Find of low-Ni, high-Mg basalt from the Miocene volcanic rocks in eastern Fukui City: Evidence for pyroxenite melting?

Akira Ishiwatari[1], Takehiro Katsuragi[2]

[1] Earth Sci., Kanazawa Univ., [2] Natural Science and Technology, Kanazawa Univ

http://kgeopp6.s.kanazawa-u.ac.jp/~ishiwata/

Miocene Green Tuff volcanic rocks (21-16 Ma) are widely distributed in the eastern Fukui City. Relatively primitive basalt(FeO*/MgO=1.0) with very low Ni content (20 ppm or less) is found from the Ichijo Valley area, where basaltic lavas are more abundant than the andesitic pyroclastic rocks. This basalt contains phenocrysts of magnesian olivine (Modal Abundance=10.1%, Fo87) with very low NiO content (0.03 wt.%) along with augite (MA=23.7%) and plagioclase (MA=7.5%, An80-90). This basalt and the associated, more evolved basalts and andesites together follow calc-alkaline differentiation trend in the SiO2-FeO*/MgO diagram. These volcanic rocks show slightly enriched chondrite-normalized REE patterns ((La/Yb)n=3-7), high Zr contents (80-130 ppm) and Zr/Y ratios (3-10), and distinct negative Nb and positive Pb anomalies characteristic of the continental arc volcanic rocks in common with the other Green Tuff volcanic rocks of the Hokuriku Province, except for the apparent Ni-poor nature of the studied volcanic rocks. The Ni-poor nature of the primitive basalt may be explained by the following hypotheses. (1) Extensive fractional crystallization of a highly magnesian magma generated by partial melting of extremely magnesian (forsteritic) mantle peridotite. (2) Fractional crystallization of an ordinary basaltic magma under unusually low oxygen fugacity to crystallize metallic nickel-iron or under very high sulfur fugacity to crystallize nickel-iron sulfides. (3) Generation of Ni-poor basaltic magma by partial melting of an olivine-poor mantle material such as pyroxenite. Overall chemical similarity of the studied Ni-poor basalt with the Ni-rich basalts of the same age in the nearby Noto Peninsula and Tango Peninsula prefers hypothesis (3), that is partial melting of the olivine-poor (pyroxenitic) part of the same (essentially peridotitic) mantle source. Recent studies show that large degrees of partial melting of pyroxenitic or eclogitic (gabbroic) mantle material may be important for generation of LIPs (large igneous provinces). The low Ni content of primitive basalt (both in bulk rock and olivine phenocryst) as revealed by this study provides a direct evidence for the origin of basaltic magma in an olivine-poor source material.