Goldschmidt 2024 Abstract
https://doi.org/10.46427/gold2024.23567

Thallium isotopic data unravel heterogeneity beneath Kamchatka arc

SHELBY T. RADER[1], ALEKSANDR MARFIN[1], VESTA DAVYDOVA[2], MOLLY KARNES[1] AND VASILY D. SHCHERBAKOV[2]

[1]Indiana University

[2]Lomonosov Moscow State University

Presenting Author: shtrader@iu.edu

Arc magmatism is a crucial process in forming continental crust and related ore deposits, which we have recently been able to track using nontraditional stable isotopes. To better understand the observed variations in subduction-related arc systems and metal deposits, including the role of metasomatic fluids and mantle heterogeneities, we present trace element and thallium (Tl) isotopic data (shown as ε^{205}Tl, which is ^{205}Tl/^{203}Tl relative to SRM NIST 997) from the north Kamchatka arc setting. Eleven basaltic andesite samples and five mantle wedge spinel harzburgite xenoliths from Bezymianny volcano (BV) were studied. Studied volcanic samples are K-medium basaltic andesite and are relatively enriched, compared to primitive mantle, demonstrated by Cs, Th, U, Ba Zr, and Ta-Nb depletion, flat rare earth element (REE) distribution, and high Th/Yb ~ 0.5 and Nb/Yb ~ 0.8, which is consistent with Kamchatka volcanic rocks (ref). Bulk-rock trace-elements composition for ultramafic xenoliths are characterized by enriched Cs, Tl, Ba, U and Pb compared to primitive mantle and flat REE distribution.

Basaltic andesite ε^{205}Tl values are indistinct from that of the mantle, ranging from -2.7 to -1.1 ($\varepsilon^{205}Tl_{avg}$ = -1.8 ± 0.5, n=10) and, in general, are consistent with previous data[1]. One outlier, characterized by a large Cs/Tl (>20) and more positive ε^{205}Tl value, is interpreted to be the product of degassing, which is also consistent with other Kamchatka volcanoes[2]. Within mantle wedge xenoliths, ε^{205}Tl values vary significantly, from -1.8 to +18.2, which is interpreted to be the result of multistage metasomatism by isotopically heavy dehydration slab fluids during subduction and/or the melting of manganese nodules, which are characterized by heavy ε^{205}Tl (~+15).

References

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[2]Nielsen, S.G., Shu, Y., Wood, B.J., Blusztajn, J., Auro, M., Norris, C.A. and Wörner, G., 2021. Thallium isotope fractionation during magma degassing: Evidence from experiments and Kamchatka arc lavas. Geochemistry, Geophysics, Geosystems, 22(5), p.e2020GC009608.