CHEMICAL COMPOSITION OF FINE-GRAINED RIMS IN THE TAGISH LAKE CARBONACEOUS CHONDRITE. Ansgar Greshake[1], George J. Flynn[2], Alexander N. Krot[3], and Klaus Keil[3], [1]Museum für Naturkunde, Institut für Mineralogie, Humboldt-Universität zu Berlin, Invalidenstraße 43, 10115 Berlin, Germany, email: ansgar.greshake@rz.hu-berlin.de, [2]Department of Physics, SUNY Plattsburgh, Plattsburgh NY 12901, USA, [3]Hawai'i Institute of Geophysics & Planetology, SOEST, University of Hawai'i at Manoa, Honolulu, HI 96822, USA.

Introduction: One of the striking similarities of the Tagish Lake carbonaceous chondrite to CM chondrites is that the majority of distinct components in Tagish Lake, i.e. chondrules, CAIs, mineral fragments, and magnetite-rich clusters, are mantled by fine-grained phyllosilicate-rich rims [1, 2]. The rims consist of a highly unequilibrated assemblage of phyllosilicates, FeNi-sulfides, FeNi-metal, magnetites, pyroxenes, and olivines and are, except for a lower abundance of carbonates, mineralogically very similar to the matrix of Tagish Lake [2]. In order to address the origin of the matrix and rim material, we have determined the bulk chemical compositions of the fine-grained rims and matrix in Tagish Lake by electron microprobe and x-ray microprobe.

Method: Using a polished thin section prepared with an acetone soluble glue, we selected four chondrules with well-defined rims and five representative matrix areas for study (Fig. 1).

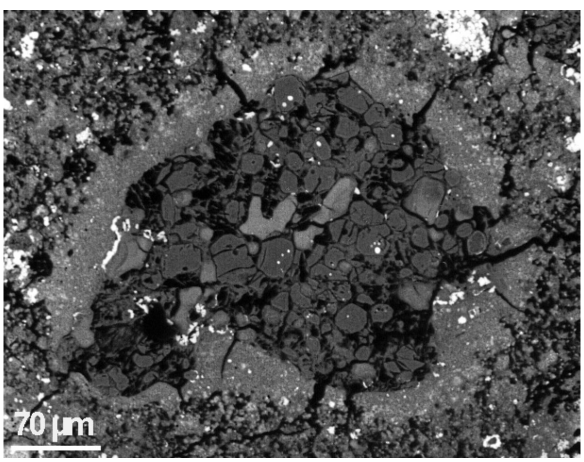

Fig. 1. Chondrule with well defined fine-grained rim.

Major and minor element compositions were determined by electron microprobe analysis applying a defocussed 10 µm electron beam. The objects were then removed from the glass slide and mounted on a Kapton film with a small drop of silicon oil. Trace element concentrations were measured in fragments from four rims, two chondrules, and five matrix areas using the x-ray microprobe at the National Synchrotron Light Source (Brookhaven National Laboratory). Depending on the size of the individual fragment, up to four analyses were carried out on each sample using a synchrotron X-ray beam size of about 15×15 µm. The analytical errors of the SXRF analyses are on the order of ±10%.

Results: The major and minor element compositions of rims and matrix normalized to the bulk composition of Tagish Lake are shown in Fig. 2. It is apparent that both, rims and matrix, are almost identical in composition and differ from the bulk meteorite by being depleted in Na, K, and Ca. Aluminum, Si, and Ni may be slightly and Ti more strongly enriched. The only compositional differences between rims and matrix are that the Ca and Mn contents of the rims are slightly depleted relative to those of the matrix.

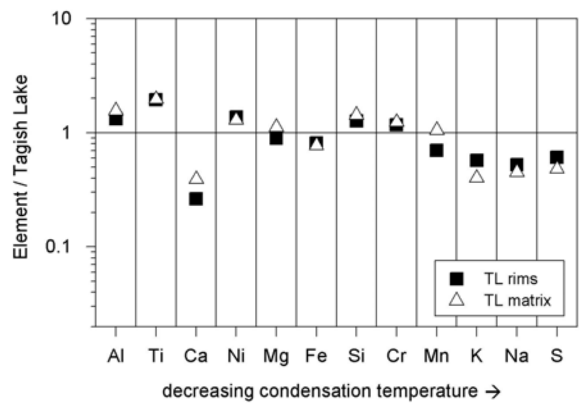

Fig. 2. Major and minor elements in fine-grained rims and matrix of Tagish Lake relative to its bulk composition.

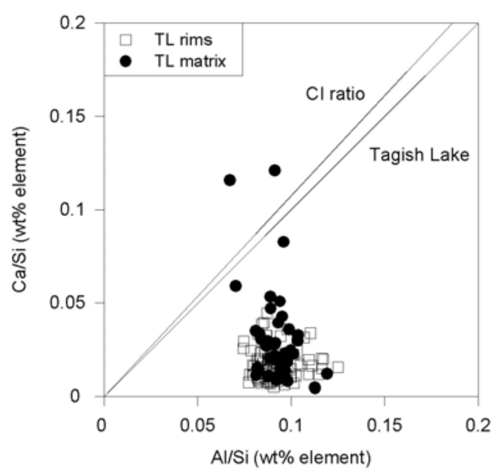

Fig. 3. Ca/Si vs. Al/Si ratios in fine-grained rims and matrix of Tagish Lake.

The refractory elements Al and Ca are strongly fractionated in the rims and in the matrix and the Ca/Al ratios of both are significantly below CI and Tagish Lake mean values (Fig. 3), indicating loss of Ca from chondrules and CAIs and deposition into the rims and matrix during aqueous alteration in an asteroidal setting.

The results of x-ray microprobe analyses show that, within the analytical errors, there is only little variation for moderately volatile element concentrations from rim to rim (Fig. 4). Average matrix and rims again seem to have almost identical contents of Ni, Zn, Ga, and Se. Only Ge seems to be enriched in the rims. Relative to the mean Tagish Lake composition, rims and matrix are on average enriched in Ni, Zn, Ge, and Se. For the two chondrules analyzed, depletions in Zn and Se as well as enrichments in Ga and Ge over the Tagish Lake mean are observed (Fig. 4).

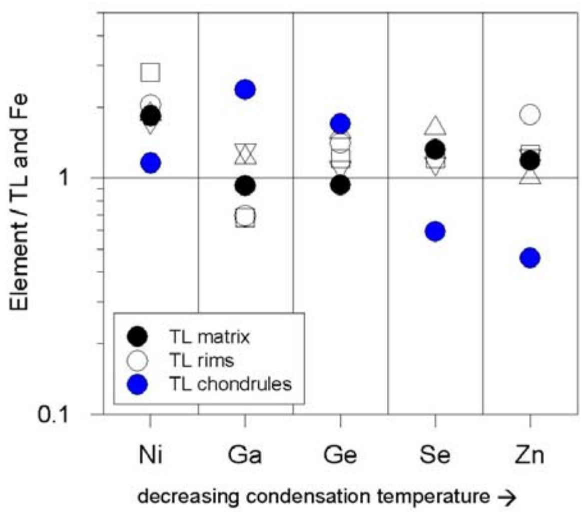

Fig. 4. Moderately volatile elements in four rims, matrix (average of 5 fragments) and chondrules (average of two chondrules) relative to Tagish Lake bulk composition and Fe. Empty squares and triangles represent compositions of individual fine-grained rims.

Discussion: Detailed investigations of the chemical composition of fine-grained dust rims were performed for several unequilibrated ordinary chondrites, for the CO3 chondrite ALHA 77307, and for several CM chondrites [e.g., 3-6]. However, moderately volatile element abundance patterns have so far only been determined for rims in ALHA 77307 [4]. The ALHA 77307 fine-grained rims have very similar element concentrations, independent of the composition of the enclosed chondrules. Relative to the average CO compositions, all moderately volatile elements are enriched in the rims and the ALHA 77307 bulk chondrite. Since aqueous alteration can be excluded for this meteorite, it is concluded that (a) the rims are not genetically linked to the chondrules and (b) the matrix is the major reservoir of the moderately volatile elements [4].

In the Tagish Lake meteorite, the major, minor and trace element concentrations of fine-grained rims around different chondrules are also very similar and significantly different from the enclosed and often aqueously altered object. Thus, a formation of the rims by alteration of chondrule material can be excluded.

Rims and matrix in Tagish Lake are almost indistinguishable in composition. This holds also for the moderate volatile elements. However, since Tagish Lake has undergone significant pre-terrestrial aqueous alteration, the observed element pattern could be the result of redistribution of the elements rather than a primary feature. This may especially be the case for chalcophile elements, i.e., Zn and Se whose hosts pyrrhotite and pentlandite are often altered and replaced by magnetite (Fig 5).

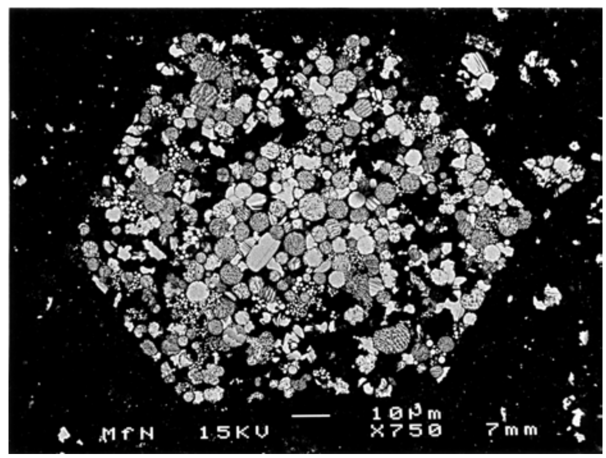

Fig. 5. Magnetite pseudomorph after pyrrhotite.

A possible primary difference in composition between rims and matrix could thus now be hidden due to alteration. This view is also supported by the fact that for volatile elements no significant decrease in abundance as a function of condensation temperature can be observed.

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References: [1] Zolensky M. E. et al. (2002) *MAPS 35*, 737-761. [2] Greshake A. et al. (2002) *LPS 33*, #1751. [3] C. M. O. Alexander (1989) *EPSL 95*, 187-207. [4] Brearley A. J. et al. (1995) *GCA 59*, 4307-4319. [5] Metzler K. et al. (1992) *GCA 56*, 2873-2897. [6] Hua X. and Buseck P. R. (1998) *MAPS 33*, A215-A220.