High Resolution Imaging of Fault Zone Structures

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Fault zone structures with material discontinuity interfaces and low velocity layers of damaged fault zone rock can produce several indicative wave propagation signals, including scattering, anisotropy, non-linearity, and guided head and trapped waves. Fault zone head waves propagate along material interfaces in the structure, while trapped waves are generated by constructive interference of critically reflected phases within low velocity fault zone layers. Results associated with systematic analysis of such signals recorded at several large strike-slip fault zones (including the San Andreas, North Anatolia, and San Jacinto faults) can be summarized as follows: The observed FZ trapped waves are generated by relatively shallow structures that extend generally only over the top ~3-4 km of the crust. The shallow trapping structure in the NAF is surrounded by broader anisotropic and scattering zones that are also confined primarily to the top 3 km. On the other hand, analyses of FZ head waves along the Parkfield and Bear-Valley sections of the SAF reveal FZ material interfaces that extend to the bottom of the seismogenic zone (e.g., 10 km). Systematic analyses of anisotropy and scattering around the NAF do not show precursory temporal evolution of properties. The anisotropy results show small co-seismic changes. However, the scattering results show clear co-seismic changes and post-seismic logarithmic recovery. The observed co- and post-seismic effects are likely to reflect mostly properties of the very shallow (e.g., ~200 m) top section of the crust. Only fault zone head waves appear at present capable of resolving key mechanical elements of faults at seismogenic depths.