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Cross Borehole Change Detection Imaging for the Source Physics (SPE) at the Nevada National Security Site (NNSS)

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Quantification of changes in the near-source medium associated with subsequent explosive testing is critical to the Source Physics Experiment (SPE) for differentiating source characteristics from site effects (i.e., localized damage) in far field seismic and infrasound recordings. We have mapped changes in compressional wave velocity attributed to damage associated with five separate chemical explosions of varying yields and depths during the SPE experiments in the Climax Stock at the Nevada National Security Site (NNSS). Each of the five change detection surveys were undertaken with great care ensuring that survey geometry, recording parameters, and equipment were consistent, thereby allowing for direct comparison between the surveys. Data challenges, such as early triggering, were rigorously addressed. For instance, signals were stacked using cross-correlation of a known pre-event impulse before each shot to ensure proper timing. Also, appropriate filters were determined using a Monte Carlo method in a band-pass frequency space to find localized peaks in cross-correlation coefficients. These tomographic surveys used active source signals produced by both an accelerated weight drop (AWD) at the surface and a borehole sparker at depth, producing dense ray path coverage in the ground zero (GZ) region. Source-receiver pairs for each survey range between 29,232 in the first survey to 36,480 in the latest survey. We present five separate models for P-wave velocity (Vp), the four associated changes in Vp (dVp) between each explosion, and the total change in Vp between SPE-3 and SPE-6. Sandia National Laboratories is a multi-mission laboratory managed and operated by Sandia Corporation, a wholly owned subsidiary of Lockheed Martin Corporation, for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.