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Assessing off-fault deformation at an extensional tectonic setting using 3-D GPR

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Near-surface geophysical studies of active faulting in the Eastern California Shear Zone are being conducted at the University of Kansas. The Emigrant Peak Fault in Fish Lake Valley, Nevada is a normal fault that aids in the transfer of regional right-lateral deformation. We collected ground-penetrating radar (GPR) data across the Emigrant Peak Fault and the associated alluvial fan. The GPR study was conducted in conjunction with high-resolution shallow seismic and geologic investigations to image fault displacement and quantify off-fault deformation along active normal faults in an alluvial fan setting.

The GPR data is comprised of a 50 MHz 3-D grid and 25 MHz 2-D lines. The 3-D grid covers an area of 115 m X 500 m and the 2-D GPR data forms a 1500 m regional line over the fault and alluvial fan deposits. Depth of imaging ranges between 20 m for the 50 MHz data and 25 m for the 25 MHz data. Differential GPS was used to survey GPR trace locations.

GPR surveying at the Emigrant Peak Fault provided high-resolution imaging of an active extensional tectonic setting and associated structural and stratigraphic features. Radar data revealed considerable off-the-main fault deformation not evident in surface observations, aerial photography, and differential GPS digital elevation models. Surface expression of active off-fault deformation has been erased, rendering high-resolution geophysical imaging methods as the best means to quantify subsurface geometries, timing and process rates. Furthermore, this work illustrates that in order to accurately determine fault displacement and off-fault deformation, high resolution 3-D subsurface imaging is necessary. Ongoing research is combining GPR with high-resolution reflection seismic and cosmogenic nuclide dating of surfaces for quantitative determination of fault displacement and rates of deformation.