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SHALLOW-CRUSTAL MAGMA ZONES IN AND SOUTH
OF LONG VALLEY, CALIFORNIA

FINAL REPORT
FOR THE PERIOD

01 Sept 1986 to 30 April 1988

William A. Peppin
25 April 1988

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Seismological Laboratory
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PREPARED FOR THE

U.S. DEPARTMENT OF ENERGY
OFFICE OF ENERGY RESEARCH
DIVISION OF ENGINEERING, MATHEMATICS & GEOSCIENCES

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ABSTRACT

This report summarizes our investigations of seismic data from the Long Valley caldera region based mainly on data obtained from the USGS - DOE seismic network. During the contract period several thousands of earthquakes were recorded and located, including the extensive aftershock sequence of the July 1986 Chalfant Valley. This contract has provided partial operating support for this network, including the establishment of the first permanently-recording wideband digital station in the Mammoth Lakes region. Results presented here include five manuscripts involving various aspects of the research. These manuscripts cover: (1) a general description of unusual seismic phases near Mammoth Lakes and their possible use in the delineation of shallow-crustal anomalous bodies, (2) a paper which pinpoints the location of a shallow-crustal anomaly about 6 km deep and 2 to 3 km in lateral extent near the south end of Hilton Creek fault, (3) the documentation of a strong lateral structural change in the vicinity of Inyo Craters, and (4) papers contributing to knowledge of the tectonics of the Mammoth Lakes area.

1. Network Operations.

Figure 1 shows the distribution of seismic stations near Long Valley caldera operated by the University of Nevada (UNR) during the recently-concluded contract period. The station *BIW* is the DOE-funded wideband digital site. This station operates in the frequency band 0.05 to 25 Hz and transmits 12-bit digital data, at 50 samples per second for three channels plus a bit of gain range, back to Reno. The data formally were recorded on a PDP 11/23 computer, but will soon be recorded on a Microvax system funded by the State of Nevada in connection with the Yucca Mountain waste repository site investigation. This system, which will run the Caltech - USGS Seismic Processing software (CUSP), will be the first such system to record both digital and analog data in the same incoming data stream. This capability will provide, for the first time, easy access to the UNR digital data, and will lead to some immediate advances in the scope of possible research applications. The *BIW* site was selected because some very strong pre-S phases were seen here (Peppin and others, 1988a, see below) and because the site is located on rock (granite). The pattern of seismicity recorded by the network around the caldera is shown in Figure 2.

2. Investigation of the SLK phase.

Peppin and Delaplain (1988, see below) described a pre-S observation at station *SLK* (see Figure 2) for earthquakes occurring in an elliptical region SE of Long Valley caldera. Using 300 observations of this phase, they determined that this phase was either a converted phase within the caldera (at about the position of the Sanders, 1984 proposed magma body) or a conversion across a dipping fault NW of the caldera. Recently, under funding from this DOE contract, a graduate student, Scott Lewis, performed an extensive field experiment to determine the nature of this phase. Results of this work will be presented at the spring meeting of the SSA (Lewis and Peppin, 1988). The experiment, greatly assisted by personnel from the U.S.G.S. in Menlo Park, consisted of putting out an array of some 30 components in a dense mini-array near the *SLK* station. Several three-component instruments were included. Great care was taken in the calibration of the instruments. A common time base was provided on each of five recorders. Calibrations were used to compute head offsets, all of which resulted in the ability to time phase onsets to a precision less than 0.001 second. Three earthquakes showing the *SLK* phase were taken after extremely laborious fieldwork. Records from one of the earthquakes are shown in Figure 3. Note that phase correlation of the *SLK* phase is quite good across this array, whose dimension is only 100 meters. Preliminary analysis of the data, to be reported by Lewis and Peppin (1988), has rather definitely established that the *SLK* phase has the same apparent-velocity and particle-motion characteristics as the phases investigated by Zucca and others (1987). Therefore, their conclusion - that the *SLK* phase is a deep reflection under the caldera from beneath a large magma body - can fairly definitely be ruled out. The model proposed by Peppin and Delaplain (1988) is able to explain both sets of observations. Further work by Scott Lewis, for a Masters thesis, will provide further constraints on the direction of approach of the *SLK* phase. The cause of the phase appears to be an S to P conversion in the vicinity of Inyo Craters.

3. Manuscripts Submitted or Published Under This Grant.

The remainder of this report contains five manuscripts supported by this grant. The first, Peppin (1987), generally catalogs the occurrence of unusual seismic phases seen in the vicinity of Long Valley, and proposes their use in pinpointing crustal anomalies. The second, Peppin and Delaplain (1988), was submitted to the Bulletin of the Seismological Society of America (BSSA), and describes the *SLK* phase. The third, Peppin and others (1988a), makes a case

Figure 1. Map of Long Valley caldera and vicinity showing stations recorded by UNR. Small symbols: UNR/USGS stations; large, bold, open triangles: stations funded by DOE; solid triangles: stations WIT and BIW, three-component digital stations, the latter a permanent station supported by DOE in the present contract period.

Figure 2 Seismicity near Long Valley caldera through mid 1956. The dashed line encircles the region containing earthquakes which produce the SLK phase at station SLK, NW of the caldera. From Peppin and Delaplain (1987).

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Figure 3 Observations on a mini-array near the SLK station for the earthquake of 29 August 1987 at 2020 GCT, showing P, S, and the SLK phase. Traces V1, N1, and W1 are three-component observations showing that the SLK phase is seen dominantly on the vertical component (ordinate scale in equivalent digital counts). Traces V2, V3, and V4 are vertical component observations from three other stations within 100 meters of station V1, showing phase coherency for the SLK phase (surprisingly, more than for the P and S phases themselves). Four other mini-arrays were deployed at the same time, and data for these has not yet been worked up.

for a localized magma body at the south end of Hilton Creek fault at about latitude 37 degrees 45' N, 118 degrees 30' W and a depth of about 8 km. The fourth, Peppin and others (1988b), describes locations of aftershocks of the 1978 Wheeler Crest earthquake, which may be of importance to understanding tectonic problems near Long Valley. The fifth, Vetter (1988), places Long Valley seismicity in a regional tectonic context, and shows something of the unusual extension direction in this vicinity.

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