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Characterizing the Yucca Mountain Site for Developing Seismic Design Ground Motions

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Yucca Mountain, Nevada is the designated site for the first long-term geologic repository to safely dispose spent nuclear fuel and high-level nuclear waste in the U.S. Yucca Mountain consists of stacked layers of welded and non-welded volcanic tuffs. Site characterization studies are being performed to assess its future performance as a permanent geologic repository. These studies include the characterization of the shear-wave velocity (Vs) structure of the repository block and the surface facilities area. The Vs data are an input in the calculations of ground motions for the preclosure seismic design and for postclosure performance assessment and therefore their accurate estimation is needed. Three techniques have been employed: 24 downhole surveys, 15 suspension seismic logging surveys and 95 spectral-analysis-of-surface-waves (SASW) surveys have been performed to date at the site. The three data sets were compared with one another and with Vs profiles developed from vertical seismic profiling data collected by the Lawrence Berkeley National Laboratory and with Vs profiles developed independently by the University of Nevada, Reno using the refraction microtremor technique. Based on these data, base case Vs profiles have been developed and used in site response analyses.

Since the question of adequate sampling arises in site characterization programs and a correlation between geology and Vs would help address this issue, a possible correlation was evaluated. To assess the influence of different factors on velocity, statistical analyses of the Vs data were performed using the method of multi-factor Analysis of Variance (ANOVA). The results of this analysis suggest that the effect of each of three factors, depth, lithologic unit, and spatial location, on velocity is statistically significant. Furthermore, velocity variation with depth is different at different spatial locations: Preliminary results show that the lithologic unit alone explains about 54% and 42% of the velocity variation in the suspension and downhole data sets, respectively. The three factors together explain about 73% and 81% of the velocity variation in the suspension and downhole data sets, respectively. Development of a relationship, using multiple regression analysis, which may be used as a predictive tool to estimate velocity at a new location, is currently being examined.