

## Manganoquadratite, AgMnAsS<sub>3</sub>, a new manganese-bearing sulfosal from the Uchucchacua polymetallic deposit, Lima Department, Peru: Description and crystal structure

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### ABSTRACT

Manganoquadratite, ideally AgMnAsS<sub>3</sub>, is a new mineral from the Uchucchacua polymetallic deposit, Oyon district, Catajambo, Lima Department, Peru. It occurs as dark gray, anhedral to subhedral grains up to 0.5 mm across, closely associated with alabandite, Mn-rich calcite, Mn-rich sphalerite, proustite, pyrite, pyrrothite, tennantite, argentotennantite, stannite, and other unnamed minerals of the system Pb-Ag-Sb-Mn-As-S. Manganoquadratite is opaque with a metallic luster and possesses a reddish-brown streak. It is brittle, the Vickers microhardness (VHN<sub>10</sub>) is 81 kg/mm<sup>2</sup> (range 75–96) (corresponding Mohs hardness of 2–2½). The calculated density is 4.680 g/cm<sup>3</sup> (on the basis of the empirical formula). In plane-polarized reflected light, manganoquadratite is moderately birefringent and very weakly pleochroic from dark gray to a blue gray. Internal reflections are absent. Between crossed polars, the mineral is anisotropic, without characteristic rotation tints. Reflectance percentages ( $R_{\min}$  and  $R_{\max}$ ) for the four standard COM wavelengths are 29.5, 31.8 (471.1 nm), 28.1, 30.5 (548.3 nm), 27.3, 29.3 (586.6 nm), and 26.0, 28.2 (652.3 nm), respectively.

Manganoquadratite is tetragonal, space group  $P4_32_1$ , with unit-cell parameters:  $a = 5.4496(5)$ ,  $c = 32.949(1)$  Å,  $V = 978.5(1)$  Å<sup>3</sup>,  $c:a = 6.046$ ,  $Z = 8$ . The structure, refined to  $R1 = 0.0863$  for 907 reflections with  $F_o > 4\sigma(F_o)$ , consists of a stacking along [001] of alabandite-like Mn<sub>2</sub>S<sub>2</sub> layers connected to each other by a couple of AgAsS<sub>2</sub> sheets where As<sup>3+</sup> forms typical AsS<sub>3</sub> groups, whereas Ag<sup>+</sup> cations are fivefold coordinated. The six strongest lines in the observed X-ray powder-diffraction pattern [ $d$  in Å ( $I/I_0$ ) ( $hkl$ )] are: 3.14 (60) (116), 2.739 (50) (0012), 2.710 (100) (200), 1.927(70) (2012 + 220), 1.645 (25) (3016), and 1.573 (20) (2212).

Electron microprobe analyses gave the chemical formula (on the basis of six atoms) (Ag<sub>0.95</sub>Cu<sub>0.05</sub>) $\Sigma=1.00$  (Mn<sub>0.96</sub>Pb<sub>0.04</sub>) $\Sigma=1.00$  (As<sub>0.87</sub>Sb<sub>0.14</sub>) $\Sigma=1.01$  S<sub>2.99</sub>, leading to the simplified formula AgMnAsS<sub>3</sub>.

The name was chosen to indicate the close analogy of the formula and unit-cell dimensions with quadratite, Ag(Cd,Pb)(As,Sb)S<sub>3</sub>. The new mineral and mineral name have been approved by the Commission on New Minerals, Nomenclature and Classification, IMA 2011-008.

**Keywords:** Manganoquadratite, new mineral, electron microprobe data, reflectance data, X-ray diffraction data, quadratite, Uchucchacua deposit, Peru