Composition and Structure of the San Andreas Fault Observatory at Depth (SAFOD) Phase III Whole-Rock Core: Implications for Fault Zone Deformation and Fluid-Rock Interactions

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Compositional analysis of the San Andreas Fault Observatory at Depth (SAFOD) Phase III Whole-Rock Core: Implications for Fault Zone Deformation and Fluid-Rock Interactions

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I. Abstract

We examine the composition and texture of whole-rock core from ~3 km depth in the San Andreas Fault Observatory at Depth (SAFOD) borehole, which provides a unique opportunity to study the lithological and compositional fabric of a transtensional fault system. Whole-rock core analyses show that the ~100m thick fault zone is a complex petrofabric zone, characterized by pervasive cataclasite with localized boudinage, stylolite development, and pervasive anastomosing scaly clay fabric. These observations are coupled with high-resolution X-ray diffraction and X-ray microdiffraction techniques used to address deformation mechanisms, fluid flow, and sample integrity. A detailed analysis of the composition and texture of the fault zone provides new insights into the processes that govern the deformation of active faults. These new insights may improve our understanding of the lithological fabric of other fault systems, as well as the implications for tectonic processes and fluid-rock interactions within active faults. This work was supported by NSF-Earthscope grants EAR-044527 and 0643027 to Evans, and EAR-0346190. Bradbury received supplementary support for sample analyses and travel to the IODP Gulf Coast Repository (GCR) from DOSECC, SEG Foundation, AAPG, SPWLA Foundation, and the GDL Foundation.

II. Internal Fault Zone Structure: Mesoscale Core-Based Observations

Study Area Location

- Fault Gouge ~3192 m (SDZ)
- Fault Gouge ~3302 m (CDZ)
- Fault Rock ~ ultraPure cataclasite

Boxed area ~300m thick fault zone

Block Fault Rock ~ ultraPure cataclasite

Self-similar textural relationship of blocks floating within anastomosing matrix from meso-scale model

Mikado fabrics supports localized scale deformation (Jeppson and others, 2010) - structural fabrics and distributed fabrics in matrix

Petrolithology of whole-rock core ~300m thick fault zone

III. San Andreas Fault Rock Composition and Texture: Micro-scale Observations

Fault Gouge ~3192 m (CDZ)

- Self-similar textural relationship of blocks floating within anastomosing matrix

- Mikado fabrics supports localized scale deformation

- Structural fabrics and distributed fabrics in matrix

IV. Whole-Rock Geochemistry

- Toluene extracts of ultraPure cataclasite

V. Implications

- Compositional analysis of whole-rock core from ~3 km depth in the San Andreas Fault Observatory at Depth (SAFOD) borehole provides unique insights into the lithological fabric of a transtensional fault system.

VI. References


VII. Acknowledgements