American Mineralogist, Volume 84, pages 392–399, 1999

Systematics of Ni and Co in olivine from planetary melt systems: Lunar mare basalts

J.J. Papike,* G.W. Fowler, C.T. Adcock, and C.K. Shearer

Institute of Meteoritics, Department of Earth and Planetary Sciences, University of New Mexico, Albuquerque, New Mexico 87131-1126, U.S.A.

Abstract

The systematics of Co and Ni in olivine from six Apollo 12 olivine basalts were studied by SIMS techniques and correlated with major and minor element data obtained with the electron microprobe. Our results, together with previous studies, demonstrate that one of these basalts (12009) was extruded, as a liquid, onto the lunar surface and was parental to five other cumulates (12075, 12020, 12018, 12040, and 12035). The concentrations of Ni in zoned olivine phenocrysts behave as expected for a highly compatible element with initial estimated $D_{Ni} = 9.9$. On the other hand, Co concentrations in olivine vary hardly at all and show flat patterns across crystals that retain normal zoning trends for Mg, Fe, Mn, and Ni. The explanation for this behavior is not that $D_{Co} \approx 1$ (our estimated $D_{Co} = 4$) or that Co zoning has been erased by rapid diffusion of Co compared to the other elements (e.g., Mg and Fe) that still show normal zoning. The explanation for the behavior, as originally suggested by Kohn et al. (1989), is that the increase in D_{Co} with crystallization exactly balances the depletion of Co in the melt. This decoupling of the behavior of Ni and Co in olivine results in significant increases in Co/Ni with crystallization.