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Wangyanite, $PdNi_8S_8$, a new Pd end-member mineral of the pentlandite group from the J-M Reef, Stillwater Complex, Montana, U.S.A.

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Abstract

Wangyanite (IMA 2024-008a), ideally $PdNi_8S_8$, is a Pd end-member mineral of the pentlandite group that was discovered in the J-M Reef of the Stillwater Complex, Montana, U.S.A. Wangyanite occurs as anhedral to subhedral granular crystals, 200–400 μm in size, associated with isoferroplatinum, braggite, pentlandite, and chalcopyrite, interstitial to plagioclase grains within anorthosite. Wangyanite exhibits a yellowish-brown color with a black streak and a metallic luster. It is brittle, with uneven fractures, and has a calculated density of 5.14 g/cm^3. The mineral does not show discernible pleochroism, bireflectance, or anisotropy. It has an average composition of 9.95 wt% Pd, 31.95 wt% Ni, 25.02 wt% Fe, 0.57 wt% Co, 31.74 wt% S, totaling 99.23 wt%. The empirical formula, based on eight sulfur atoms per formula unit, is $(Pd_{0.76}Co_{0.08})_{\Sigma 0.84}(Ni_{4.39}Fe_{3.60})_{\Sigma 7.99}S_8$. Wangyanite has a cubic unit cell with a space group of $Fm\bar{3}m$ (#225), with lattice parameters of $a = 10.1167(12)$ Å, $V = 1035.4(4)$ Å^3, and $Z = 4$. Its crystal structure has been solved by single-crystal three-dimensional electron diffraction study. The strongest X-ray diffraction lines of wangyanite are calculated at [d in Å (I%)(hkl)]: 5.841(14.03)(111), 3.050(100)(311), 1.947(29.16)(115,333), 1.264(11.66)(800), 3.577(8.79)(220), 2.920(20.82)(222), and 2.321(9.34)(331). Wangyanite shares the similar crystal structure as pentlandite, but the octahedrally coordinated site is mainly occupied by Pd in wangyanite. Based on the textural features and previous experiments in the Pd-Fe-Ni-S phase system, wangyanite could form by a peritectic reaction between braggite, pentlandite, and a sulfide liquid. These mineral associations are stable in a Ni-Pd-rich sulfide melt system at about 550 °C or even lower temperatures. Therefore, wangyanite can potentially serve as an indicator of the presence of Pd-rich residual melts. The mineral is named in honor of Christina Yan Wang, a renowned researcher of platinum-group element (PGE) occurrences and enrichment mechanisms in mafic-ultramafic intrusions, particularly those related to the Emeishan large igneous province in China.

Keywords: Wangyanite, new mineral, platinum-group element, crystal structure, J-M Reef