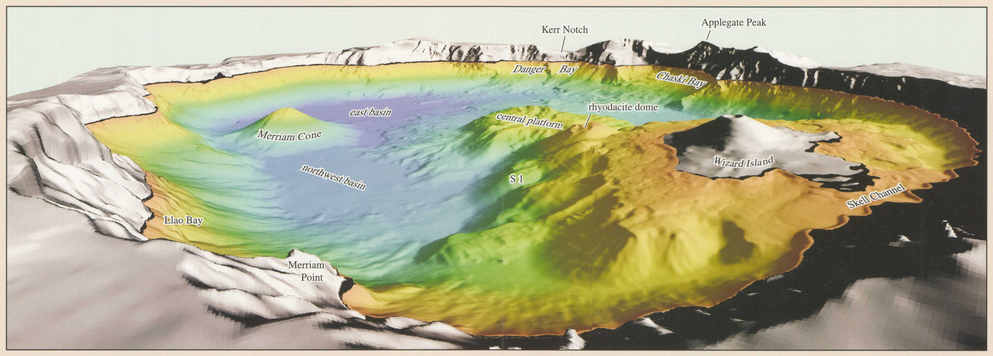


Figure 1. *Oblique view of Crater Lake caldera. Colored area shows shaded-relief bathymetry of lake floor. Gray area shows shaded relief of caldera walls and Wizard Island. Distance across bottom of image about 6 kilometers (3.7 miles).*

Crater Lake, the deepest lake in the United States, occupies a caldera in Mount Mazama, a Cascade Range volcano that once stood about 3,700 meters (12,000 feet) above sea level. About 7,700 years ago, in a catastrophic eruption that lasted only a few days at most, Mount Mazama ejected about 50 cubic kilometers (12 cubic miles) of magma in the form of pumice and ash. Toward the end of the eruption, the mountain collapsed upon itself to form the caldera shown in this view. After this climactic event, volcanic activity resumed within the caldera, creating Wizard Island and other new landforms. All but the uppermost portion of the Wizard Island volcano is hidden from view below the surface of Crater Lake.

Within perhaps 200 to 300 years after the formation of the caldera, the lake filled to its present level. As a result, many of the volcanic landforms that rose from the caldera floor during this period display the effects of rising lake waters in the form of shorelines and other features. An exception is the rhyodacite dome, which formed underwater about 2,500 years later.

The Wizard Island volcano grew as the lake filled. Older, submerged shorelines of the island (see S1 and S3 in figure 5) can be seen where lava flows shattered after entering the lake, creating steep underwater talus slopes.

The gently sloping bench around Wizard Island consists of lava flows that were later drowned by the rising lake. Submerged near the center of Crater Lake is the central platform volcano, which also has breaks in its slopes that indicate the location of shorelines. Below its steep north and east flanks, however, are sinuous lava flows that apparently flowed underwater, down over the shattered older lava.

Near the north shore of the lake is Merriam Cone, another postcaldera andesite volcano which erupted under water. Merriam Cone is bordered by the flat-bottomed northwest basin, a depression that contains up to about 80 meters (262 feet) of sediment largely derived from the adjacent caldera walls (Nelson and others, 1988). To the east of Merriam Cone is the east basin, where up to about 100 meters (328 feet) of sediment have been deposited. Merriam Cone and the lava flows north of the central platform partially dam the northwest basin. In the foreground of this view, at Llao Bay, sediment transport from the upper walls to the basins can be seen. Chutes in rock outcrops mark the beginning of talus cones that extend in the form of debris flow lobes out onto the caldera floor. Far more extensive landslide and debris flow deposits can be seen in Chaski Bay and Danger Bay (figure 6).

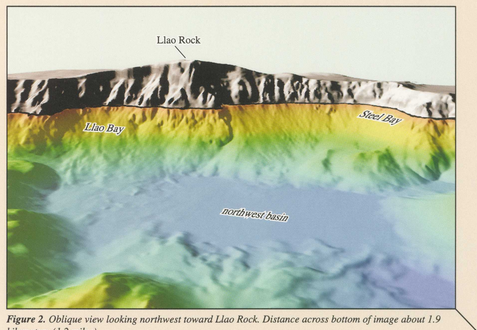


Figure 2. *Oblique view looking northwest toward Llao Rock. Distance across bottom of image about 1.9 kilometers (1.2 miles).*

The great cliff of Llao Rock, a rhyodacite lava flow that erupted about 200 years before the collapse of Mount Mazama, towers nearly 600 meters (2,000 feet) above the surface of Crater Lake. Andesitic lava flows at the surface of the lake date from about 150,000 years ago (this and other ages from Bacon and Lanphere, 1990). Submerged in Llao Bay are outcrops of lava flows from earlier periods of Mount Mazama's growth. Below these outcrops, and in Steel Bay, the caldera wall is composed largely of talus and debris flow materials that extend onto the lake floor. Sediment fill in the northwest basin partially buries the lower wall deposits. Projecting from the caldera wall in the deep water of Steel Bay are prominent hills that may be in-place lava outcrops or huge, down-dropped blocks of caldera wall lavas. In the foreground are sinuous lava flows that emanate from a vent on the central platform. A small part of the central platform occupies the lower left corner of this view.

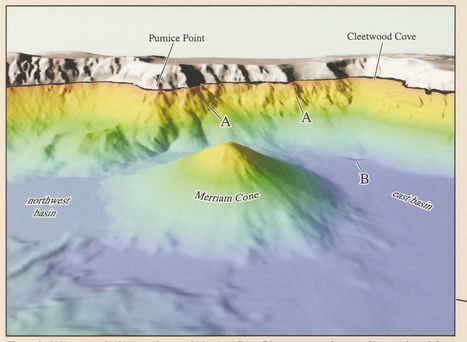


Figure 3. *Oblique view looking north toward Merriam Cone. Distance across bottom of image about 1.8 kilometers (1.1 miles).*

Merriam Cone, a symmetrical mound composed of andesite, was named for a former president of the Carnegie Institution of Washington. Its surface features and lack of a crater (compare to the Wizard Island cinder cone shown in figure 4) indicate that it formed under water. The andesite composition of Merriam Cone is similar to that of deeply submerged parts of the Wizard Island volcano and to the southeast part of the central platform.

On the caldera wall north of the cone are steep outcrops (A) that extend far below the surface of the lake. Benches on these features probably correspond to significant breaks in the growth of Mount Mazama. Above the lake, such breaks divide the mountain's eruptive history into "packages" of lavas derived from specific source vents. Most of the rocks at this part of the shoreline are more than 120,000 years old, suggesting that the deepest outcrops below the surface stem from the mountain's early history (see figures 6 and 7).

On the lake floor between Cleetwood Cove and Merriam Cone is a depression (B) that marks the approximate location of small pools of relatively warm water. These pools, discovered in 1988 and 1989 by researchers aboard the one-person submersible craft *Deep Rover*, are denser than the overlying lake water because of a higher concentration of dissolved salts. This location also marks the area of the highest measured heat flow in Crater Lake (Williams and Von Herzen, 1983).

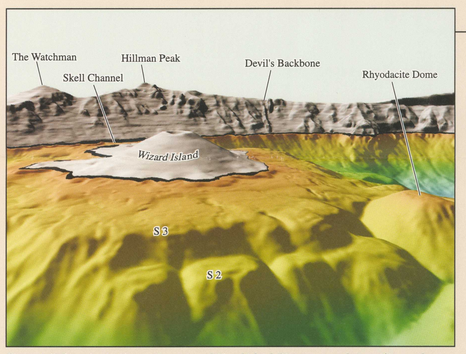
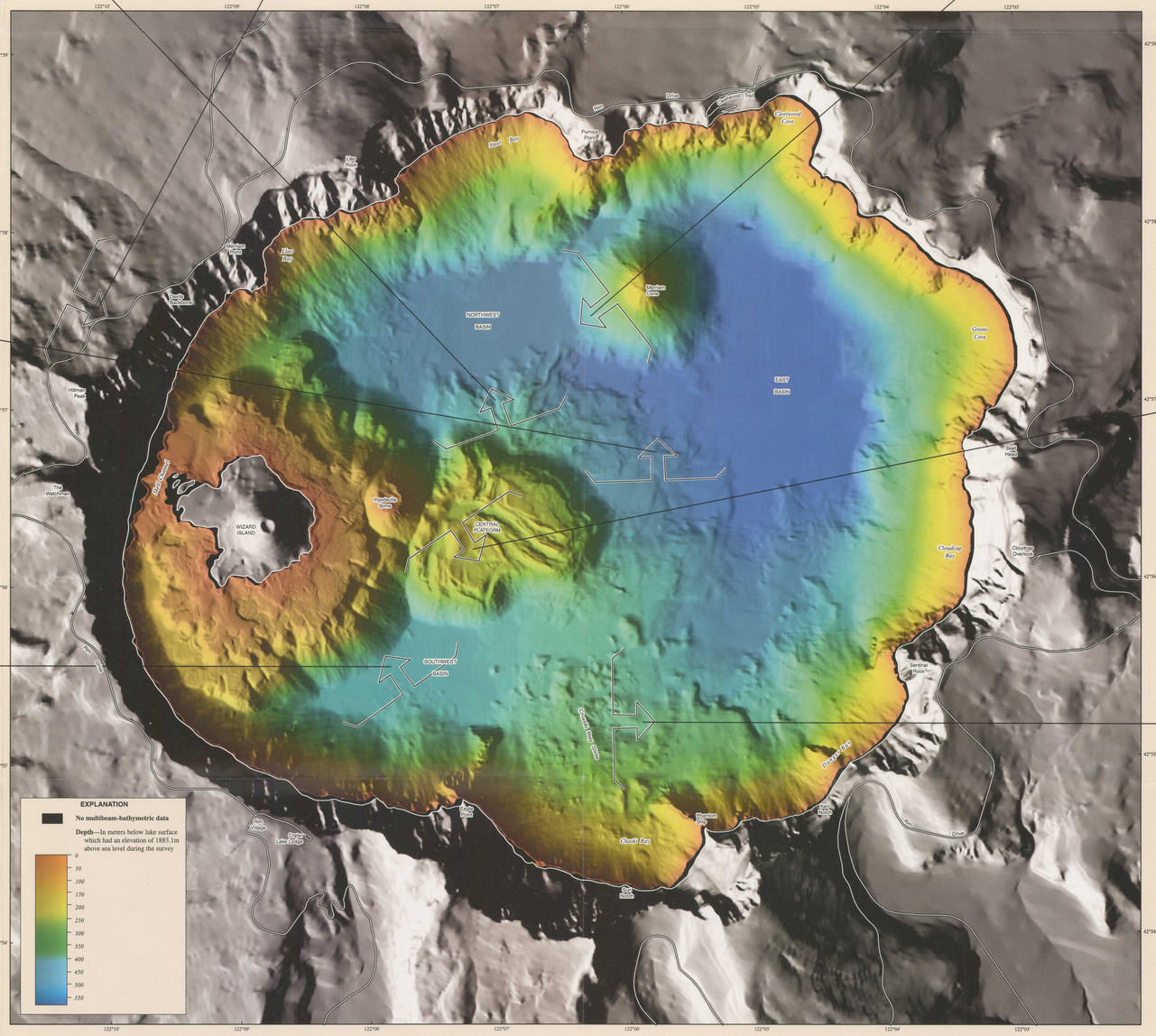


Figure 4. *Oblique view looking northwest toward Wizard Island. Distance across bottom of image about 1.5 kilometers (0.9 miles).*

The cinder cone atop Wizard Island (which was named for its resemblance to a wizard's hat) is composed of small fragments of frothy andesite. Blocky andesite lava flows emanate from the base of the cinder cone. Sinuous channels in the drowned lava field are depressions between lava flow lobes. The Wizard Island volcano rose from the floor of the caldera while Crater Lake was filling and ceased erupting before the lake reached its present level. As flowing lava reached the water's edge, it shattered into melon-sized and smaller pieces that make up the slope below the old shoreline (S3) located 84 meters (262 feet) below the surface of the lake. An earlier shoreline (S2) at a depth of 180 meters (590 feet) can be seen partway down the east flank of the volcano, perhaps representing a pause in the series of eruptions that formed Wizard Island. At Skell Channel, lava flows from the Wizard Island volcano abut the caldera wall. These flows have been partially buried by loose rock falling from the talus below The Watchman and Hillman Peak. At the right edge of this view is the younger rhyodacite dome.



Base from U.S. Geological Survey digital data, 1:24,000 and 1:100,000, 1969–85
Universal Transverse Mercator projection, Zone 10, WGS84 ellipsoid.
Land image generated from USGS 7.5-minute, 10-meter DEM.
Shaded-relief image generated using a multi-directional shaded-relief program written by Bob Mark, USGS OFR 92-422. Illumination angles are 225°, 270°, 315°, and 360°, at 40° above horizon.

1 Kilometer
1 Mile

Lake-floor image generated from multibeam-bathymetry data acquired in July–August 2000 by the U.S. Geological Survey in cooperation with the National Park Service and the University of New Hampshire, using a Kongsberg Simrad EM-1002 multibeam sonar system. Lake-floor pixel resolution is 2 meters.

More information available on World Wide Web at
<http://walrus.wr.usgs.gov/pacmaps> [last modified August 2000]

Bathymetry formal metadata available on World Wide Web at
<http://walrus.wr.usgs.gov/docs/infobank/tiger/s/s100or/html/s-1-00-or.meta.html>

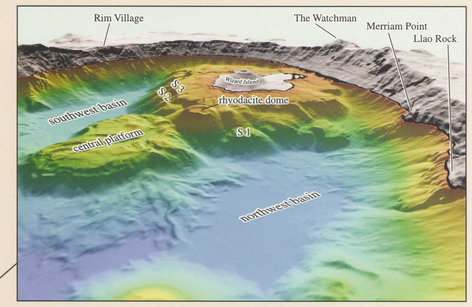


Figure 5. *Oblique view looking southwest toward Wizard Island. Distance across bottom of image about 2.8 kilometers (1.7 miles).*

Visible in this view are three of the four volcanoes that erupted on the floor of Crater Lake after the caldera formed 7,700 years ago: the central platform, Wizard Island, and the rhyodacite dome. Emanating from the north base of the platform are andesite lava flows that form sinuous ridges. The relatively subdued top of the central platform gives way at a uniform elevation to steep slopes. This morphology suggests that the andesite lava that forms the platform erupted from a vent above the surface of the rising lake, flowed outward over earlier products of that vent, and broke up when it entered the lake to form talus. The break in the slope marks the shoreline at the time that the last lava flowed. On the surface of the platform, broad lava flow channels and a small crater indicate that the vent was located near the platform's northwest corner.

Deeply submerged on the north flank of the Wizard Island volcano are a bench and a break in slope (S1). Sinuous flows of andesite lava north of the central platform were fed by a lava channel that connects them with the crater on top of the platform. These are at the same depth as a similar but less pronounced feature on the central platform, suggesting that eruptions were occurring at both vents at the same time.

Two more old shorelines are evident on the Wizard Island volcano. One is located on its southeast flank (S2). A higher shoreline (S3) goes all around the island. On the eastern flank of the Wizard Island volcano, overlapping the central platform, is the rhyodacite dome. Radiocarbon dating of the sediment above and below a corresponding ash layer on the central platform indicates that the dome erupted about 5,000 years ago. Submerged below such promontories on the caldera wall as Merriam Point and Llao Rock are steep rock outcrops. Between these are talus aprons that coincide with embayments in the wall.

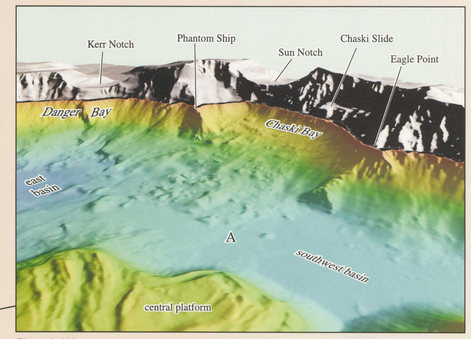


Figure 6. *Oblique view looking southeast toward Chaski Bay. Distance across bottom of image about 2.6 kilometers (1.6 miles).*

A major lake floor feature in this view is the extensive landslide deposit that originated in the caldera wall at Chaski Bay. Characterized by irregular topography and isolated blocks, the Chaski Bay slide separates the southwest basin from the east basin. At the western margin of the slide (A) is an area in which warm water vents into the lake. This area is marked by bacterial mats that were discovered by scientists aboard the *Deep Rover*. Remnants of the failed caldera wall that fed the Chaski Bay slide can be seen in the form of large down-dropped blocks up to 200 meters (656 feet) in length. Other landslide deposits are found west of Eagle Point, in Danger Bay, and in the East Basin.

As in other views of the caldera walls, steep rock outcrops are submerged below promontories above the surface of the lake. Between these promontories are Kerr Notch and Sun Notch, which mark the location of prominent U-shaped valleys that were carved into Mount Mazama by glaciers before the formation of the caldera. In the foreground, prominent channels can be seen on the surface of the central platform. These carried lava flows that cascaded over the platform's east slope to form a field of lava spreading from its east base.

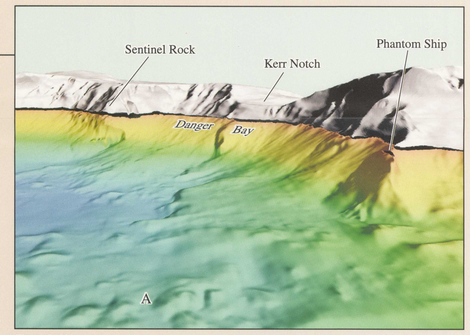


Figure 7. *Oblique view looking east toward Phantom Ship and Danger Bay. Distance across bottom of image about 1.2 kilometers (0.7 miles).*

Andesite lava from near the Phantom Ship is the oldest rock found above the surface of the lake, and dates from about 400,000 years ago. The Phantom Ship itself is composed of resistant, hydrothermally altered lava. The steep underwater cliffs below it owe their survival to the same alteration system within and beneath the ancient Phantom Ship volcano. Rocks forming the more deeply submerged cliffs almost certainly pre-date the formation of Mount Mazama, as do the rocks of the cliff below Sentinel Rock. Clearly shown in the foreground of this view is the Chaski Bay landslide deposit (A). In the middle distance is the Danger Bay slide.

References

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Nelson, C. H., Carlson, P. R., and Bacon, C. R., 1988, The Mount Mazama climactic eruption (6900 BP) and resulting convulsive sedimentation on the continent, ocean basin, and Crater Lake caldera floor: in, Clifton, H. E., editor, Sedimentologic consequences of convulsive geologic events. Geological Society of America Special Paper 229, p. 37–57.

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BATHYMETRY AND SELECTED PERSPECTIVE VIEWS OF CRATER LAKE, OREGON

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