

# Assessing Fault Seal Behavior Using Fluid Flow Indicators from Infrared Spectral Measurements of Clay Gouge in the Moab Fault, Utah

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## Abstract

The origin, continuity, and mineralogy of fault gouge is crucial for determining the potential degree of fault seal formation as well as seismic hazard. Of particular interest is the role of fluids in gouge formation. These issues have broad applicability in petroleum geology, underground waste disposal, carbon sequestration, and more. The Moab Fault in Utah is a classic example of a sedimentary basin-bounding normal fault complex in a salt-related petroleum system with abundant gouge, and spectral signatures of its gouge may be indicative of past fluid flow events and related formation of clay minerals. The Terraspec Halo, a “quantitative reconnaissance” tool and infrared mineral identifier, was applied to exposures of clay gouge at various locations along the 45 km long Moab Fault to assess the nature and origin of the gouge. Calcite, silica, and copper mineralization in the core and damage zone of the fault suggests significant post-faulting fluid movement. Spectral indicators of mineral maturity (e.g. Illite Spectral Maturity or ISM) help gauge the temperature of hydrothermal alteration events. Absorbance peak locations (e.g. Al-OH absorption feature of clay minerals), help indicate geochemical conditions during mineral formation or alteration. This combination of spectral features can be diagnostic of diagenetic vs. hydrothermal origins for clay minerals. The method consists of measuring profiles of infrared spectra and scalar values in close spacing across the fault plane, extending into the adjacent wall rock. Minerals identified include smectite, magnesium and potassium illites, montmorillonite, hematite, malachite, phengite, and goethite. Preliminary results suggest a distinctly lower ISM in most of the clay gouge

compared to surrounding bedrock. This indicates a significant component of hydrothermal alteration and clay formation, and a major contribution of neo-formed clays to the gouge.