Physical seismic modeling of a near-vertical fault zone

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Abstract

Detecting faults and subsequent deformation zones is significant in geotechnical engineering applications, seismic hazard assessment in earthquake studies, and the petroleum industry for reservoir potential where faults act as a conduit to migrate or trap hydrocarbon flow. Fault identification is also important in shale gas development to design better productive reservoir stimulation by accounting for the slow slip of pre-existing faults during hydraulic fracturing.

This study shows seismic physical modeling results for a shallow vertical fault zone with slight vertical throw. Several physical model prototypes were created with materials which range in velocity and density to best simulate host rock and a deformed fault zone. 2D marine seismic data were acquired and processed at the University of Calgary Seismic Physical Modeling Facility. Physical model materials tested include plaster, sandstone, limestone, lard, wax, and liquid acrylic.

The post-stack imaged results are compared and it can be seen that the fault zone is resolved in both zero offset and common source data from physical modeling. An interesting by-product from the physical modeling acquisition was the identification of ghost reflections captured later than the primary reflections, which could be used in ‘mirror imaging’, thus providing better illumination of the fault zone.
The modeled fault zone images show close similarity