Fluid-fluxed melting of the mantle as the cause of intraplate magmatism over a stagnant slab: evidence from Fukue Volcano Group, SW Japan

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The Pacific Plate subducting from the Japan Trench has accumulated in the mantle transition zone beneath NE Asia, and intraplate magmatism has been active above the stagnant Pacific slab. Since the discovery of a remnant of the Pacific slab in the mantle transition zone (Fukao et al., 1992), slab stagnation and its relationship with intraplate magmatism has received growing attention. In particular, electric conductivity observations have suggested a remarkably hydrous mantle transition zone beneath NE China (e.g., Kelbert et al., 2009), and experimental, seismic, and numerical studies have indicated that dehydration of the stagnant slab plays a significant role in magma genesis (e.g., Ohtani and Zhao, 2009). In this study, a petrological and geochemical study was carried out on basalts from a monogenetic volcano (Akashima Volcano) in the Fukue Volcano Group, SW Japan, to clarify the role of deep dehydration of the stagnant Pacific slab in the magmatism.

The eruption products of the volcano consist of low-Si and high-Si groups, and the two magmas are hypothesized to originate from different mantle source material based on radiogenic isotopic compositions. The H_2O contents of the primary magmas were estimated as ~2 wt.% for both the low-Si and high-Si groups. Analyses using multicomponent thermodynamics suggested that the low-Si and high-Si primary magmas were generated at ~2.5 GPa and 1345ºC and at ~1.8 GPa and 1285ºC, respectively. These results, and the geochemical characteristics of the products, indicated that the low-Si magma was generated in the asthenospheric mantle whereas the high-Si magma was produced by interaction of the low-Si magma with the sub-continental lithospheric mantle. The low mantle potential temperature of ~1300ºC and hydrous nature (H_2O/Ce = 650) of the low-Si magma suggested that the magma was generated by fluid-fluxed melting of the asthenospheric mantle. We infer that the fluids for the flux melting have been released from the mantle transition zone where water was locally saturated.