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Geographical distribution of shear wave anisotropy within marine sediments in the northwestern Pacific

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Elastic properties of marine sediments, including P and S wave velocities, have been recently investigated well by active seismic surveys. However, information on S anisotropy associated with alignments of fractures and fabric remains elusive. To obtain such information, we used ambient noise records observed by ocean bottom seismometers at ~250 sites in the northwestern Pacific to calculate auto-correlation functions for retrieving S reflections coming from a sedimentary basement. We measured differential travel times and polarized directions of these S reflections to see, if any, geographical systematic distribution of S anisotropy. Consequently, the observed differential times were at most 0.05 s. The fast polarization axes tend to align in trench-parallel direction in the outer rise region. In particular, their directions systematically change in accordance with the direction of trench axis that changes sharply across the junction of the Kuril and Japan Trenches. We suggest two contributors for the obtained S anisotropy within marine sediments in the outer rise region, cracks induced by stresses due to bending of the plate and fractures associated with the basement deformation below the sediments. Which effect is dominant depends on the degree of plate bending. In the northwestern Pacific, both stress-induced cracks and fractures due to the basement deformation cause S anisotropy in a region where a large bending of the plate is observed, while fractures due to the basement deformation only create S anisotropy in other region of small bending of the plate. Moreover, we carried out numerical simulations with three-dimensional finite difference method taking into account anisotropy to simple, two-layered structure. Our results indicate that successful extraction of S anisotropy from the retrieved S reflection attributes near-vertically propagating S reverberations associated with extremely low Vs within marine sediments. Another numerical simulation with a realistic velocity model underneath the seafloor was conducted on the Earth Simulator in order to confirm whether S reflections from interfaces below the basement could be extracted or not. As a result, it is considered that such S reflections would be hindered by S reverberations with large amplitudes within marine sediments.

Keywords: marine sediment, S anisotropy, ambient noise, northwestern Pacific