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TIME-DEPENDENT SEISMIC TOMOGRAPHY OF THE COSO GEOTHERMAL AREA, 1996-2004

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ABSTRACT

Local-earthquake tomographic images were calculated for each of the years 1996 - 2004 using arrival times from the U.S. Navy's permanent seismometer network at the Coso geothermal area, California. The results show irregular strengthening with time of the wave-speed ratio V_P/V_S at shallow depths. These changes result predominately from progressive relative increase in V_S with respect to V_P, and could result from processes associated with geothermal operations such as decrease in fluid pressure and the drying of argillaceous minerals such as illite.

INTRODUCTION

Studies at several geothermal areas show that (1) geothermal reservoirs often exhibit strong anomalies in the ratio, V_P/V_S, of the seismic-wave speeds (Julian et al., 1996), and (2) economic exploitation can cause measurable changes in seismic wave speeds, which may provide valuable information for monitoring reservoir processes critical for sustained production (Foulger et al., 1997; Gunasekera et al., 2003). We investigated the possibility of such changes during the period from 1996 through 2004 at the seismically active Coso geothermal area. We used data from the U.S. Navy's permanent 18-station seismometer network (Figure 1). This network provides high-quality three-component digital microearthquake (MEQ) data that are well suited to such an investigation.

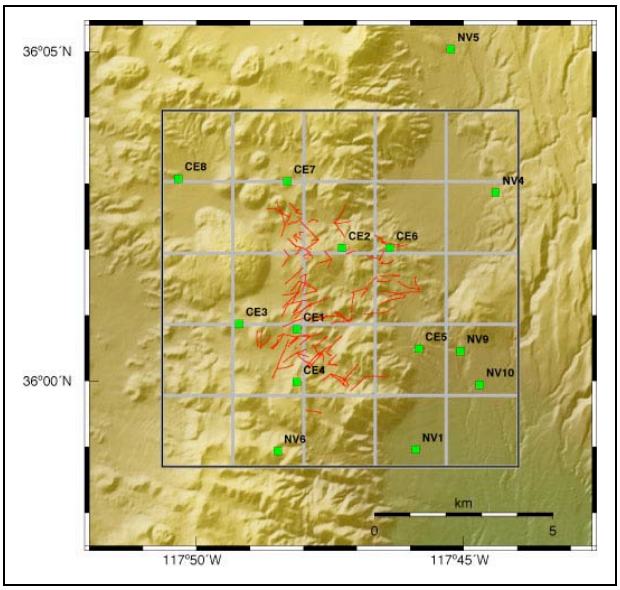

Figure 1: Map of the Coso geothermal area, showing the surface projection of the grid upon which the seismic wave-speeds are defined. Green squares: seismometers of U.S. Navy's permanent network. Red lines: surface traces of well bores.

DATA SELECTION

We winnowed the large data set of arrival times in the Navy MEQ catalog to reduce redundancy and eliminate low-quality data, ranking events in terms of the number and geographic distribution of seismic readings available and the goodness-of-fit to the arrival times for each event. We kept the best 10