ID: Type: **Poster**

Experiment and Numerical Modelling to Understand Response Near Chemical Explosions

The Source Physics Experiment (SPE) is a series of buried chemical explosions in granite and includes a comprehensive set of measurements. Among these are near-source accelerometers and unmanned aerial system (UAS)-borne photogrammetry. Data analysis is supported by numerical modeling with the goal of better understanding wave propagation phenomenology, particularly generation of shear. Inspection of near-source velocity traces reveals that non-radial components are initially quiescent as expected for quasi-spherical sources. However, immediately following the peak radial motion, the non-radial components display a sudden surge to significant amplitude, providing a candidate for shear generation. We propose that this response reflects a build-up of strain on the fractures during initial loading. After peak stress, unloading results in an extensional state, allowing release of the stored shear strain. We support this hypothesis with high-fidelity, explicitly-jointed finite element simulations. Moreover, the data indicate release occurs in the direction of least regional horizontal stress and aligns with local geologic structure. This is consistent with analysis of pre- and post-test photogrammetry data where the horizontal component of displacement aligns with the direction implied by the velocity data. Further, we illustrate quantitative agreement between surface displacements computed in our numerical model and those determined in the photogrammetry survey.

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Track Classification: 2. Events and Nuclear Test Sites