Mantle Serpentinization near the Mariana Trench Constrained by Ocean Bottom Surface Wave Observations

*Chen Cai[1], Douglas Wiens[1], Daniel Lizarralde[2], Melody Eimer[1]

1. Washington University in St. Louis, 2. Woods Hole Oceanographic Institution

Although water is essential for many subduction processes, the water cycle at subduction zones remains poorly constrained. Serpentinization within the subducting and overriding plates have been observed at numerous subduction zones, with significant percentage variations. Widespread normal faulting on the incoming plate and serpentinite seamounts on the outer forearc in Mariana makes it an ideal place to study serpentinization of the incoming plate and the forearc mantle, and thus helps us to better understand the water budget of subduction zones. We investigate the shear wave structure of the crust and uppermost mantle across the Northern and Central Mariana trench using data collected by a temporary network involving both ocean bottom seismographs (OBSs) and land stations on the arc islands. Rayleigh wave phase velocities (10s –64s) are obtained with three different methods, including ambient noise tomography for short periods, Helmholtz tomography for the intermediate periods and two-plane-wave tomography for long periods. The dispersion curve obtained at each location is then inverted to SV velocities. Linear inversion results show low velocity anomalies around the trench axis, both within the incoming plate mantle and the forearc mantle wedge. The low velocity anomaly extends to about 30 km deep from the seafloor, well correlated with the 600-degree isotherm. The western and eastern boundaries of the anomalies are sharp, and have good correlation with the forearc serpentinite seamount locations and the incoming plate normal faulting earthquake distributions. The mantle shear velocity is as low as 3.2 km/s, indicating ~60% serpentinite component if the velocity reduction is purely caused by serpentinization. We will further apply a Bayesian Monte-Carlo algorithm to avoid the potential biases due to starting models and to better apply a priori constraints.

Keywords: Mantle Serpentinization, Water Budget, Surface Wave