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DISCOVERY OF A NEW CHROMIUM SULFIDE MINERAL, Cr_5S_6, IN MURCHISON

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Introduction: During a nano-mineralogy investigation of the Murchison CM2 meteorite, a new chromium sulfide mineral, Cr_5S_6, 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 subhedral micro-grain $[(Cr_{4.59}Fe_{0.23}V_{0.13}Ni_{0.02})_{\sum 4.97}(S_{5.98}P_{0.05})_{\sum 6.03}]$ (the type material) occurs associated with a ~10 μm alloy inclusion hosted by an irregular olivine ($Fo_{99}Fa_1$, ~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 Cr_5S_6 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 Cr_5S_6 were also observed in another isolated olivine ($Fo_{99}Fa_1$) 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 Cr_5S_6 from [1]. The structure is trigonal, $P\bar{3}1c$ (a = 5.982 Å, c = 11.509 Å, V = 356.67 Å^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 (Cr_5S_6) is a new meteoritic chromium sulfide, joining the Cr-dominant meteoritic sulfide minerals brezinaite (Cr_3S_4) and daubreelite ($FeCr_2S_4$). Cr_5S_6 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 Cr_5S_6 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.

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USING GRAIN DENSITY AND MAGNETIC SUSCEPTIBILITY TO QUANTIFY WEATHERING IN CHONDRITE FINDS

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Introduction: Unlike petrographic type and shock state, weathering states of meteorite finds are not well standardized, difficult to determine, and rely in large part on personal judgment. Few meteorites even have a weathering state in the public record. In addition, different stones from the same meteorite may weather differently due to variations in local environmental conditions or even size of the stone. This makes weathering determinations performed on thin sections only partially informative for other stones.

Chondritic meteorites with moderate to high metal content weather in a predictable manner that is well-understood [1, 2]. Iron metal oxidizes, expanding into available pore space until it is mostly filled, at which point weathering slows considerably. In addition, the oxidation of iron metal greatly reduces magnetic susceptibility and grain density [3].

Using techniques developed by Consolmagno and Britt [4] and Gattacceca et al. [5], we have measured grain density and magnetic susceptibility as well as bulk density and porosity of ~1200 stones from ~650 meteorites of all types, including both falls and finds. Using this database, we have created a weathering modulus based on grain density and magnetic susceptibility that is applicable to ordinary chondrites and enstatite chondrites. With this modulus, we can compare degree of weathering of stones within the meteorite type.

Some Results: Our ordinary chondrite results are consistent with [1–3]. All finds are 0–10% porous but porosity alone does not correlate to degree of weathering. We also see a negative correlation of weathering modulus with bulk density; assuming bulk density is not strongly affected by weathering, this indicates that the most weathered finds were originally the most porous.

Enstatite chondrites show a peculiar trend: porosity increases with weathering, and the most weathered finds' porosities exceed those of typical falls. This suggests that either (1) cracks are being introduced into the meteorites during weathering or (2) a significant amount of at least one mineral species is leeched out as a result of weathering.

Work on carbonaceous chondrite weathering is under way.

References: [1] Bland P. A. et al. 1998. *Geochimica et Cosmochimica Acta* 62: 3169–3184. [2] Consolmagno G. J. et al. 1998. *Meteoritics & Planetary Science* 33: 1221–1230. [3] Consolmagno G. J. et al. 2006. *Meteoritics & Planetary Science* 41: 331–342. [4] Consolmagno G. J. and Britt D. T. 1998. *Meteoritics & Planetary Science* 33: 1231–1240. [5] Gattacceca J. et al. 2004. *Geophysical Journal International* 158: 42–29.