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Anisotropy in the Shallow Crust Observed around the San Andreas Fault Before and After the 2004 **M** 6.0 Parkfield Earthquake

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Abstract Local seismic arrays were deployed at two locations along the San Andreas fault (SAF) near Parkfield, California, before and after the 2004 **M** 6.0 Parkfield earthquake. Using local earthquakes we determine the anisotropic field within 1–2 km of the main trace of the SAF at the two array locations separated by 12 km. The initial array, near the SAFOD site, was deployed for six weeks in October and November 2003, and the second array, located near the town of Parkfield, was deployed for 3 months following the 28 September 2004 **M** 6.0 Parkfield earthquake.

We find the fast shear-wave polarization direction nearly fault-parallel (N40°W) for stations on the main fault trace and within 100 m to the southwest of the SAF at both array locations. These fault-parallel measurements span the 100- to 150-m-wide zone of pervasive cracking and damage interpreted from fault-zone-trapped waves associated with the main fault core (Li *et al.*, 2004, 2006). Outside of this zone, the fast orientations are scattered with some preference for orientations near N10°E, roughly parallel to the regional maximum horizontal compressive stress direction (σ_h). In addition, fast directions are preferentially oriented parallel to a northern branch of the SAF recorded on stations in the 2004 Parkfield deployment.

The measured anisotropy is likely due to a combination of stress-aligned microcracks away from the fault and shear fabric within the highly evolved fault core. The majority of our measurements are taken outside of the main fault core, and we estimate the density of microcracks from the measured delay times. Apparent crack densities are approximately 3%, with large scatter. The data suggest weak depth dependence to the measured delay times for source depths between 2 and 7 km. Below 7-km source depth, the delay times do not correlate with depth suggesting higher confining pressure is forcing the microcracks to close.

No coseismic variation in the anisotropic parameters is observed, suggesting little to no influence on measured splitting due to the 2004 **M** 6.0 Parkfield earthquake. However, the premainshock and postmainshock data presented here are from arrays separated by 12 km, limiting our sensitivity to small temporal changes in anisotropy.

Introduction

We examine crustal shear-wave anisotropy at two locations along the San Andreas fault (SAF) near Parkfield to investigate lateral and possible temporal variation in anisotropy. Local earthquake data were recorded on seismic arrays prior to and following the 28 September 2004 Parkfield **M** 6.0 earthquake. The data are from one array deployed in October and November 2003, and a second immediately after the **M** 6.0 mainshock. The 2003 array, referred to hereafter as the SAFOD array, is located adjacent to the SAFOD drilling site and the 2004 array, referred to as the Parkfield array, is located 12 km to the southeast along the main trace of the SAF (Fig. 1). During the SAFOD deployment in 2003, prior to the **M** 6.0 earthquake, the background seismicity was moderate, so we have a small but sufficient number of records to compare to the hundreds of aftershock records from 2004. The main points we address in this article are as follow: (1) the lateral variation in anisotropy along the SAF, (2) the physical cause of the observed anisotropy, and (3) the absence of a temporal change in the anisotropic parameters due to the 2004 **M** 6.0 Parkfield earthquake.

Shear-wave splitting studies have long been conducted to estimate the *in situ* stress field in the shallow crust. Shear

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