EDSCOTTITE, Fe_5C_2, A NEW IRON CARBIDE MINERAL FROM THE WEDDERBURN IRON METEORITE.

Chi Ma[1] and Alan Rubin[2]. [1]Division of Geological and Planetary Sciences, California Institute of Technology, Pasadena, CA 91125, USA; [2]Department of Earth, Planetary, and Space Sciences, University of California, Los Angeles, CA 90095-1567, USA; Email: chi@gps.caltech.edu.

Introduction: The Wedderburn iron meteorite, found as a single 210-g mass in Victoria, Australia in 1951, is a Ni-rich ataxite belonging to subgroup sLH of the IAB complex (Low-Au, High-Ni subgroup). It is one of the most Ni-rich irons known (23.4 wt.% Ni [1]), initially classified as group IIID. During a re-investigation of a polished thick section of Wedderburn, we identified a new iron-carbide mineral, Fe_5C_2 with the *C*2/*c* Pd_5B_2-type structure, named "edscottite" (Fig. 1). Field-emission scanning electron microscopy, energy-dispersive X-ray spectroscopy, electron back-scatter diffraction (EBSD) and electron probe microanalysis (EPMA) were used to characterize edscottite and associated phases. This mineral was first identified in Wedderburn [2,3]; synthetic Fe_5C_2 was previously known (e.g., [4-6]). We report here the first natural occurrence of Fe_5C_2 in an iron meteorite as a new carbide mineral. Edscottite (IMA 2018-086a) was approved by the IMA-CNMNC [7]. The mineral name is in honor of Edward (Ed) R. D. Scott, University of Hawai'i, USA, for his seminal contributions to meteorite research. He discovered haxonite, $(Fe,Ni)_{23}C_6$ [8] as well as this new iron carbide [2,3].

Occurrence, Chemistry, and Crystallography: Edscottite occurs as subhedral, lath-shaped or platy single crystals, ~0.8 μm × 15 μm to 1.2 μm × 40 μm in size, which is the holotype material, in an assemblage with low-Ni iron (kamacite), taenite, nickelphosphide (Ni-rich schreibersite), and small amounts of cohenite in a matrix of fine-grained iron (plessite) (Fig. 1).

The mean chemical composition of type edscottite, determined by EPMA, is (in wt%) Fe 87.01, Ni 4.37, Co 1.04, C 7.90, total 100.31, yielding an empirical formula of $(Fe_{4.73}Ni_{0.23}Co_{0.05})C_{1.99}$. The end-formula is Fe_5C_2. The EBSD patterns are indexed only by the *C*2/*c* Pd_5B_2-type structure and give a best fit by the synthetic χ-Fe_5C_2 cell from [5], with a mean angular deviation of 0.45º - 0.48º, revealing a = 11.57 Å, b = 4.57 Å, c = 5.06 Å, β = 97.7°, V = 265.1 Å^3, and Z = 4. The calculated density is 7.63 g/cm^3 using the empirical formula.

Origin and Significance: Edscottite is Hägg-carbide, χ-Fe_5C_2, a new iron-carbide mineral, joining cohenite (Fe_3C) and haxonite ($(Fe,Ni)_{23}C_6$) as a naturally occurring phase. During cooling from high temperature, edscottite (like cohenite and haxonite) forms metastably in iron meteorites in kamacite, but unlike the other two carbides it forms laths, possibly due to very rapid growth after supersaturation of carbon.

Computational studies of Earth's inner core shows that the most stable Fe carbides are Fe_3C, Fe_7C_3 and Fe_2C; edscottite (along with Fe_4C) is close to stability at these high pressures (~350 GPa, [9]) and might be present.

References: [1] Wasson J.T. and Kallemeyn G.W. 2002. *Geochimica et Cosmochimica Acta* 66:2445–2473. [2] Scott E.R.D. and Agrell S.O. 1971. *Meteoritics* 6:312–313. [3] Scott E.R.D. 1972. University of Cambridge, Ph.D. thesis. [4] Hägg G. 1934. *Zeitschrift für Kristallographie - Crystalline Materials* 89:92–94. [5] Jack K.H. and Wild S. 1966. *Nature* 212:248–250. [6] Leinweber et al. 2012. *Zeitschrift für Kristallographie - Crystalline Materials* 227:207–220. [7] Ma C. and Rubin A. 2019. *European Journal of Mineralogy* 31:204. [8] Scott E.R.D. 1971. *Nature* 229:61–62. [9] Weerasinghe et al. 2011. *Physical Review B* 84:174110.

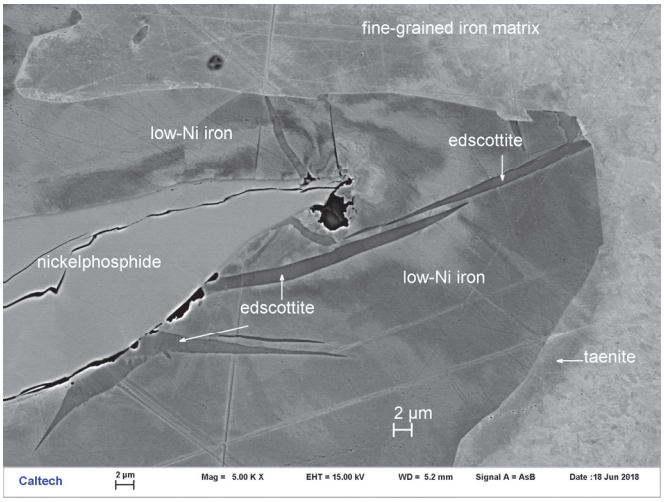

Fig. 1. Back-scatter electron image revealing edscottite in the Wedderburn iron meteorite.