Goldschmidt 2026 Abstract
https://doi.org/10.46427/gold2026.35121

Enigmatic Ni- and Cu-bearing sulfide and Fe-phosphate inclusions in orthopyroxenite xenoliths hosted in adakitic dacites at Clear Lake volcanic field, California

DAWNIKA L. BLATTER, DR. THOMAS W SISSON, PHD AND SETH D. BURGESS

U.S. Geological Survey

Adakitic lava flows ranging from ~0.67 to 2.1 Ma crop out at the eastern edge of the Clear Lake volcanic field, California. These lavas track partial melting of the Juan de Fuca plate's retreating edge as a slab window opened in the wake of the north-migrating Mendocino Triple Junction. One adakitic flow, the dacite of Grizzly Peak, hosts small (<2 cm) orthopyroxenite xenoliths comprised of idiomorphic enstatitic orthopyroxene (En_{72-91}) that formed by reaction of volatile-rich silicic liquids (preserved as glass veins) with precursor mantle olivine (remaining as anhedral $Fo_{82–89}$) and high-Cr# spinel. Rare Cu- and Ni-bearing sulfide and Fe-phosphate inclusions occur throughout the orthopyroxenite xenoliths as either small (<10 mm) two-phase droplets encased in orthopyroxene or as larger (50–300 mm) subrounded multiphase inclusions associated with voids. The larger inclusions have irregular-shaped sulfide cores surrounded by Fe-phosphate that is compositionally banded and with apparent exsolution textures.

Electron microprobe analyses reveal that the Cu-bearing sulfides are chalcopyrite, and the Ni-bearing sulfides are pyrrhotite + monosulfide solid solution. Fe-phosphate compositions span 50–88 wt% FeO^T inversely correlated with 4–28 wt% P_2O_5. Fe-phosphate minor components include Al_2O_3, CaO, SO_3, CuO, NiO, MnO, SiO_2, MgO, and As_2O_5. All elements detected on X-ray wavescans were included in Fe-phosphate analyses, yet analytical totals are low by 8–30 wt%, the deficits from 100 wt% possibly signaling abundant H_2O/CO_2 and perhaps ferric iron.

To our knowledge, Fe-phosphate inclusions have not previously been observed in ultramafic rocks/xenoliths. These enigmatic inclusions appear to preserve phosphate-sulfide liquid(s) immiscible with the silicate melt (glass veins). Silicate melt, phosphate-sulfide liquid(s), and vapor participated in forming orthopyroxenite veins as the fluids and vapor transited precursor peridotite. The adakitic nature of the host lava suggests that these melts/fluids and vapor originated by partial melting of the slab edge (and possibly sediments) by slab-window processes. Together, these melts/fluids metasomatized the overlying mantle to form orthopyroxenite veins from which the xenoliths derive. Geographic proximity and age equivalency of the erupted adakites to the adjacent McLaughlin Au deposit raises the possibility that these or similar fluids/melts may have participated in ore mineralization.

