Insights into the mineralogy of the Tagish Lake meteorite through EPMA, XRD and CL. A. Blinova and C.D.K. Herd[1]. [1]Department of Earth and Atmospheric Sciences, 1-26 Earth Sciences Building, University of Alberta, Edmonton, AB, T6G 2E3, Canada (blinova@ualberta.ca),.

Introduction: Based on the study of [2], the Tagish Lake C2 carbonaceous chondrite is a brecciated meteorite with two prominent lithologies: a carbonate-poor lithology with abundant phyllosilicates, Fe-Ni sulfides and magnetite with sparse, altered chondrules and CAIs; and a carbonate-rich lithology with abundant Fe-Mg-Ca-Mn carbonates with rare magnetite and poor in CAIs or chondrules. Althoguh we previously described another distinct lithology, the "dark, dusty lithology" (sample 11i of [3]), as well as sample 5b, which is similar to the carbonate-poor lithology of [2], little is yet known about this meteorite. The present study is the continuation of [3] with an aim to mineralogically describe prominent lithological variations that can be seen macroscopic characteristics [4].

Samples: In addition to 5b and 11i [3], two other samples were selected as representative of lithological variations: 11v and 11h. Sample 11v is a "grab-bag" pristine sample, i.e., disaggregated material of Tagish Lake meteorite that was collected and stored in a Ziploc bag. From a macroscopic view sample 11h is similar to 11i ("dark, dusty" lithology).

Methodology: A JEOL 8900 Electron Microprobe operating at 20kV with a beam current of 20nA and a Rigaku Geigerflex Power Diffractometer with a Co tube and a graphite monochromator (XRD) were used for mineral analyses and bulk rock mineralogy. Both are housed in the Department of Earth and Atmospheric Sciences at the Univeristy of Alberta. A Zeiss EVO 15 scanning electron microscope (SEM) equipped with an Oxford Instruments Inca EDS/EBSD system and Gatan Chroma cathodoluminescence (CL) detectors, housed in the Canadian Centre for Isotopic Microanalysis (CCIM) at the University of Alberta, were used for mapping the overall compositional and structural heterogeneity of olivines.

EPMA analyses:

Sample 5b: This sample contains abundant chondrule-like objects set in a phyllosilicate-rich matrix. These remnant chondrules can reach up-to 500 µm in diameter and are surrounded by fine-grained accretionary rims. Rims can vary from 20 to 100 µm in thickness and are heavily altered with prominent sulfide inclusions. Most chondrule-like objects are circular in cross-section; however, some appear to have have been compacted. All exhibit porphyritic textures and are primarily composed of olivine (Fo_{99} to Fo_{95}) with rare Ca-rich pyroxene, magnetite and sulfide close to the altered rim. Several Cr,Mg,Al-rich 'hot spots' (possible Mg-Al chromites) have been identified inside these remnant chondrules.

Within the altered matrix several grains of isolated refractory forsterite ($Fo_{99.8-99.9}$) and Ca-rich pyroxene grains have been identified. Foresterite grains are euhedral to angular in shape and reach up to 400 µm. Ca-rich pyroxenes are rare and small (~30 µm). Carbonates are fairly abundant (up to 2-3%) within the matrix reaching ~5-10 µm size and dominated by Ca-carbonate.

During processing of sample 5b a large (~2000 µm diameter) chondrule fell out of the porous matrix (Fig. 1). This chondrule is nearly perfectly spherical and is only moderately altered on its exterior. It is a porphyritic type I (Fe-poor) chondrule dominated by pyroxene and olvine (Fo_{95-96}) set in an Al-rich mesostasis. Three Cr-rich spinels (largest ~15 µm) have been identified. Several areas of this chondrule are under investigation at the time of abstract submission. These are numerous Ca,Cr-rich and Si-poor spots mostly around forsterites, and a Ca,Al-rich 'hot spot' surrounding one forsterite grain.

Overall, lithology 5b is similar in its mineralogy, alteration and abundance of chondrule-like objects to CM chondrites.

Sample 11i: This sample contains less chondrule-like objects and is mostly dominated by altered matrix. Most remnant chondrules are dominated by magnetite, Fe-Ni sulfide and clusters of small olivines. Most of these objects are smaller in comparison to those in sample 5b, the largest reaching ~200 µm in diameter. Matrix is dominated by abundant framboidal magnetite, Fe-Ni sulfides and phyllosilicates with dispersed lithic fragments of the same mineralogy but finer-grained. Several isolated forsterite grains and Ca-pyroxene grains have been found dispersed within the matrix. Ca-carbonates are more abundant than in 5b (up to 4 wt% on the baiss of Ca mapping). A large Mg-rich phosphate (~30 µm in largest dimention) has been identified only within this lithology.

A unique porphyritic chondule with zoned olivines has been found within 11i (Fig. 2). The largest olivine has a euhedral shape and exhibits oscillatory zoning. Other olivine grains within this chondrule exhibit normal zoning with Mg-rich cores (Fo_{79-99}) and Fe-rich rims (Fo_{61-74}). More work is underway on this enigmatic chondrule.

Sample 11v: Although two chips of the same lithology were mounted for EPMA, both contain different amounts of chondrule-like objects. One is almost devoid of these objects. Matrix is phyllosilicate-rich with a high abundance of clusters of framboidal magnetite with rare Fe-Ni sulfides and Ca-carbonates. The largest chondrules (~150 μm) in the chip with more abundant chondrule-like objects is porphyritic dominated by olivine and contains fairly large 'hot spots' of Cr,Fe-rich and Si-poor areas (possibly Fe-rich chromites).

Sample 11h: The sample is very friable, and upon processing it shattered into numerous pieces. Elemental maps of three such pieces have been completed thus far. Based on these maps this sample is similar to 11i and to chondrule-absent chip of 11v. The matrix is fine-grained, altered with dispersed magnetite. Isolated clusters of fine-grained olivines are present. A large (~150 μm) remnant chondrule fragment was found, that preserves a porphyritic texture with no visible accretionary rim. It also contains fairly large 'hot spots' of Cr concentrations. Work on this sample is ongoing.

XRD analyses:

Two samples (11v and 11h) were analyzed by XRD to perform bulk rock mineral identification. Based on preliminary data both of these samples contain abundant forsterite and magnetite. Sample 11h contains both types of carbonate material: Fe-rich (siderite) and Ca-rich (calcite), whereas 11v has a peak for siderite only. In addition, sample 11h appears to contain smectite and serpentine minerals, whereas in 11i clay minerals were not detected.

CL analyses: Preliminary CL analyses were performed on a zoned remnant chondrule from sample 11i (Fig. 2). Only the core of one zoned olivine (Fo_{99} core and Fo_{71} rim) exhibited red luminescence under CL (Fig. 3). Other Fe-rich olivines did not exhibit any CL colours.

Future work: So far, lithologies that we have identified present some unique mineralogical components such as olivines with oscillatory zoning, potential primary chromites within chondrule relicts, variation in Ca content within the matrix, etc. More work is on-going on these components that can shed light not only on the alteration history of Tagish Lake parent body, but on processes that operated in the early solar nebula.

References:

[1] Brown P.G. et al. (2002) *Meteoritics and Planetary Science*, 37(5), 661-675. [2] Zolensky et al. (2002) *Meteoritics and Planetary Science*, 37(5), 737-761. [3] Blinova et al. (2009) *LPSC XL*, Abstract #2039. [4] Herd R.K. and Herd C.D.K. (2007) *LPS XXXVIII*, Abstract #2347.

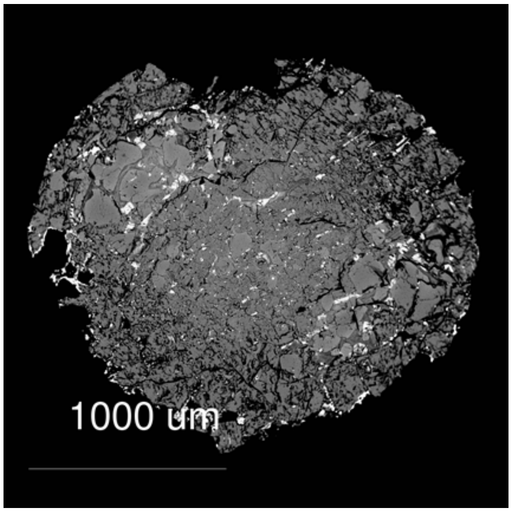

Figure 1: BSE image of large chondrule from Sample 5b.

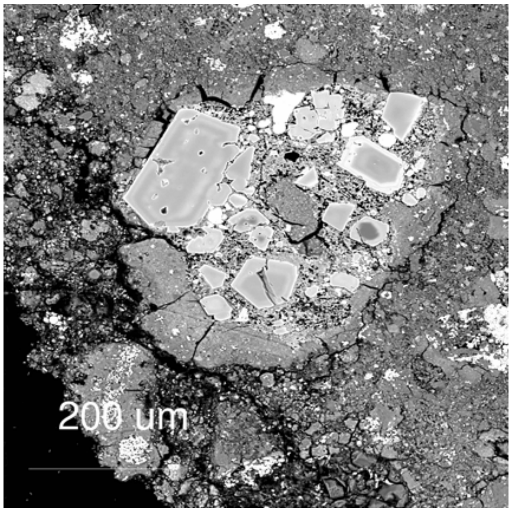

Figure 2: BSE image of oscillatory zoned and normally zoned olivines in a chondrule remnant in sample 11i. Darker bands (zones) are Mg-rich, lighter Fe-rich.

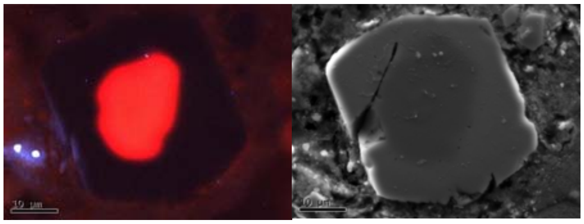

Figure 3: Cathodoluminescence (left) and SE image (right) of zoned olivine from a chondrule remnant in sample 11i (Fig. 2). Fo_{99} core exhibits red luminescence whereas Fo_{71} rim does not. Two bright blue dots on the lower left are under investigation.