Edscottite, Fe$_5$C$_2$, a new iron carbide mineral from the Ni-rich Wedderburn IAB iron meteorite

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**ABSTRACT**

Edscottite (IMA 2018-086a), Fe$_5$C$_2$, is a new iron carbide mineral that occurs with low-Ni iron (kamacite), taenite, nickelphosphide (Ni-dominant schreibersite), and minor cohenite in the Wedderburn iron meteorite, a Ni-rich member of the group IAB complex. The mean chemical composition of edscottite determined by electron probe microanalysis, is (wt%) Fe 87.01, Ni 4.37, Co 0.82, C 7.90, total 100.10, yielding an empirical formula of (Fe$_{4.73}$Ni$_{0.23}$Co$_{0.04}$)C$_{2.00}$. The end-member formula is Fe$_5$C$_2$. Electron backscatter diffraction shows that edscottite has the C2/c Pd$_5$B$_2$-type structure of the synthetic phase called Hägg-carbide, _γ_·Fe$_5$C$_2$, which has $a = 11.57$ Å, $b = 4.57$ Å, $c = 5.06$ Å, $\beta = 97.7^\circ$, $V = 265.1$ Å$^3$, and $Z = 4$. The calculated density using the measured composition is 7.62 g/cm$^3$. Like the other two carbides found in iron meteorites, cohenite (Fe,C) and haxonite (Fe$_2$C$_3$), edscottite forms in kamacite, but unlike these two carbides, it forms laths, possibly due to very rapid growth after supersaturation of carbon. Haxonite (which typically forms in carbide-bearing, Ni-rich members of the IAB complex) has not been observed in Wedderburn. Formation of edscottite rather than haxonite may have resulted from a lower C concentration in Wedderburn and hence a lower growth temperature. The new mineral is named in honor of Edward (Ed) R.D. Scott, a pioneering cosmochemist at the University of Hawai‘i at Manoa, for his seminal contributions to research on meteorites.

**Keywords:** Edscottite, Fe$_5$C$_2$, new mineral, iron carbide, Wedderburn iron meteorite

**INTRODUCTION**

The Wedderburn iron meteorite, found as a single 210 g mass in Victoria, Australia, in 1951 (Buchwald 1975), is a Ni-rich ataxite belonging to subgroup sLH of the IAB complex (Low-Au, High-Ni subgroup; Wasson and Kallemeyn 2002). It was initially classified as group IIID (Buchwald 1975). During a mineralogical re-investigation of a polished thick section of Wedderburn, we identified a new iron-carbide mineral, Fe$_5$C$_2$ with the C2/c Pd$_5$B$_2$-type structure, which we named “edscottite” (Fig. 1). To characterize its chemical composition, structure, and associated phases, we used high-resolution scanning electron microscopy (SEM), electron backscatter diffraction (EBSD), and electron probe microanalysis (EPMA). This phase was identified chemically as Fe$_5$C$_2$ by Scott and Agrell (1971) and described simply as a carbide by Buchwald (1975). Although synthetic Fe$_5$C$_2$ is well known (e.g., Hägg 1934; Jack and Wild 1966; Retief 1999; Leineweber et al. 2012), the discovery by Scott and Agrell (1971) prompted us to characterize Fe$_5$C$_2$ in Wedderburn as the first natural occurrence of this new carbide mineral.

**MINERAL NAME AND TYPE MATERIAL**

The new mineral and its name have been approved by the Commission on New Minerals, Nomenclature and Classification of the International Mineralogical Association (IMA 2018-086a) (Ma and Rubin 2019). The mineral name is in honor of Edward (Ed) R.D. Scott (born in 1947), esteemed cosmochemist at the University of Hawai‘i at Manoa, for his multifaceted contributions to research on meteorites. He discovered haxonite, (Fe,Ni)$_2$C$_3$ (Scott 1971), as well as this new iron carbide in Wedderburn. The new carbide phase was described as forming plates a few micrometers thick within kamacite (Scott and Agrell 1971; Scott 1972). The type specimen of edscottite is in Wedderburn polished thick section UCLA 143, housed in the Meteorite Collection of the Department of Earth, Planetary, and Space Sciences, University of California, Los Angeles, California, U.S.A.

**APPEARANCE AND OCCURRENCE**

Edscottite occurs as subhedral, lath-shaped or platy single crystals, ~0.8 × 15 μm to 1.2 × 40 μm and 4.0 × 18 μm in size, which is the holotype material in thick section UCLA 143 (Fig. 1). The new carbide is commonly associated with small amounts of cobaltite and forms in low-Ni iron (known as “kamacite” in the meteorite literature) surrounding grains of nickelphosphide (Ni-rich schreibersite) in a matrix of fine-grained iron (plessite). The mineral appears white microscopically in reflected light. Luster, streak, hardness, tenacity, cleavage, fracture, density, and optical properties were not determined because of the small grain size.

**CHEMICAL COMPOSITION**

Backscattered electron (BSE) images were obtained at Caltech using a ZEISS 1550VP field emission SEM and a JEOL 8200 electron microprobe with solid-state BSE detectors. Six quantitative WDS elemental microanalyses of type edscottite