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Allabogdanite, $(Fe,Ni)_2P$, a new mineral from the Onello meteorite: The occurrence and crystal structure

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ABSTRACT

Allabogdanite, $(Fe,Ni)_2P$, is a new mineral from the Onello iron meteorite (Ni-rich ataxite). It occurs as thin lamellar crystals disseminated in plessite. Associated minerals are nickelphosphide, schreibersite, awaruite, and graphite. Crystals of the mineral, up to $0.4 \times 0.1 \times 0.01$ mm, are flattened on (001) with dominant {001} faces, and other faces that are probably {110} and {100}. Mirror twinning resembling that of gypsum is common, with possible twin composition plane {110}. Crystals are light straw-yellow with bright metallic luster. Polished (001) sections look silvery-white against an epoxy background. In reflected light in air, the mineral has a creamy color, with distinct anisotropy from light to dark creamy tint. No bireflectance was observed. R_1/R_2 (λ, nm) in air: 48.4/37.2(440), 46.7/36.8(460), 47.0/37.6(480), 47.5/38.1(500), 47.6/38.8(520), 48.2/39.2(540), 49.0/39.9(560), 49.6/40.7(580), 50.1/41.6(600), 50.5/41.9(620), 51.9/43.0(640), 52.3/44.3(660), 53.3/45.0(680), 54.4/46.2(700). No cleavage or parting was observed. Moh's hardness is 5–6; the mineral is very brittle, and its calculated density 7.10 g/cm^3. Its chemical composition (determined by microprobe methods, average of nine analyses) is: Fe 57.7, Ni 20.7, Co 1.4, P 20.4, Total 100.2 wt%, corresponding to $(Fe_{1.51}Ni_{0.50}Co_{0.03})_{2.04}P_{0.96}$ (three atoms per formula unit). Crystal structure: $R1$ = 0.040 for 138 unique observed ($|F_o| \geq 4\sigma_F$) reflections. Orthorhombic, *Pnma*, unit-cell parameters refined from powder data: a = 5.748(2), b = 3.548(1), c = 6.661(2) Å, V = 135.8(1), Å^3, Z = 4; unit-cell parameters refined from single-crystal data: a = 5.792(7), b = 3.564(4), c = 6.691(8) Å, and V = 138.1(3) Å^3. Strongest reflections in the X-ray powder diffraction pattern are [d in Å, (I) (hkl)]: 2.238(100)(112), 2.120(80)(211), 2.073(70)(103), 1.884(50)(013), 1.843(40)(301), 1.788(40)(113), 1.774(40)(020). The mineral is named for Alla Bogdanova, Geological Institute, Kola Science Centre of Russian Academy of Sciences.