SULFIDE–OXIDE ASSEMBLAGE IN TAGISH LAKE CARBONACEOUS CHONDRITE; N.Z. Boctor[1], G. Kurat[2], and C.M.O.D'Alexander[3], [1]Geophysical Laboratory, Carnegie Institution of Washington, 5251 Broad Branch Rd., NW, Washington, DC 20015; USA, [2]Naturhistorisches Museum, Postfach 417, A-1014, Vienna, Austria, [3]Department of Terrestrial Magnetism, Carnegie Institution of Washington, 5241 Broad Branch Rd., NW, Washington, DC 20015, USA.

Introduction: Tagish Lake, an observed fall in the year 2000, was classified by [1] as a type 2 carbonaceous chondrite. It bears similarity to CI 1 and CM chondrites but is distinct from both. [2] noted that the overall trace elements abundance pattern in Tagish Lake is similar to those of CM chondrites indicating that Tagish Lake and CMs experienced very similar nebular processes. The mineralogy of Tagish Lake was studied by [1], who identified two lithologies a dominant carbonate-poor lithology and a less abundant carbonate lithology. Abundant phyllosilicate indicates that aqueous alterations affected both lithologies. Aqueous fluids were abundant during the alteration process as suggested by the oxygen isotope data of [3], which requires a water/rock ratio of 2.This is higher by a factor of 2 than estimates for CM or CI. In this investigation, we report on sulfide and oxide minerals in Tagish Lake and assess their origin.

Petrography and Mineral Chemistry: We investigated a sample of the carbonate-poor lithology. This lithology consists of olivine aggregates, rare chondrule-like objects, phyllosilicate clasts in a matrix dominated by phyllosilicate through remnant of matrix olivine are present. Abundant phyllosilicate form a matrix for olivine in the chondrule-like objects. Most of the chondrules like objects and olivine aggregates show very fine-grained sulfide-rich rims. Clasts of phyllosilicates are abundant. The pervasive phyllosilicates are associated with abundant magnetite and sulfides. These features are similar to those reported by [1] for the carbonate-poor lithology.

The sulfide and magnetite relations are complex. Except for droplets of troilite-metal in the porphyritic chondrule-like objects (Fig. 1), the sulfide-oxide assemblage in Tagish Lake is secondary. Olivine crystals in the matrix are sometimes mantled by two layers of magnetite separated by an intervening thin discontinuous rim of pyrrhotite (Fig. 2). Magnetite occurs as framboids occasionally mantled by rims of pyrrhotite (Fig. 3). It also ocurr as disseminated single crystals or nonspherical aggregates of crystals associated with phyllosilicates. Some phyllosilicate clasts show cores composed of aggregates of magnetite crystals and rims rich in fine-grained iron-nickel sulfides (Fig. 4). Most of the magnetite and sulfides appears to be precipitates from aqueous fluids Sulfides are represented by pyrrhotite, iron-nickel monosulfide solid solution, and rare pentlandite. Pyrrhotite varies in composition (Fe_{46} to $Fe_{48.5}$ at. %) and contains minor amounts of Ni (0.42 to 1.71 wt. %) and Co (0.1 to 0.38 wt. %). The monosulfide solid solution shows variable Ni contents (3.8 to 15.2 wt. %). The pentlandite composition is typically 33.2 wt. % S, 38.0 wt. % Fe, 27.3 wt. % Ni, and 1.16 wt. % Co.

Discussion: The troilite-metal droplets in the chondrule-like objects are trapped metal-sulfide melt that separated by liquid immiscibility from silicates during chondrule formation. These troilite-metal droplets are the only primary opaque phases in Tagish Lake. Though the precipitation of the secondary sulfides and magnetite overlapped, sulfide precipitation continued after formation of the magnetite framboids. This is suggested by the presence of sulfide rims on the magnetite framboids and some of the phyllosilicate clasts. This interpretation differs from that[1], who suggested that magnetite framboids are formed by replacement of framboidal pyrrhotite. The presence of Ni and Co in the pyrrhotite and its absence in magnetite argue against the replacement hypothesis. The iron-nickel monosulfide solid solution is metastable. Monosulfide with high Ni content such as those observed in Tagish Lake should under equilibrium conditions exsolve pentlandite. The lack of exsolutions in the Fe-Ni monosulfide suggests that the sulfide formation occurred at very low temperatures at which kinetic barriers prohibited exsolution from taking place. The occurrence of olivine mantled by magnetite rims with intervening sulfides suggests episodic fluctuations in oxygen and sulfur fugacities during oxide and sulfide precipitation. The sulfur and oxygen fugacities were likely close to those of the iron-magnetite-pyrrhotite buffer.

References: [1] M.E. Zolensky (2002) Meteorit. Planet. Sci. **37**, 737. [2] D.W. Mittlefehldt (2002) Meteorit. Planet. Sci. **37**, 703. [3] R.N. Clayton and T. Mayeda (2001) Lunar Planet. Sci. **32**, #1885.

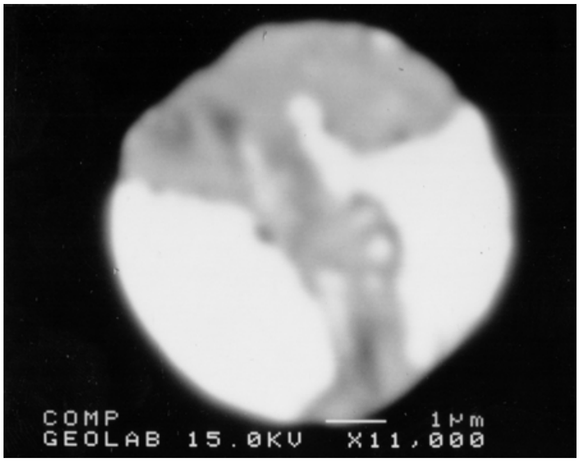

Fig. 1. BSE image of a metal-troilite droplet.

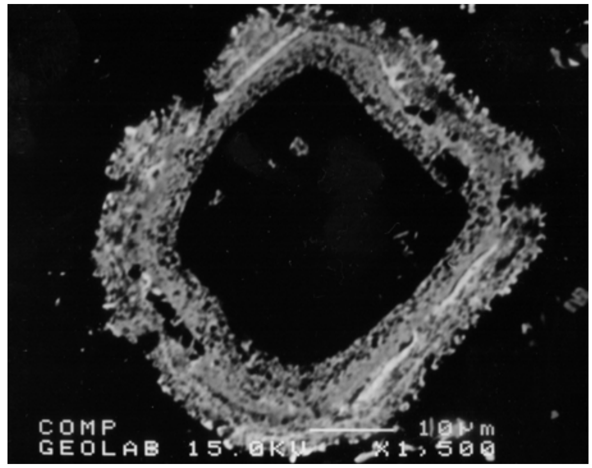

Fig. 2. BSE image of olivine mantled by magnetite and pyrrhotite.

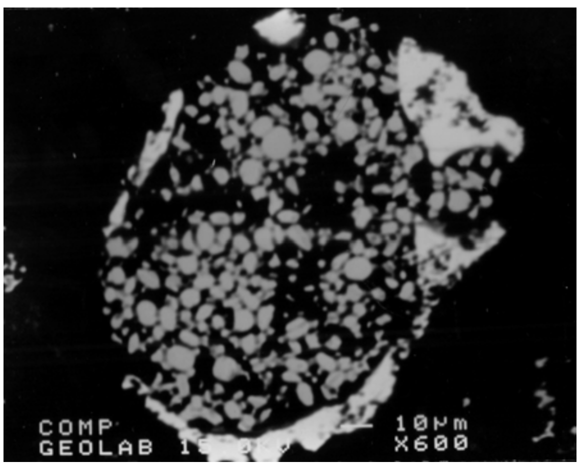

Fig. 3. BSE image of a magnetite framboid with a rim of pyrrhotite.

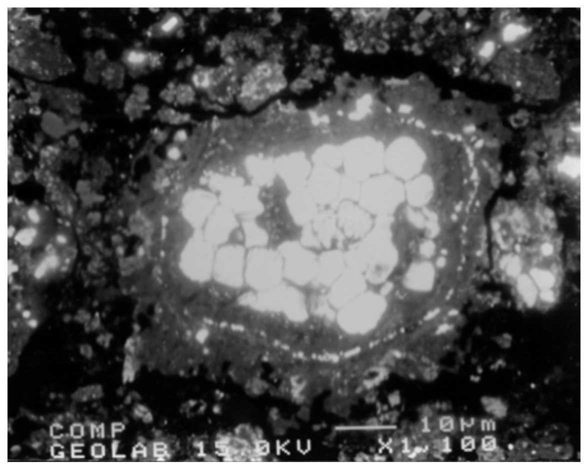

Fig. 4. BSE image of a phyllosilicate clast with magnetite crystal aggregates in the core and a thin sulfide rim.