Variety and origin of the ultralow velocity zone in the lowermost mantle

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A large amount of waveform data of PcP and ScP waves reflected from the core-mantle boundary (CMB) beneath the Philippine-Kalimantan region and recorded at the Hi-net and IMS stations enables us to constrain very precisely the physical properties of the ultralow-velocity zone (ULVZ) at the base of the mantle. Clear arrivals of postcursor are detected in ScP wavelet from the specific source-receiver pairs which have proximal reflection points with each other beneath the Philippine-Kalimantan region, indicating the existence of the ULVZ there. The waveform modeling of both PcP and ScP waves in this region shows the different ULVZ structures between the northeastern and southwestern parts of the Philippine-Kalimantan; the ratio of shear-to-compressional velocity reductions (dlnVs/dlnVp) is 2.0 to 2.5 and the ratio of density-to-shear velocity changes is -0.5 to -0.33 in the northeastern part, while minimal changes in compressional velocity and large shear velocity decrease in the southwestern part are found. Increase in density and decrease in shear velocity throughout our observation imply that the iron incorporation into the lowermost mantle minerals may generate the ULVZ anomaly. However, other mechanisms such as partial melting can explain the structural difference between the northeastern and southwestern parts of the ULVZ beneath the Philippine-Kalimantan region.