

Mantle Source Characteristics and Petrogenesis in the Lunar Crater Volcanic Field

C. RASOZANAMPARANY¹, E. WIDOM^{1*}, J.A. CORTES², E.I. SMITH³, G.A. VALENTINE², D. KUENTZ¹
AND R. JOHNSEN³

¹Department of Geology, Miami University, Oxford, USA, widome@muohio.edu (*presenting author)

²Department of Geology, State University of New York, Buffalo, USA, gav4@buffalo.edu

³Department of Geoscience, University of Nevada, Las Vegas, USA, gene.smith@unlv.edu

The nature of the mantle sources and the role of lithospheric assimilation in producing compositional variations in basaltic monogenetic volcanic fields remains controversial. To address these issues, we have performed major and trace element and Sr, Nd, Pb, Hf and Os isotope measurements on 19 mafic lavas from 4 volcanic centers in the northern Lunar Crater Volcanic Field (LCVF), Nevada. Three eruptive centers (Giggle Springs, <100 Ma; and Hi Desert and Mizpah, ~620-740 Ma) are located within ~500 m of each other; the Marcath volcano (~40 ka), the youngest eruptive center in the field, is located ~6 km SW of these cones. The lavas have essentially constant Nd and Hf isotope ratios, but significant heterogeneity in Sr and Pb isotopes, and superchondritic Os isotope ratios. The older Mizpah and Hi Desert lavas exhibit HIMU-like trace element and Sr-Pb isotope signatures, with Nb-Ta enrichment, Rb, Cs and K depletion, and high ²⁰⁶Pb/²⁰⁴Pb but low ⁸⁷Sr/⁸⁶Sr. In contrast, the younger Marcath and Giggle Spring lavas have enriched mantle (EM) type signatures with high Ba, Rb and Cs, and lower ²⁰⁶Pb/²⁰⁴Pb and higher ⁸⁷Sr/⁸⁶Sr. Together, the LCVF lavas produce a negative correlation between Sr and Pb isotopes that could be attributed to lower crust assimilation. However, the lack of correlation of isotopes with indices of fractionation, OIB-like Nb/U ratios, and a positive correlation of ¹⁸⁷Os/¹⁸⁸Os with Nb/U argue against an important role for crustal assimilation. Instead, the compositional variations are attributed to heterogeneous mantle sources. Mixing models indicate that incorporation of ~18% of 0.8Ga recycled oceanic crust into a depleted mantle source can explain the trace element and isotopic signatures of the HIMU lavas. Subsequent addition to the HIMU-like source of minor (~1%) hydrous fluid derived from subducted oceanic crust could account for the chemical and isotopic compositions of the EM lavas. Our data indicate that the mantle source region in the LCVF is characterized by chemical and isotopic heterogeneity over a very small spatial scale (<500m), and that the nature of the mantle source and the depth of melt generation has changed systematically with time.

Compositions and zoning of coexisting minerals in alkaline-ultrabasic rocks, phoscorites, and carbonatites from the Kovdor Complex, Kola Peninsula

I. RASS AND E. KOVALCHUK

Institute of Geology of Ore Deposits, Petrography, Mineralogy & Geochemistry, Russ. Acad. Sci., 35 Staromonetny, 119017 Moscow, e-mail: rass@igem.ru

The compositions of coexisting pyroxene, magnetite, perovskite, schorlomite, titanite, and apatite in silicate and carbonate rocks were studied by electron-probe microanalysis (EPMA) techniques. The principally different major- and trace-element compositions and zoning of the above minerals from magmatic and metasomatic rocks reflect their different crystallization circumstances (*P*, *T*, *f*O₂, *p*CO₂, *a*SiO₂) in the Earth's crust. Magnetite in silicate rocks is noticeably richer in Ti than this mineral in carbonatites and phoscorites. The Ti content decreases from the cores to rims of magnetite crystals in any magmatic rock but shows the opposite tendency in magnetite of metasomatic Ne-Px rocks. A higher proportion of the magnesioferrite component in magnetite from phoscorites compared to that in silicate rocks is likely attributed to higher oxygen fugacity during the crystallization of the former. Apatite in younger derivatives of silicate rocks bears higher Sr concentrations. Its crystals exhibit core-to-rim variations in the contents of F (by up to 3.2 wt.%), REE, and SiO₂. The F content increases in apatite from magmatic rocks and decreases in that mineral from metasomatic ones. The SiO₂ content of apatite in silicate rocks reaches ~1 wt.% and shows a core-to-rim increase, whereas its concentrations in carbonatitic and phoscoritic rocks are noticeably lower. The presence of Si-rich apatite suggests its crystallization at shallower depths, at which CO₂ activity is lower. The occurrence of Ti-rich andradite and titanite in Px-Ne rocks instead of perovskite is due to a higher *a*SiO₂.

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