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SPdKS Constraints on a Thin Slow Layer at the Base of the Mantle Beneath the Northwestern Pacific

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The thermal and chemical structure of the lowermost mantle has important implications for models of mantle heat flow and core-mantle interactions. The goal of this study is to use the SPdKS phase to constrain velocity structure at the base of the mantle in a localized region beneath the northwestern Pacific. Previous studies that employed SPdKS on long-period records found evidence for a very slow layer (~10%) with thicknesses of 5-40 km just above the core in the central Pacific where the lower 300 km of the mantle is also slower than average. Here we examine data for a large, deep event that occurred beneath the Japan Sea on 8/23/95 and was recorded by the MOMA experiment, a roughly linear array of 18 temporary broadband stations that extended from Missouri to Massachusetts. The first appearance of SPdKS in the back swing of SKS occurs at a distance of ~102°, significantly closer than the distance of 110° which is predicted by standard Earth models such as PREM that do not contain a slow basal layer. To model these data, we generated 1D reflectivity synthetics, exploring basal layers with thicknesses of 5-30 km and velocity perturbations of up to 30%. For most of our stations, very thin layers (5 km) with strong reductions in both P- and S-wave velocities (10-30%) best model the moveout of SPdKS with respect to SKS. We were not able to find an acceptable fit to the entire array with a single 1D model, implying that velocity structure at the base of the mantle is laterally heterogeneous on length scales of less than 100 km. Previous SPdKS studies indicate PREM-like velocity structure at the base of the mantle beneath eastern North America where our rays exit the outer core, suggesting that we can attribute these velocity perturbations to a thin layer at the base of the mantle beneath the northwestern Pacific where the downgoing SPdKS waves encounter the CMB. In contrast to previous studies, we have found a thin very slow basal layer in a region where overall D" velocities are not consistently slow. The slow basal velocities may be caused by a layer of partial melt, or perhaps by a layer of strong chemical heterogeneity.