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EVIDENCE FROM TELESEISMIC P-WAVE OBSERVATIONS FOR A LOW VELOCITY BODY UNDER THE ROOSEVELT HOT SPRINGS GEOTHERMAL AREA, UTAH

R. Robinson
H. M. Iyer

U.S. Geological Survey
Menlo Park, CA 94025

ABSTRACT

Teleseismic P-wave delays were measured in the region of the Roosevelt Hot Springs geothermal area ,Utah, using a closely spaced array of 15 seismographs. Average relative delays show a well-defined pattern of azimuthal variation of up to 0.3 sec. Interpretation of the data using ray-tracing and three-dimensional inversion techniques shows the presence of a clearly defined low-velocity region extending from a depth of 10 km into the upper mantle, centered under the Mineral Mountains. Signal shape variations observed at some of the stations may be due to diffraction around a smaller low-velocity body at a depth of 5 km or less.

The Roosevelt Hot Springs geothermal area, Utah, is interesting because of its forthcoming commercial development for electric power. Extensive geologic, geophysical, and geochemical surveys and drilling have been done there (Ward et al., 1978). We have investigated the velocity structure of the crust and uppermost mantle in the vicinity of the Roosevelt Hot Springs by operating a roughly square (30 x 30 km) array of 15 seismographs for 45 days, centered on the Mineral Mountains, southwest Utah. The Roosevelt Hot Springs lie on the western flank of these mountains, which have been the site of recent rhyolitic and basaltic volcanic activity. The methods we have used are similar to those used by Iyer et al. (1979) at The Geysers geothermal area.

Seventy-two teleseismic events were recorded with sufficient quality for the calculation of traveltime residuals. Readings made from high-speed paper playbacks of the recording tapes have an estimated error of 0.05 sec. To eliminate the effects of source mislocation, relative traveltime residuals were calculated by subtracting the mean residual for each individual event.

The resulting relative traveltime residuals show a well-defined pattern of azimuthal variation of up to 0.3 sec. This pattern is such that it could be explained qualitatively by a region of relatively low velocity centered under the Mineral Mountains at mid- to lower-crustal depths (10-25 km). In order to better define this anomalous region, we have used the inversion method developed by Aki et al., (1977) to evolve a three-dimensional model of the crust and upper mantle. Preliminary results confirm the presence of a region of low velocity under the mountains, extending somewhat to the east and west, with a velocity decrease of about 10% from the surrounding rocks at the same depth. This anomalous region extends from about 10 km depth down into the uppermost mantle. The near surface velocities obtained in the inversion clearly reflect the basin and range structure of the region.

On a smaller scale, there is evidence for an anomalous region at shallow depths ($\leq$ 5 km) under the central Mineral Mountains, centered about 5 km southeast of the Roosevelt Hot Springs area. This anomalous region, which appears to be no more than 5 to 7 km in diameter, manifests itself by an azimuthally changing pattern of wave-form distortion, probably caused by diffraction effects, rather than traveltime delays. It could be the cause of a gravity low in the central Mineral Mountains (Ward et al., 1978).

We speculate that the deeper and more extensive anomalous region of low velocity is due to the presence of magma of primarily basaltic composition, whereas the more shallow anomalous region is due to the presence of rhyolitic magma formed by crustal fusion.

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