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SPECIAL COLLECTION: OLIVINE

Nickel–cobalt contents of olivine record origins of mantle peridotite and related rocks

Claude Herzberg[1,*], Christopher Vidito[1], and Natalie A. Starkey[2]

[1]Department of Earth and Planetary Sciences, Rutgers University, 610 Taylor Road, Piscataway, New Jersey 08854, U.S.A
[2]Planetary and Space Sciences, The Open University, Walton Hall, Milton Keynes, MK7 6AA, U.K.

Abstract

Olivine is distinguished from all other minerals in providing a remarkable chemical narrative about magmatic processes that occurred in Earth's crust, mantle, and core over the entire age of Earth history. Olivines in mantle peridotite have Ni contents and Mg numbers that were largely produced by equilibrium crystallization in an early turbulently convecting magma ocean; subsequent stages of partial melting operated to slightly elevate Ni and Mg number in residual olivines. Olivines from Archean komatiites from the Abitibi greenstone belt have Ni contents and Mg numbers that are consistent with an extensively melted peridotite source at great depths in the mantle. Olivines from basaltic oceanic crust, the Icelandic mantle plume and other Phanerozoic occurrences have compositions that record magma chamber crystallization, recharge, mixing, and partial melting. Olivines from the present-day Icelandic mantle plume have compositions that are consistent the melting of a peridotite source; unlike Hawaii, the melting of recycled crust as a distinct pyroxenite lithology is not evident in the olivine chemistry of Iceland. Paleocene picrites from Baffin Island and West Greenland from the ancient Icelandic plume have olivines with Ni contents that are consistent with either Ni-rich peridotite that formed by core-mantle interaction or by low-pressure crystallization of hot and deep magmas. In general, hot magma oceans, mantle plumes, and ambient mantle magmatism form in ways that are captured by the compositions of the olivine crystals that they contain.

Keywords: Olivine, nickel, cobalt, mantle