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Cruise Report: Newberry Crater, Oregon; August 27-29, 1984

Two ocean bottom seismometers (OBS) were deployed in lakes on Newberry volcano in central Oregon as part of an experiment directed by Doug Stauber of the USGS, Menlo Park. The OBS were used to fill holes in an array of 120 seismometers distributed in a grid on the surface of the volcano with a station spacing of 1 km. Explosive shots were detonated outside the array, and wide angle reflections from the Moho and from an intra crustal layer (determined previously from conventional seismic refraction data) will be used to construct an image of the velocity structure beneath the volcano. This volcano, situated in central Oregon to the east of the Cascades, is being studied extensively because of its potential for geothermal energy exploitation. Further information on the experiment can be found in the attached article.

Anne Trehu (USGS-Woods Hole) and Bruce Ambuter (consultant for Sea Data) participated in the OBS portion of the experiment. One instrument was deployed in each of two lakes in the volcano's crater. The OBS were deployed from small motorboats which are rented by the hour and are usually used for fishing. Total "ship time" cost $20! OBS locations were determined from LORAN which was calibrated relative to points which could be located on orthophotos and topographic maps.

Station coordinates were:

OBS 1 - 43°43.20'N, 121°15.86'W, 120-125 ft. depth

OBS 2 - 43°43.41'N, 121°12.10'W, 49 ft. depth

OBS 1 did not record any data. OBS 2 recorded arrival times from the shots, and these data are being included in the data set from the land instruments which is being analysed in Menlo Park.

Oregon Seismic Experiment

The United States Geological Survey (USGS), with support from the Geothermal and Hydropower Technologies Division of the U.S. Department of Energy, will be conducting an active seismic experiment in central Oregon using nine large explosions during the last week of August 1984. A major goal of this experiment is to detect kilometer-size magma chambers in the upper crust below Newberry Volcano (Figure 1). The planned experiment is a small-scale version of one type of seismic-imaging experiment proposed by the Program for Array Seismic Studies of the Continental Lithosphere (PASSCL). Because of the required density of the recording array, the USGS recording effort will be concentrated in and around the summit caldera and leave ample opportunity for additional recording of the large shots, by interested parties, to study the rest of the volcano and surrounding geologic provinces.

Newberry Volcano is situated in central Oregon 50 km east of the High Cascade Range axis at the intersection of several major geologic provinces (Figure 1). Rhyolites of Newberry Volcano are the northwestern, young end members of a westward progression of rhyolitic volcanism which has occurred in south-central Oregon during the past 10 m.y. MacLeod and Sammel (*Calif. Geol., 35,* 235–244, 1982) presented an excellent description of the geology of Newberry Volcano, from which the following brief description is abstracted. The volcano is a broad shield, about 1 km high and covering an area of 1,200 km². The flanks are veneered by hundreds of basalt and basaltic-andesite flows and cinder cones with carbon 14 ages as young as 5,800 years. A caldera, 6–8 km in diameter, is present at the summit; the recent volcanism inside this caldera, in contrast to the mafic volcanism on the flanks, is predominantly rhyolitic. The most recent rhyolitic volcanism occurred 1,350 years ago. The occurrence of young silicic volcanism and hot springs in the summit caldera makes Newberry Volcano a prime target for geothermal exploration. Drilling within the caldera has been conducted by the USGS and Sandia National Laboratories. Similar temperature profiles were determined in both holes, and a temperature of 265°C was measured at the bottom of the USGS hole at a depth of 932 m (MacLeod and Sammel, *Calif. Geol., 35,* 235–244, 1982). This high temperature and the occurence of young silicic volcanism suggest the existence of magma chambers within the shallow crust below the summit of the volcano.

Several seismic experiments have been conducted by the USGS in the vicinity of Newberry Volcano, including a teleseismic *P* residual study of the volcano, and two seismic-refraction lines. The teleseismic *P* residual study detected a column of high *P* velocity material, about 15 km in diameter, extending from within 10 km of the surface to 25 km depth beneath the summit, which is interpreted to result from numerous subsolidus mafic intrusions. One of the seismic-refraction lines runs along the margin of the High Cascade and Western Cascade provinces (Figure 1)

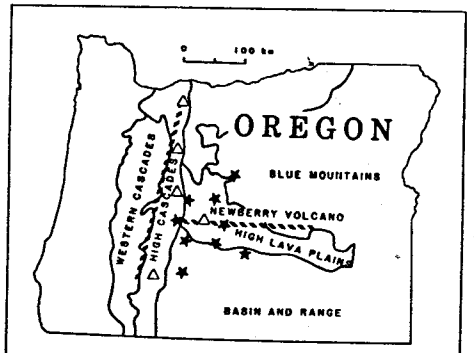

Fig. 1. Oregon, showing physiographic provinces (Baldwin, *Geology of Oregon,* 147 pp., 1976), major Cascade Range volcanos, including Newberry Volcano (triangles), existing USGS refraction lines (heavy-dashed lines), and planned shots (stars).

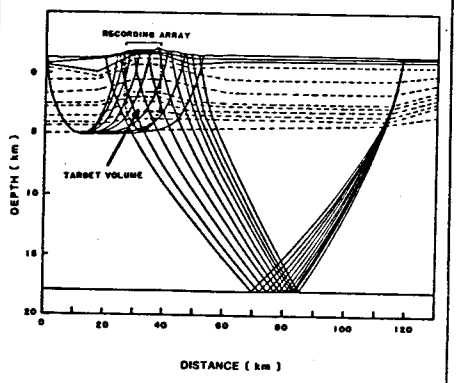

Fig. 2. East-west cross section through Newberry Volcano, showing ray paths for two phases to be used in the USGS experiment.

and the results have been published by Leaver, Mooney, and Kohler (*J. Geophys. Res., 89,* 3121–3134, May 1984). The other seismic-refraction line which runs east-west through Newberry Volcano (Figure 1) was shot in fall 1983 as preliminary work for the current USGS experiment. A station spacing of 0.5 km and a shotpoint spacing of 15.0 km were used to allow concentration of a detailed seismic-velocity cross section of the volcano. Interpretation of this refraction line is in progress.

The upcoming USGS experiment is similar to that performed at Le Mont-Dore Volcano, France, by Nercession, Hirn, and Tarantola (*Geophys. J. R. Astron. Soc., 76, 307–315, 1984*). *P* waves, generated by explosions distant from the volcano and reflected or refracted back toward the surface by the crustal velocity structure, will be used to illuminate, from below, the summit region of Newberry Volcano from many azimuths. The receiving array will consist of 120 portable analog recorders normally used in USGS refraction work and will cover a region, about 12 km in diameter, centered on the summit caldera, with an average station spacing of 1 km. Traveltime residuals will be inverted to obtain a three-dimensional *P* velocity model to a depth of about 5 km, with a spatial resolution of about 1 km. The distances from the array to the shot points were selected, after partial analysis of the detailed east-west refraction line through Newberry Volcano, to use two coherent impulsive and high-amplitude phases. Figure 2 illustrates ray paths for these two phases. Nine shot points are located at these two distances with as uniform an azimuthal distribution as possible (Figure 1). Here, 2,700 kg of explosives will be detonated below the surface at each shot point at scheduled times divided between two nights.

Because of the large number and sizes of the planned shots, many opportunities exist for recording reversed and unreversed refraction profiles (which will not be covered by the USGS) on Newberry Volcano and in the adjacent provinces, including the High Cascade Range, the Basin and Range, and the High Lava plains. Persons interested in utilizing these planned shots for such experiments should contact the author to obtain more information about the shots, the exact schedule, and possible coordination with other interested parties.

This news item was contributed by Douglas Stauber *of the U.S. Geological Survey in Menlo Park, Calif.*