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HFSE behavior during liquid immiscibility between carbonatitic and silicate melts

MINGXING LING[1], WANZHU ZHANG[1] AND SHUO XUE[2]

[1]East China University of Technology

[2]Guangzhou Institute of Geochemistry, Chinese Academy of Sciences

The study focuses on the partitioning behaviors of high field strength elements (HFSEs) such as Nb, Ta, Zr, and Hf during the liquid immiscibility process between carbonatitic and silicate melts, a process of significant relevance to understanding carbonatite-related HFSE deposits [1]. These elements, crucial for various technological and industrial applications, exhibit considerable variation in their concentrations across different natural carbonatites, with significant impacts on economic ore formations. Despite carbonatites' association with HFSEs, understanding the precise mechanisms behind their fractionation during magmatic processes has been limited.

Through high-pressure, high-temperature piston-cylinder experiments, the study elucidates how temperature, pressure, and melt composition, especially SiO_2 content, influence the partitioning of these elements between coexisting carbonatitic and silicate melts. Key results show that a positive correlation exists between the partition coefficients of Si and HFSEs, where higher SiO_2 content in the melts favors increased HFSE concentrations in the carbonatitic melt. Furthermore, the study reveals that liquid immiscibility causes differential concentration of HFSEs, with silicate melts generally enriched in HFSEs compared to carbonatitic melts [1].

These findings have important implications for the formation and differentiation of carbonatite-related deposits, suggesting that conditions fostering Si-enriched carbonatitic melts at shallower depths are more conducive to HFSE mineralization. The data also underscores the role of magmatic exsolution processes and crystallization differentiation in enhancing HFSE enrichment, potentially guiding future exploration of large HFSE deposits in carbonatites [1].

This research offers new insights into the partitioning behavior of HFSEs during liquid immiscibility, contributing to the broader understanding of their role in the genesis of mineralization processes in carbonatite systems.

References:

[1] Zhang, W., Xue, S., Ling, M.X., & Ding, X. (2024). *American Mineralogist*, 109(9), 1569–1577.