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Expanding the speciation of terrestrial molybdenum: Discovery of polekhovskyite, $MoNiP_2$, and insights into the sources of Mo-phosphides in the Dead Sea Transform area

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Abstract

Polekhovskyite, $MoNiP_2$, is the first terrestrial Mo phosphide, a phosphorus-rich homolog of meteoritic monipite, MoNiP. The mineral represents a novel phosphide type of terrestrial Mo speciation. It was discovered among phosphide assemblages in pyrometamorphic rocks of the Hatrurim Formation (the Mottled Zone) in Israel, the area confined to the Dead Sea Transform fault system. Polekhovskyite occurs in the altered diopside microbreccia, as micrometer-sized euhedral crystals intimately intergrown with murashkoite, FeP and transjordanite, Ni_2P, in association with Si-rich fluorapatite, hematite, and magnetite. In reflected light, the mineral has a bluish-gray color with no observable bireflectance and anisotropy. Chemical composition (electron microprobe, wt%): Mo 44.10, Ni 22.73, Fe 4.60, P 29.02, total 100.45, which corresponds to the empirical formula $Mo_{0.99}(Ni_{0.83}Fe_{0.18})_{1.01}P_{2.01}$ and leads to the calculated density of 6.626 g/cm. Polekhovskyite is hexagonal, space group $P6_3/mmc$, $a = 3.330(1)$, $c = 11.227(4)$ Å, $V = 107.82(8)$ Å^3, and $Z = 2$. The crystal structure has been solved and refined to $R_1 = 0.0431$ based on 50 unique observed reflections. The occurrence of Mo-bearing phosphides at the Dead Sea Transform area is a regional-scale phenomenon, with the localities tracked across both Israel and Jordan sides of the Dead Sea. The possible sources of Mo required for the formation of Mo-bearing phosphides are herein reviewed; they are likely related to the processes of formation of the Dead Sea Transform fault system. The problem of anthropogenic contamination of geological samples with Mo and Ni is also discussed in the paper in the context of the general aspects of discrimination between natural and technogenic ultra-reduced phases.

Keywords: Molybdenum, phosphide, pyrometamorphism, meteorite, carbonaceous chondrite, Ca-Al-rich inclusions, Dead Sea Rift, anthropogenic contamination