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Geophysical images of the creeping segment of the San Andreas fault: implications for the role of crustal fluids in the earthquake process

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Abstract

High-resolution magnetotelluric (MT) studies of the San Andreas fault (SAF) near Hollister, CA have imaged a zone of high fluid content flanking the San Andreas fault and extending to midcrustal depths. This zone, extending northeastward to the Calaveras fault, is imaged as several focused regions of high conductivity, believed to be the expression of tectonically bound fluid pockets separated by northeast dipping, impermeable fault seals. Furthermore, the spatial relationship between this zone and local seismicity suggests that where present, fluids inhibit seismicity within the upper crust (0–4 km). The correlation of coincident seismic and electromagnetic tomography models is used to sharply delineate geologic and tectonic boundaries. These studies show that the San Andreas fault plane is vertical below 2 km depth, bounding the southwest edge of the imaged fault-zone conductor (FZC). Thus, in the region of study, the San Andreas fault acts both as a conduit for along-strike fluid flow and a barrier for fluid flow across the fault. Combined with previous work, these results suggest that the geologic setting of the San Andreas fault gives rise to the observed distribution of fluids in and surrounding the fault, as well as the observed along-strike variation in seismicity.

Keywords: San Andreas fault; Calaveras fault; Magnetotellurics; Hollister; Seismic tomography

1. Introduction

Large strike-slip faults such as the San Andreas fault (SAF) and North Anatolian fault have generated some of the most destructive earthquakes of the last century. A range of geological and geophysical studies in the last 20 years have greatly improved our understanding of the earthquake rupture process. These faults often show significant spatial and temporal variations in seismic behavior. For example, the San Andreas fault is characterized by a creeping central segment, with locked segments to the north and south, each having ruptured just once during the historical record (Allen,

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