

DISCOVERY OF A NEW CHROMIUM SULFIDE MINERAL, Cr₅S₆, IN MURCHISON

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Introduction: During a nano-mineralogy investigation of the Murchison CM2 meteorite, a new chromium sulfide mineral, Cr₅S₆, was identified as inclusions in two isolated olivine grains. High-resolution SEM, electron-backscatter diffraction (EBSD) and electron microprobe analyses have been used to characterize its composition and structure. The phase is known from laboratory studies of the Cr-S system [1] but has not been previously reported in nature. The new mineral has been approved by the Commission on New Minerals, Nomenclature and Classification of the International Mineralogical Association (IMA 2010-003).

Occurrence, Chemistry, and Crystallography: One sub-hedral micro-grain [(Cr_{4.59}Fe_{0.23}V_{0.13}Ni_{0.02})_{Σ4.97}(S_{5.98}P_{0.05})_{Σ6.03}] (the type material) occurs associated with a ~10 μm alloy inclusion hosted by an irregular olivine (Fo₉₉Fa₁, ~400 μm in size) grain; it is bounded in section by schreibersite (Fe_{2.45}Ni_{0.55}P) on one side, which largely separates the Cr₅S₆ from the kamacite (Fe_{0.929}Ni_{0.060}P_{0.008}Cr_{0.003}), and, on the other, a Si-rich glass. Submicron-sized grains of Cr₅S₆ were also observed in another isolated olivine (Fo₉₉Fa₁) grain in Murchison, occurring in fine-grained mixtures of serpentine and tochilinite with chromite and eskolaite nearby.

EBSD patterns of this new phase were indexed using the structure and unit cell data for synthetic Cr₅S₆ from [1]. The structure is trigonal, $P\bar{3}1c$ ($a = 5.982 \text{ \AA}$, $c = 11.509 \text{ \AA}$, $V = 356.67 \text{ \AA}^3$, $Z = 2$) and consists of close packed S layers in hexagonal stacking with Cr in octahedral voids and ordered vacancies in every second interlayer [1,2].

Origin and Significance: This mineral (Cr₅S₆) is a new meteoritic chromium sulfide, joining the Cr-dominant meteoritic sulfide minerals brezinaite (Cr₃S₄) and daubreelite (FeCr₂S₄). Cr₅S₆ is a low temperature phase, limited in the Cr-S system, by a eutectoid at 327°C. Given the absence of additional coexisting sulfides, it seems unlikely that this new sulfide mineral formed through eutectoid or peritectoid decomposition of a high temperature Cr-S solid solution (e.g., formed through sulfidation of an original Cr-, P-bearing Fe-Ni, which also exsolved schreibersite). It is more likely a low-temperature secondary phase formed during parent body aqueous alteration with Cr derived from the alloy. The interposition of schreibersite between Cr₅S₆ and kamacite suggests that growth may have occurred in a chemical potential gradient.

References: [1] Jellinek, F. 1957. Acta Crystallogr., 10, 620-628. [2] Van Laar, B. 1967. Phys. Rev., 156, 654-662.