Preliminary SEM and TEM study of pristine samples of Tagish Lake meteorite. A. Blinova [1], C.D.K. Herd [1], T. Zega [2] , B. De Gregorio[2] and R. Stroud[2]. [1]Department of Earth and Atmospheric Sciences, 1-26 Earth Sciences Building, University of Alberta, Edmonton, AB, T6G 2E3, Canada (blinova@ualberta.ca), [2] Materials Science and Technology Division, Code 6366, Naval Research Laboratory, 4555 Overlook Ave. SW, Washington D.C., 20375

Introduction: The Tagish Lake meteorite fell on the frozen lake in northern British Columbia, Canada, on 18th of January, 2000 [1]. It has been the subject of intense preliminary petrographical, geochemical (both organic and non-organic), lithological and isotopic studies [e.g., 2-4]. However, little is still known about this meteorite. These studies demonstrated that Tagish Lake is an ungrouped Type 2 carbonaceous chondrite, unique among known meteorites, but with affinities to CIs and CMs. Two distinct lithologies were identified by [2], including a carbonate-poor lithology containing abundant phyllosilicates, Fe-Ni sulfides and magnetite with sparse, altered chondrules and CAIs; and a carbonate-rich lithology containing abundant Fe-Mg-Ca-Mn carbonates with rare magnetite and poor in CAIs or chondrules.

Lithological variations, beyond what has been previously described [2] are evident from casual inspection of the exterior of individual samples of the pristine Tagish Lake meteorites [5]. The origin of these variations are not known and form the basis for the current study.

Samples investigated: Two samples representative of the macroscopic lithological variation were selected. Sample 5b is a compact, coherent fragment with relatively abundant chondrules evident in hand sample. Sample 11i is an example of a "dark, dusty" lithology; fragments of it are very friable and tend to shed a residue of very fine black dust.

SEM methods and observations: Scanning electron microscopy, including energy-dispersive spectrometry (EDS) was carried out using the JEOL 6301F Field Emission SEM in the Department of Earth and Atmospheric Sciences at the University of Alberta. In addition to standard observation methods, still-frozen fragments of sample 11i were investigated using the Emitek K1250 cryogenic system, which allows samples to be kept at -40ºC during observation. Sample 5b was examined using the JEOL 6500F Field Emission SEM at the Carnegie Institution of Washington, also with EDS capability.

Sample 5b consists of altered chondrules in a matrix of Mg-Fe silicates, some Fe-Ni sulfide and magnetite grains, the latter present as either individual grains, framboids, or whiskers. The chondrules consist of Fe-Mg olivine and pyroxene, or Mg-rich olivine and enstatite. Alteration rinds on chondrules consist of framboidal (and occasional whisker) magnetite replacing what may have been interstitial metal, and Mg-Fe (with minor Al) silicates replacing olivine or pyroxene. Rare Ca carbonate and Mg(Fe) carbonate grains were found in the rinds.

Sample 11i (dark, dusty lithology) consists almost entirely of very fine-grained material (average grain size < 5 μm) which has a broadly chondritic composition at the scale of the interaction volume of the electron beam, consisting primarily of Mg, Si, Fe, S with minor Ca, Al, and Ni. Some compositional variation was observed, indicating the presence of Fe-Mg silicate (presumably phyllosilicate) with embedded sulfides. Distinct Fe-Ni sulfides and individual magnetite grains are dispersed throughout. Framboidal magnetite clusters are present. The largest distinct grain found thus far is a refractory forsterite grain, 80 μm in longest dimension; however, this is the only grain with a presumably high-temperature origin so far discovered. Elongate, Ca-rich (carbonate?) grains of unknown origin were found in this lithology (Fig. 1).

TEM methods and observations: Fragments (≤ 1mm) of samples 11i and 5b were embedded in elemental S, glued to epoxy stubs, and ultramicrotomed to electron transparency (≤ 100-nm thick). The ultramicrotome sections were examined at the Naval Research Laboratory with a 200 keV JEOL 2200FS transmission electron microscope (TEM) equipped with an EDS X-ray spectrometer and scanning-TEM (STEM) based bright- and high-angle annular-dark-field detectors.

Bright-field imaging of 11i sample reveals several different textures throughout. We identified three types of silicate morphologies in 11i that we call 'ropy', 'rough' and 'smooth' (Fig. 2). EDS shows them as an Fe-Mg-rich phyllosilicates. The most abundant material exhibits a feather-like, 'ropy', texture. This material has a high aspect ratio and appears connected in bright-field images. The texture may be a result of the microtome slicing due to the softness of the material. The 'rough' lithology exhibits a higher diffraction contrast than the other silicate textures. In addition, the 'smooth' silicates are amorphous. Fe-sulfides occur throughout the silicate material as discrete grains with sizes ranging from tens to hundreds of nanometers. Some contain minor Ni.

Our preliminary examinations of sample 5b showed that this lithology behaved differently during microtomy, as evident on a TEM scale. It contains larger sulfide grains that appear to correlate with the sulfide

whiskers observed in the SEM. Smaller sulfides, measuring tens of nanometers wide, also occur and are spatially associated with sheet silicates. High-resolution imaging shows that the sheet silicates have a wispy texture and are poorly ordered. Magnetite occurs as euhedral grains measuring hundreds of nanometers wide. It appears to have broken up into distinct patches (Fig. 3) and feather-like or 'ropy' texture is mostly lacking. This sample appears to have relatively less amorphous material than 11i.

Conclusions: Based on preliminary SEM and TEM observations sample 5b (compact coherent lithology) is similar to the carbonate-poor lithology studied by [2], characterized by chondrules supported by a matrix rich in Fe-Mg phyllosilicates, magnetite and Fe-Ni sulfide clusters. In contrast, sample 11i (dark, dusty lithology) is lacking in chondrules and contains more amorphous material. This lithology is distinct from what has been described previously. Further studies of this unique lithology are underway.

References: [1] Brown P.G. et al. (2000) *Science*, *290*, 320-325. [2] Zolensky M.E. et al (2002) *Meteoritics & Planet. Sci., 37,* 737-761. [3] Nakamura T. et al (2001) *Earth Planet. Sci. Lett.*, *207*, 83-101. [4] Clayton and Mayeda (2001) *LPS XXXII,* Abstract #1885. [5] Herd R.K. and Herd C.D.K. (2007) *LPS XXXVIII,* Abstract #2347.

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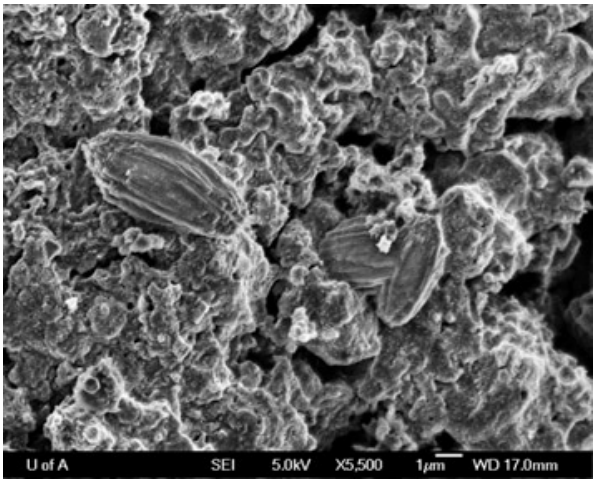

Figure 1: SEM image of elongate, Ca-rich (carbonate?) grains of unknown origin in sample 11i.

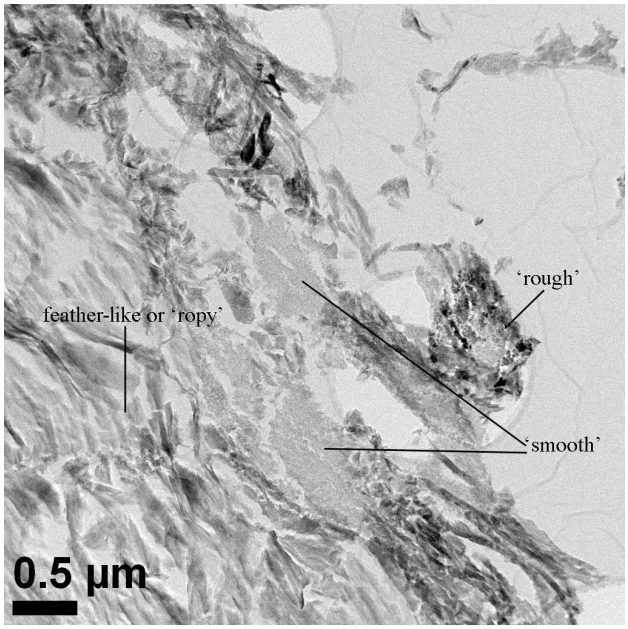

Figure 2: Bright-field TEM image of silicate textures within sample 11i.

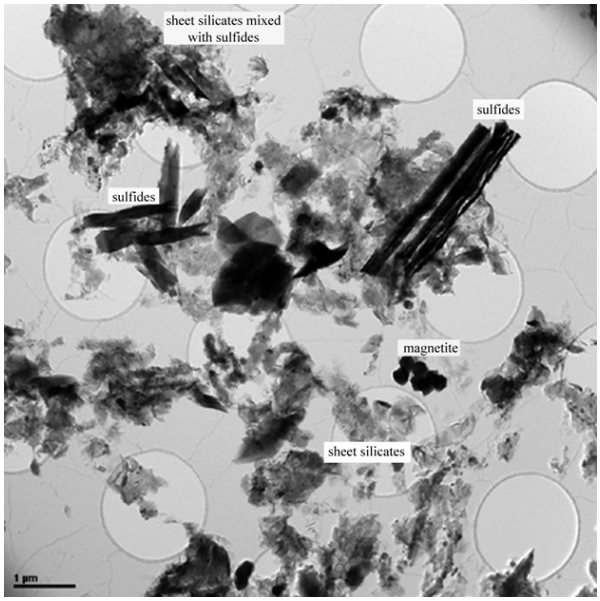

Figure 3: Bright-field STEM image of sample 5b with magnetite (clusters) and iron-sulfide (sticks or whiskers?) within the silicate material.