

Characterization of fracturing and fracture reactivation during folding at Raplee Ridge, UT

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Folding and fracturing can be intimately related processes in which the overburden stress, the remote tectonic stress, stresses induced by underlying faults, local folding related stresses and stress perturbations due to pre-existing fractures all influence new fracture formation. As a case study, we closely examine the fracture characteristics at Raplee Ridge, a Laramide aged monocline with N-S axial trend that is exposed over ~14 km length in the Monument Upwarp of south-eastern Utah. Measurements of fracture orientations and spatial densities at ~120 locations across and around the fold indicate three distinct fracture sets based on their orientations. Abutting relationships indicate relative ages of these sets and fracture densities measured along scan lines indicate how each set varies with structural position on the fold. Additionally, ~15 outcrop-scale maps of fractures on well-exposed pavements were created to identify and document the detailed interactions of the sets and determine the initiation, propagation and evolution histories of the fractures. The maps were created by taking high resolution (12 megapixel) photos of fracture pavements and measuring locations on the pavements using a GPS receiver and a laser range-finder. The locations were used to orthorectify the photos, making them spatially accurate. Fractures were mapped by hand onto large printouts of the orthorectified photographs. The mapping documents the following five stages of fracture evolution: 1) formation of pre-folding E-W Set I fractures; 2) formation of pre-folding N-S Set II fractures; 3) left-lateral shearing of Set II fractures with formation of tail-cracks and the flow of fluids through these fractures; 4) right-lateral shearing of set I fractures creating NW-SE Set III fractures as tail-cracks of Set I fractures and as independent fractures; and 5) formation of local E-W Set IV fractures as tail-cracks from slip along Set III fractures. Stages 3) through 5) are interpreted as developing during the folding of the monocline. This case study demonstrates the necessity of understanding the geometry of pre-folding fracture sets and the mechanics of fracture reactivation in order to elucidate fold-fracture relationships.