

Geochemistry and petrogenesis of volcanic rocks from Ulleung Island, South Korea

SUNG HI CHOI¹

¹Department of Geological Sciences, Chungnam National University, Daejeon 34134, South Korea

Ulleung Island is a Quaternary intraplate alkaline volcano located in the mid-western part of the East Sea (Sea of Japan) back-arc basin. The history of the volcano has been subdivided into five stages: Stage 1 trachybasalt, Stages 2 and 3 trachytes, Stage 4 phonolite, and Stage 5 leucite-bearing trachyandesite. This study presents geochemical compositions, including Sr-Nd-Pb isotopes, for the volcanic rocks ranging from trachybasalt to trachyte/phonolite. The trachytes and phonolites were formed by fractional crystallization of the trachybasaltic magma at different depths. The trachybasalts have highly fractionated REE patterns with $(La/Yb)_N$ values of 23.6-30.7, free of Eu anomalies. On a primitive mantle-normalized trace element distribution diagram, the trachybasalts show OIB-like LILE enrichments without HFSE depletion. However, they show negative anomalies in K, suggesting phlogopite or potassic amphibole in the source. The lithology and physical condition of the mantle source for the Ulleung basalts are estimated to have been f_{PY} (fraction of pyroxenite) of $4 \pm 2\%$, T_p of $1303 \pm 8^\circ\text{C}$, P_{mt} (minimum pressure of basalt segregation) of 2.5 ± 0.0 GPa, T_{mt} of $1327 \pm 8^\circ\text{C}$, and F (degree of melting) of 1.9 ± 0.6 wt%. The Stage 1 trachybasalts have EM1-type OIB-like Sr-Nd-Pb isotopic compositions ($^{87}\text{Sr}/^{86}\text{Sr} = 0.70472\text{-}0.70507$; $\epsilon_{Nd} = -4.5$ to -1.8 ; $^{206}\text{Pb}/^{204}\text{Pb} = 18.01\text{-}18.09$). Meanwhile, the Stage 5 trachyandesites do not show significant negative anomalies in K, and are characterized by slightly more depleted Sr-Nd-Pb isotopic compositions ($^{87}\text{Sr}/^{86}\text{Sr} = 0.70445\text{-}0.70453$; $\epsilon_{Nd} = -1.3$ to -1.2 ; $^{206}\text{Pb}/^{204}\text{Pb} = 18.06$) compared with those of the trachybasalts, implying the influence of recycled slab melting being relatively minor in the genesis. The differentiated Stages 2-4 trachytes/phonolites have more radiogenic Sr and unradiogenic Nd and Pb isotopic compositions ($^{87}\text{Sr}/^{86}\text{Sr} = 0.70455\text{-}0.71064$; $\epsilon_{Nd} = -3.4$ to -1.4 ; $^{206}\text{Pb}/^{204}\text{Pb} = 17.83\text{-}18.04$) compared with the Stage 1 trachybasalts, suggesting assimilation of attenuated lower continental crust during its evolution. The Ulleung magmatism might have been generated by small-scale/edge-driven convection in the asthenosphere.