Signature of the oceanic lithosphere asthenosphere system from seafloor electromagnetic and seismic observations

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In-situ geophysical observations provide key information to understand the signature of the oceanic lithosphere-asthenosphere system (LAS), although the relation between physical and mechanical properties of the mantle rocks is neither simple nor well understood. Recently magnetotelluric array studies have been carried out in different tectonic settings mostly in the Pacific Ocean with wide range of seafloor age (0-150 Ma). Results are inverted to either 1D, 2D or 3D model of electrical conductivity distribution in the upper mantle down to depths of several hundred km, and all available 1D profiles are compiled. Generally, thus estimated 1D profile consists of shallower low conductivity and deeper high conductivity layers (called as LCL and HCL, respectively). The LCL-HCL (LH)-transition occurs at depth of 50 km or deeper, and some results show a good correlation to the seismologically determined LID-LVZ transition. Below the LH-transition, electrical conductivity is almost constant or its variation is very gradual.

We examine the age dependence of the LH-transition depths and the typical HCL conductivity values based on thus compiled 1D profiles. The HCL conductivity is found to show little age dependence, taking value of about -1.4 in log scale (about 0.04 S/m). Only exception so far obtained is the result from the Cocos plate subduction zone (Naif et al., 2013), in which the typical conductivity value is as high as about 0.2 S/m (isotropic part). On the other hand, the age dependence of the LH-transition depth is apparently more complicated. However, if we exclude a few profiles near plate boundary such as the EPR (Evans et al, 2005) or the NW Pacific subduction zone (Baba et al., 2013), we found that the transition depth is mostly following the cooling of a plate, implying dominance of its thermal control. Of course available observation data are not enough to rule out other possible interpretation (e.g., compositional control). We definitely need more array observations (seismic and EM jointly) from different areas, as well as understanding the basic physics that relates physical to mechanical properties, for further elucidating the oceanic LAS.