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Implications for the structure and dynamics of the San Andreas Fault system from electrical conductivity and non-volcanic tremor observations

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Deep non-volcanic tremor (NVT) has been observed SW of the San Andreas Fault Observatory at Depth (SAFOD), where the San Andreas Fault (SAF) zone changes its mechanical behavior from creeping in the NE to being locked in the SW. Recent seismological array observations confirm a depth range of approximately 30-50 km for the NVT but suggest that the source region is offset from the surface trace of the SAF by about 15 km to the SW. The cause of NVT at transform faults is not understood to date, but it is speculated that fluids play an important role in their genesis. Electrical conductivity is highly sensitive to the presence of fluids and partial melts. The only geophysical technique capable of probing the lower crust and upper mantle for its electrical conductivity is the magnetotelluric (MT) method. Two-dimensional inversion of MT data acquired across the transitional-to-creeping segment of the SAF reveal a sub-vertical channel connecting a high conductivity region in the upper mantle and lower crust with the upper-crustal, brittle deformation zone of the SAF. We interpret this high conductivity as a zone where fluids can migrate into the SAF system. Interestingly, the crustal fluid channel is absent at the transitional-to-locked segment of the SAF. At this segment, the zone of high mantle conductivity correlates with the source region of NVT. We speculate that these observations could be related with a confined region of locally trapped fluids at mantle depth. It is furthermore interesting to note the lateral correlation between the mantle conductor and the axis of Coast Range heat-flow anomaly, the latter defining a zone 50-100 km wide where heat flux is significantly higher than background values and where dissipative shear heating in combination with the slab window effect might occur. This suggests that the sources of high mantle electrical conductivity and elevated temperatures are related and important aspects for a better understanding of the dynamics of the SAF at depth.