THREE-DIMENSIONAL S-WAVE VELOCITY MODEL OF NAPA VALLEY OBTAINED FROM MICROTREMOR ARRAY MEASUREMENTS AND HORIZONTAL TO VERTICAL SPECTRAL RATIO

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Napa Valley is located in North San Francisco Bay Area about 50 km from San Francisco, California. The Valley is well-known for its wine as the surrounding mountain ranges protect it from cold, damp onshore breeze from the Pacific Ocean, maintaining the valley's warm and dry climate most suitable for growing grapes. The mountain ranges around the valley are rising by several active faults parallel to the famous San Andreas Fault and the valley is under threat of earthquakes. The 2014 South Napa earthquake occurred in South Napa County on August 24 at 3:20 a.m. Pacific Daylight Time, measuring 6.0 on the moment magnitude scale. The epicenter was located southwest of downtown Napa, approximately 6.0 km northwest of American Canyon near the West Napa Fault. The earthquake was the largest in the San Francisco Bay Area since the 1989 Loma Prieta earthquake. Significant damage and several fires were reported in the southern Napa Valley area, including damage in the nearby city of Vallejo within Solano County. The earthquake caused one death and injured approximately 200 people. Clear surface rupture appeared along West Napa Fault for at least 5 km. The damage from the earthquake was concentrated between downtown Napa and St Helena Hwy (CA 29). Near-surface geology possibly contributed to the concentration of the damage. To reveal the cause of the damage and evaluate future earthquake risk, we estimated a three-dimensional (3D) S-wave velocity (Vs) model of the Napa, California, U.S. using microtremor array measurements (MAM) and horizontal to vertical spectral ratio (H/V) at approximately 100 sites. The investigation area is approximately 12 km by 16 km at Napa, CA including the valley floor and surrounding hills, Mayacamas Mountains on the west and Vaca Mountains on the east, bounded by the West Napa Fault and the Soda Creek Fault. MAM was collected with eight to twenty 2 Hz geophones, and the maximum receiver spacing ranged from 30 to 1500 m. Ambient noise for MAM and H/V were collected for 20-120 minutes. A spatial auto-correlation (SPAC) method calculated phase velocities from the vertical component of ambient noise. Minimum frequency of dispersion curves ranged from 1 to 10 Hz. H/V was calculated from three-component (3C) seismic ambient noise using a single 3C 2Hz geophone. The peak frequency of H/V ranged from 0.25 Hz to 10Hz. There were clear differences between valley floor and surrounding hills both dispersion curves and H/V. In the H/V spectra, there is a clear peak of H/V at a frequency of 0.3 Hz in the valley floor sites whereas there is no clear H/V peak below 1 Hz in the hill sites. Joint inversion of a dispersion curve and H/V spectrum estimated Vs profiles to 30 m to 1000 m depth. There is a large difference in resultant Vs profiles. Depth to a shallow engineering bedrock with Vs of 760 m/s is 300 m and 30 m at typical valley floor sites and hill sites respectively. It indicates that the velocity model changed considerably along the Soda Creek Fault. The result of inversion and geological model implies that the low frequency peak of 0.3 Hz at the valley floor site is mainly due to a deep bedrock with Vs more than 2500 m/s at approximately 1000 m depth. We compiled all Vs profiles together with the 3D Vs model based on geological information and estimated a preliminary 3D Vs model to a depth of 1000 meters. The VS30 obtained from the MAM ranged between 200 m/s and 970 m/s. Clear H/V peak frequencies of 0.25 to 0.4 Hz were consistent in the valley floor. The depth to the bedrock with Vs of 760 m/s ranged between almost surface to greater than 300 m.