State of the subducted Philippine Sea Plate beneath Central Japan: constraints from geochemistry of lavas and seismic structures

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In subduction zones, water is thought to play important roles in generating both arc magmatism and earthquakes. Arc magmas show the evidences of inclusion of aqueous fluid (water and fluid-mobile elements) which is derived from the subducting slab and contributes to generate the magmas. Potential distributions of melt, water, and hydrous mineral phases in the subducted slab, mantle wedge, and overriding crust are now being able to constrained by seismology, for example, low-velocity zone in the mantle wedge due probably to presence of melt and/or aqueous fluid (e.g., Nakajima et al., 2001, 2005), intermediate-depth earthquakes perhaps indicating the dehydration embrittlement of metamorphosed oceanic crust and mantle in the subducting slab (e.g., Yamazaki and Seno, 2003), high Poisson's ratio possibly indicating the exist of serpentinized peridotite in the mantle wedge or oceanic lithosphere (Kamiya and Kobayashi, 2000). These observations and interpretations allow us to discuss how subducted water can be related to generation of arc magmatism, earthquakes.

Central Japan is located behind a trench-trench-trench (TTT) triple junction with two obliquely subducting plates, the Pacific plate (PAC) and the Philippine Sea plate (PHS). The PAC subducts at a rate of 8-10cm/year from the east, which is overlapped by PHS subducting at a rate of 3-5cm/year from the southeast (e.g., Bird, 2003; Seno et al., 1993). Beneath Central Japan, the geometry of the subducted PAC slab is well determined by the seismic studies, whereas the depth contour of the subducted PHS slab is complex and partly not detected due to low seismic activity (e.g., Nakajima and Hasegawa, 2006). We have found the systematic spatial variations in Nd-Sr-Pb isotopic ratios of Quaternary lavas, and have identified isotopically different two aqueous fluids (PAC-fluid and PHS-fluid) from the two subducting slabs contributing to the spatial variation (Nakamura et al., 2006). Geochemical modeling suggests that amounts of the fluids added to the mantle source region from PAC and PHS slabs differ spatially and provide control of the isotopic variation in lavas (Nakamura et al., 2008). These results further suggest that the geometry of subducted two slabs would be the prime control.

In this paper, we focus on lavas in the Fuji-Myoko area located in the center of Central Japan to discuss the state of the subducted PHS and its spatial extent beneath the area. It is well known that the Izu-Bonin-Mariana (IBM) arc developed NE margins of the PHS collides to the Japan arc at this area, and existences of aseismic slab and high-temperature region are indicated seismologically (e.g., Iidaka et al., 1990; Sekiguchi, 1991; Matsubara et al., 2005). The lavas in this area are distinct from the adjacent east and west areas in that a contribution of PHS-fluid is almost zero, and the total amount of water added to the mantle source region is minimal. These geochemical features may reflect the petrological nature of PHS beneath this region probably consisting of relatively dry arc crust of the IBM. A low fluid flux rate would also be suggested due to slow subduction rate caused by the arc-arc collision. This view can also explain the low seismicity in this area due to lack of water in the slab and high temperature nature beneath the PHS slab perhaps for the remnant of molten mantle beneath the magmatic IBM arc.

The western edge of Fuji-Myoko Area almost corresponds to Itoigawa-Shizuoka Tectonic Line, while the eastern edge is not clear in terms of the surface geological features like tectonic line or fault. Considering that the geochemical characteristics of the volcanic rocks are distinct between Fuji-Myoko Area and the adjacent eastern area where more fluid is added with clear PHS-fluid signatures, geochemistry of lavas has a potential to provide a sensitive tool inferring the state of subducted slab.