Mantle transition zone beneath a normal seafloor in the northwestern Pacific: Electrical conductivity, seismic discontinuity, and water content

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We conducted a joint electromagnetic (EM) and seismic experiment to probe the mantle structure below a normal seafloor around the Shatsky Rise in the northwestern Pacific. Specifically for the investigation of the mantle transition zone (MTZ) structure, we deployed our state-of-the-art instruments in two arrays to the north and south of the Shatsky Rise for 5 years from 2010 to 2015. Here we report the result of analyses of EM and seismic data obtained in the joint experiment as well as in previous studies. From the EM data analysis, a 1-D profile of electrical conductivity was obtained for two observational arrays. The thickness of the MTZ was also obtained by the P-wave receiver function analysis, from which temperature profiles in the MTZ below two arrays were then estimated. We found that the northern array provides EM and seismic data with much higher quality than the southern array, and therefore meaningful estimation of MTZ water content is possible for the northern array. We estimated water content based on profiles of electrical conductivity and temperature obtained by our geophysical observation and electrical conductivities of dry and wet MTZ minerals (wadsleyite and ringwoodite) obtained by mineral physics. The result of the forward modeling study indicated that the upper limit of water content below the northern array is 0.5 wt.% or 0.05 wt.%, depending on different results of laboratory experiments for water effects on electrical conductivities. The lower limit of water content was not constrained by our data.

