A petrological and isotopic study of volcanic rocks from Mt. Arakurayama and other areas, North Fossa Magna, Central Japan

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The Arakurayama andesitic volcanic rocks (Pliocene) can be divided into the lower volcanic rocks, submarine fan deposits (sandstone and siltstone of the Takafu formation), and the upper volcanic rocks. The lower volcanic rocks consist mainly of hyaloclastite associated with pseudo-pillow lava and intraclastic siltstone. Some massive lavas and agglomerate deposits including bombs are distributed in the central part of the lower volcanic rocks as proximal facies. The upper volcanic rocks consist mainly of subaerial massive lavas.

The lower and upper volcanic rocks are andesitic in composition and contain phenocrysts of plagioclase, clino- and orthopyroxene, $\pm$ hornblende. The lower volcanic rocks have a wide range of bulk SiO_2 contents (52-60 wt%) compared with the upper volcanic rocks (56-58 wt%), which may reflect contrasting P-T conditions of crystallization between the two magmas (i.e., of the lower and upper magmas, respectively). Geothermobarometry using the chemical compositions of hornblende phenocrysts indicates that the lower magmas underwent polybaric crystallization in deep (989-806 MPa, 1062-1034 ℃) and shallow (374-174 MPa, 940-836 ℃) chambers, whereas the upper magmas crystallized in a single chamber at intermediate depths (789-387 MPa, 1033-928 ℃). The narrow range of SiO_2 contents of the upper volcanic rocks indicates a simple fractional crystallization in a single magma chamber, whereas the variable SiO_2 contents of the lower volcanic rocks indicate complex magmatic processes such as the mixing of magmas with different compositions in the deep and shallow magma chambers.

The Arakurayama volcanic rocks exhibit constant $^{143}Nd/^{144}Nd$ and variable $^{87}Sr/^{88}Sr$ ratios, showing a horizontal trend in Nd-Sr isotopic systematics. This trend (i.e., the Arakurayama trend) is typical of volcanic rocks from the eastern and western margins of the Fossa Magna, including the Quaternary Myoko and Kurohime volcanoes (from the western margin, near the Itoigawa-Shizuoka Tectonic line), the Yoneyama area, and the Quaternary Naeba volcano (from the eastern margin, near the Kashiwazaki-Chiba Tectonic line). A different trend is apparent for igneous rocks from the central part of the Fossa Magna region, including Miocene-Pliocene granites and the Asama volcano. This trend exhibits higher $^{143}Nd/^{144}Nd$ ratios than the Arakurayama trend. In a diagram of Nd-Sr isotopic systematics, rock samples with the least radiogenic Sr isotopes in each trend are distributed in different parts of the mantle array field, indicating two different mantle components (i.e., pre-existing mantle and newly injected asthenospheric mantle beneath the Fossa Magna area).