An interpretation on the characteristic electrical conductivity structures of the various subduction types

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We compiled two-dimensional electrical conductivity structures of subduction zones around the Japanese Islands and found the characteristic lower crutal conductor distribution depending on subduction type. The distribution is explained by the fashion of the dehydration from subducting slab and partial melting production.

We classified subduction zones around the Japanese Islands into three types. The first is PAC type, which is (c)old slab, fast subduction rate and gentle slab dipping (Hokkaido and Tohoku). The second is PHSa type that is young and warm slab, slow subduction rate, and gentle slab dipping (Kinki, Shikoku). The third is PHSb type, which is same with PHSa except steep slab dipping (Kyushu and Okinawa). The features of the electrical conductivity structure in each subduction types are:

(1)The PAC subduction zone involves the lower crustal conductor beneath the volcanic front (Uyeshima et al., 2002; Satoh et al., 2001; Utada et al., 1996; Ogawa et al., 1986).

(2)The PHSa subduction zone exhibits lower crustal conductor beneath the fore-arc only and no indication of the lower crustal conductor beneath the volcanic front (Kasaya et al., 2005; Yamaguchi et al., 1999; Fuji-ta et al., 1997).

(3)The PHSb subduction zone develops a wider lower crustal conductor beneath from fore-arc through volcanic front (Ichiki et al., 2000) than in PAC and PHSa subduction zones. Aside from the lower crustal conductor, another outstanding feature peculiar to PHSb subduction zone is the upper mantle conductors beneath the back-arc (Shimoizumi et al., 1997; Handa et al., 1992; Shimakawa and Honkura 1991; see also Toh and Honma, 2008).

Supposed that the lower crustal conductors in the subduction zones be ascribed to aquious fluids, the spatial distribution of the lower crustal conductors in PAC and PHSa subduction zones can be explained by the characteristic dehydration process in each subduction zone. It was pointed out that most of dehydration is completed beneath fore-arc for young slab subduction, while old slab subduction preserves continuous dehydration process to deep upper mantle (e.g. Maruyama and Okamoto, 2007; Maruyama et al., 1996; Peacock 1996). Hence the crustal conductor is restricted to beneath the fore-arc only in PHSa subduction zone, and the lower crustal conductor is embedded beneath the volcanic front in PAC subduction zone. The interpretation of PHSb subduction zone is that the wider conductor beneath from fore-arc to volcanic front is composed of the conductors caused by partial melting and by aquious fluids. The electrically conductive part beneath around the volcanic front in PHSb subduction zone is ascribed to partial melting rather than aquious fluid. The reason is that steep slab dip angle gives rise to drastic thermal return flow into the wedge mantle (e.g. Kincaid and Sacks, 1997) and that the dehydration from PHS slab is expected to be completed beneath the fore-arc as described above. Moreover back-arc plate motion and thermal flow provided by back-arc spreading, which appears inherently in subduction zones with steep dipping slabs (Lallemand et al., 2005), promotes partial melting beneath volcanic fronts (e.g. Kincaid and Hall, 2003). The upper mantle conductor beneath the back-arc described in (3) definitely reflects the back-arc spreading, and electrical conductivity studies also strongly support the positive correlation between back-arc spreading and steep dipping slab subduction.

The Pacific plate transports hydrous components to deep upper mantle. Electrical conductivity structures also indicate the presence of hydrogen or water in deep upper mantle beneath Pacific back-arc. Toh et al. (2006) detected a conductive zone at 150-200 km beneath the Sado Ridge, eastern margin of Japan Sea by the 2-D inversion analysis of high quality MT responses, and Ichiki et al.(2006) revealed electrically conductive deeper upper mantle than 200 km depth beneath the northeastern China.