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Title: Preliminary SPE Phase II Far Field Ground Motion Estimates

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# Preliminary SPE Phase II Far Field Ground Motion Estimates

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Phase II of the Source Physics Experiment (SPE) program will be conducted in alluvium. Several candidate sites were identified. These include existing large diameter borehole U1e. One criterion for acceptance is expected far field ground motion. In June 2013 we were requested to estimate peak response 2 km from the borehole due to the largest planned SPE Phase II experiment: a contained 50-Ton event. The cube-root scaled range for this event is 5423 m/$KT^{1/3}$.

The generally accepted first order estimate of ground motions from an explosive event is to refer to the standard data base for explosive events (Perrett and Bass, 1975). This reference is a compilation and analysis of ground motion data from numerous nuclear and chemical explosive events from Nevada National Security Site (formerly the Nevada Test Site, or NTS) and other locations. The data were compiled and analyzed for various geologic settings including dry alluvium, which we believe is an accurate descriptor for the SPE Phase II setting. The Perrett and Bass plots of peak velocity and peak yield-scaled displacement, both vs. yield-scaled range, are provided here.

Their analysis of both variables resulted in bi-linear fits: a close-in non-linear regime and a more distant linear regime. The data and fits extend to 350 m/$KT^{1/3}$, well inside the range of interest so it is important to observe that predictions based on the existing data set require significant extrapolation. The regression fits for the second slope portions of these plots are:

For displacement: $d/W^{1/3} = 222 * (R/W^{1/3})^{-1.11}$

For velocity: $v = * (R/W^{1/3})^{-1.16}$

In these equations displacement (d) is cm, velocity (v) is m/s, range (R) is m, and yield (W) is TNT equivalent KT. For our 2-km range from a 50-Ton event these equations define a peak displacement of 0.0059 cm (0.0023 in) and 0.0018 m/s (0.071 in/s).

As an alternative, DTRA/ARA (Thomsen, 2013) was consulted for a separate assessment. Thomsen agrees that the range/yield pair of concern is a very far field extrapolation to the Perrett and Bass fits. As an alternative he referenced prior work related to a 2000-lb HE DTRA test at U16b. Results of a study using a the pseudo-2D finite difference ground shock ground code WinGS suggest a "near seismic" attenuation rate beyond the second Perrett and Bass slope for both displacement and velocity of $R^{-0.5}$ as opposed to the "linear" region attenuations noted above ($R^{-1.11}$ and $R^{-1.16}$, respectively). This shallower slope achieves more conservative values of 0.012 inch peak displacement peak and 0.42 in/s peak velocity.

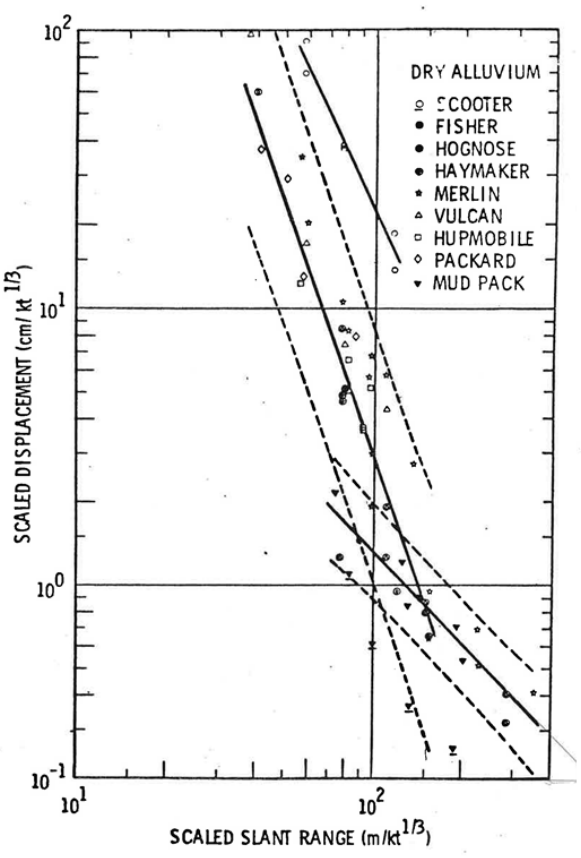
More recently LANL was asked to compute these values for a range of 1 km, approximately the range to the U1a tunnel complex. For this we use the same formulas provided above. For this new scaled range, 2712 m/$KT^{1/3}$, we expect a peak displacement of 0.013 cm (0.005 in) and a peak velocity of 0.004 m/s (0.16 in/s). DTRA/ARA was not consulted for estimates for this range.

In either case, these expected values appear to be too low to be of concern for facility response. But that judgment might better be reserved for those persons with specific concerns. We suggest inquiring whether there exist past motion measurements at locations of interest so that these expected values can be compared to movements achieved historically.

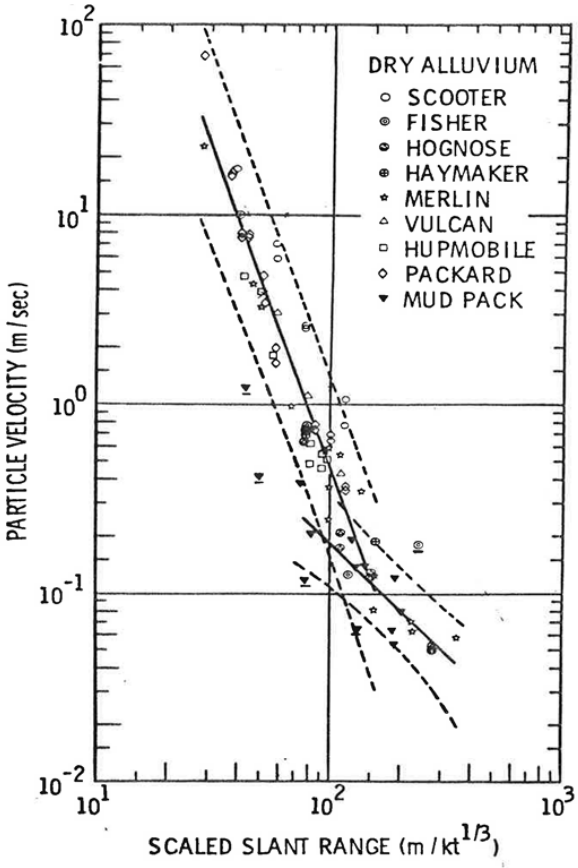
**References:**

Perrett, W. R., and Bass, R.C., "Free Field Ground Motion Induced by Underground Explosions," SAND74-0252, Sandia Laboratories, Albuquerque, NM, February 1975.

Thomsen, J., personal communication, Applied Research Associates, Albuquerque, NM June 2013.




**Displacement Attenuation**




**Velocity Attenuation**