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Structure and properties of the San Andreas fault in central California: Preliminary results from the SAFOD experiment

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The San Andreas Fault Observatory at Depth main borehole was drilled vertically to a depth of 1.5 km and then deviated at an average angle of 55 deg to vertical, passing beneath the surface trace of the San Andreas fault at a depth of 3.2 km. Repeating microearthquakes on the San Andreas define the main active fault trace at depth, as well as a secondary active fault about 250 m to the SW (i.e., closer to SAFOD). In this talk we will provide an overview of drilling, sampling and downhole measurement activities associated with the first two Phases of SAFOD, and an overview of the initial scientific results. SAFOD is located at the transition between the creeping and locked sections of the fault, 9 km NW of Parkfield, CA, approximately half way between San Francisco and Los Angeles.

The SAFOD main borehole was rotary drilled, comprehensive cuttings were obtained and a real-time analysis of gases in the drilling mud was carried out. Spot cores were obtained at three depths (at casing set points) in the shallow granite and deeper sedimentary rocks penetrated by the hole, augmented by over fifty side-wall cores. Continuous coring of the San Andreas Fault Zone will be carried out in Phase 3 of the project in the summer of 2007. In addition to sampling mud gas, discrete fluid and gas samples were obtained at several depths for geochemical analysis. Real-time geophysical measurements were made while drilling through most of the San Andreas Fault Zone and a suite of “open hole” geophysical measurements were also made over essentially the entire depth of the hole.

The geophysical logs define the San Andreas Fault zone to be relatively broad ($\sim$250 m) with discrete shear zones where localized deformation is taking place. There are no

indications of anomalous pore pressure in the core of the fault zone. Rather, the fault zone appears to separate distinct hydrologic regimes, with elevated pore pressure and anomalous geochemical signatures on the north east side of the fault. Stress and heat flow measurements in the SAFOD main hole and co-located pilot hole indicate that the San Andreas Fault is a relatively weak fault in an otherwise strong crust, confirming three decades of inferences about fault strength from heat flow and stress orientation measurements at shallower depth and greater distance from the fault.

Construction of the multi-component SAFOD observatory is well underway, with a seismometer and tiltmeter operating at 1 km depth in the pilot hole and a fiber-optic laser strainmeter cemented behind casing in the main hole.