TAGISH LAKE IS STILL THE ONLY POSSIBLE METEORITE SAMPLE FROM D-TYPE ASTEROIDS.

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Introduction: Tagish Lake meteorite (C2-ung) was identified as the first possible sample from D-type asteroids based on comparison of their visible to near-infrared (VNIR) reflectance spectra [1]. Later, Wisconsin Range (WIS) 91600 meteorite (CM2) was also identified as a possible D-asteroid sample [2]. In addition, Tarda meteorite (C2-ung) has been suggested as a D-asteroid sample based on its petrographic and isotopic similarly to Tagish Lake [3]. In this study, we revisit this issue with new spectral reflectance measurements of Tagish Lake, Tarda, WIS 91600, and Northwest Africa (NWA) 8534 (CM1/2) meteorites.

Experimental: Bidirectional VNIR and biconical Fourier-Transfer Infrared (FTIR) reflectance spectra of chip and powder samples (<125 μm) of Tarda and NWA 8534 have been newly measured. VNIR spectra were measured at the NASA RELAB using standard viewing geometry (VG) of 30° incidence and 0° emergence angles.

A small portion of previously-measured [4] WIS 91600,70 chip was ground into a powder to measure and compare with the spectrum of a powder of another subsample (WIS 91600,23) [2]. Measured spots on the meteorite chips are shown in Fig. 1.

Tagish Lake meteorite sample heated in vacuum at 100°C with an oxygen eater for one week [5] was ground and dry-sieved into three size fractions of <125, <25, and 25-125 μm to examine particle size effects on spectral properties. Unheated Tagish Lake <25 μm powder was measured over the visible range in various VGs with 15° phase angle to better reproduce telescopic asteroid observation condition.

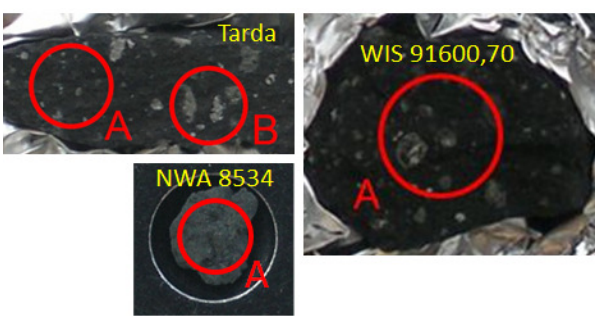

Fig. 1. Meteorite chip samples with measured spots marked with red circles (2.4 and 4.0 mm in size).

Results and Discussions: Shown in Fig. 2 are VNIR spectra of meteorite chip spots marked in Fig. 1. Tarda spot A shows typical CM-like absorption bands at 0.7, 0.9, and possibly 1.1 μm, similar to NWA 8534. On the other hand, Tarda spot B shows only a very broad and shallow 1μm band, similar to olivine absorption bands of WIS 91600 spectrum. Because D-type asteroid surfaces likely consist of regolith, their average spectrum [6] is compared with those of meteorite powders in Fig. 3. It is clear that only spectra of Tagish Lake are similar to spectra of D-type asteroids.

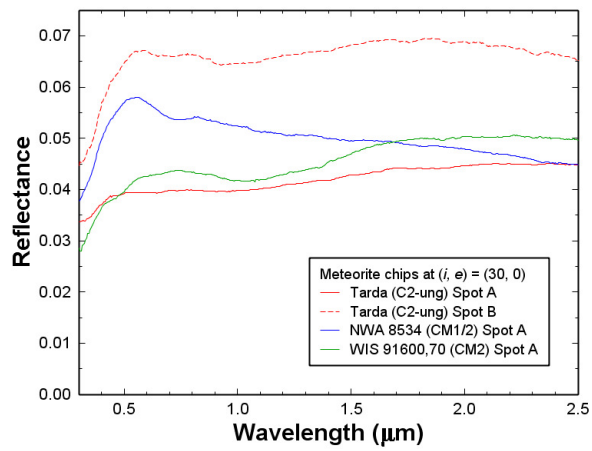

Fig. 2. VNIR reflectance spectra of meteorite chip spots shown in Fig. 1 measured in the RELAB standard VG.

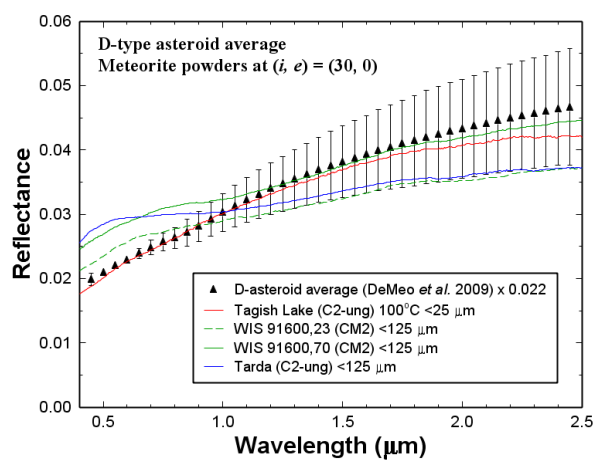

Fig. 3. VNIR reflectance spectra of meteorite powders in the RELAB standard VG in comparison with the average D-type asteroid spectrum [6].

It is known that spectral shape is influenced by particle size [7] and VG. Shown in Fig. 4 are VNIR spectra of Tagish Lake 100°C powder samples in three different size ranges. It is clear that the finer fraction <25 μm shows a redder spectrum than the coarser frac-

tion 25-125 μm, and the finer particles dominate the <125 μm fraction spectrum. Shown in Fig. 5 are visible spectra of Tagish Lake <25 μm powder measured in various VGs. As evident from the scaled reflectance spectra in Fig. 5b, the spectral slope slightly increases as the phase angle decreases while the incidence angle does not significantly affect the spectral slope.

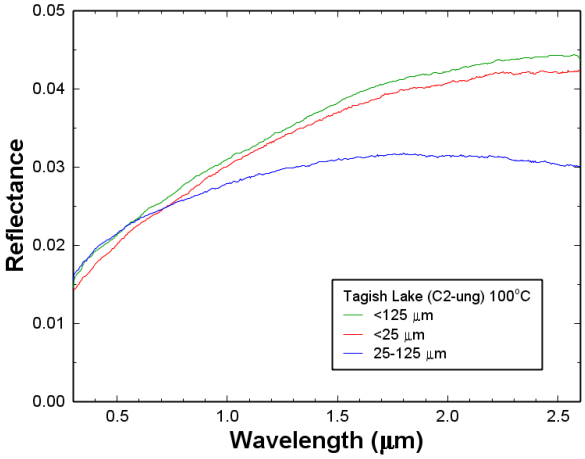

Fig. 4. VNIR reflectance spectra of Tagish Lake 100°C [5] powder samples in the RELAB standard VG.

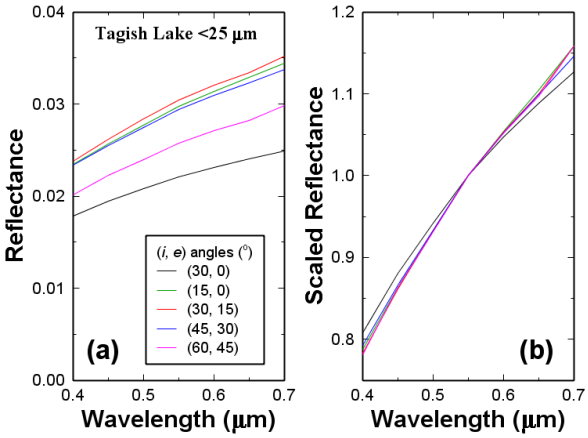

Fig. 5. Visible reflectance spectra of Tagish Lake <25 μm powder sample in various VGs.

In order to characterize Tarda meteorite in comparison with Tagish Lake and NWA 8534 meteorites, the 3 μm bands in their FTIR spectra were fit with Gaussians (in wavenumber) and a linear continuum background in the same manner as in [4], and the results are shown in Fig. 6. As shown in Fig. 7, although both Tarda and Tagish Lake show stronger Band 1 than Band 2, Tarda shows shorter Band 1 center than Tagish Lake, closer to CI1.

Conclusion: Although Tarda meteorite may show similarities in mineralogy to Tagish Lake meteorite, its VNIR reflectance spectrum is not similar to D-type asteroid spectra. Tagish Lake is still the only meteorite that provides a spectral match to D-type asteroids.

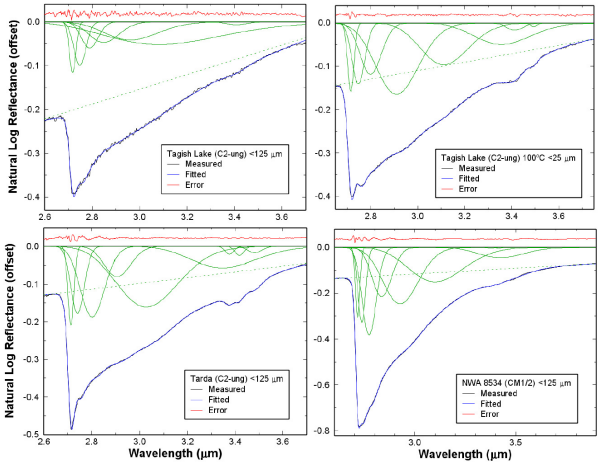

Fig. 6. Gaussian fits [4] of the hydration bands of FTIR natural log reflectance spectra of meteorite powder samples.

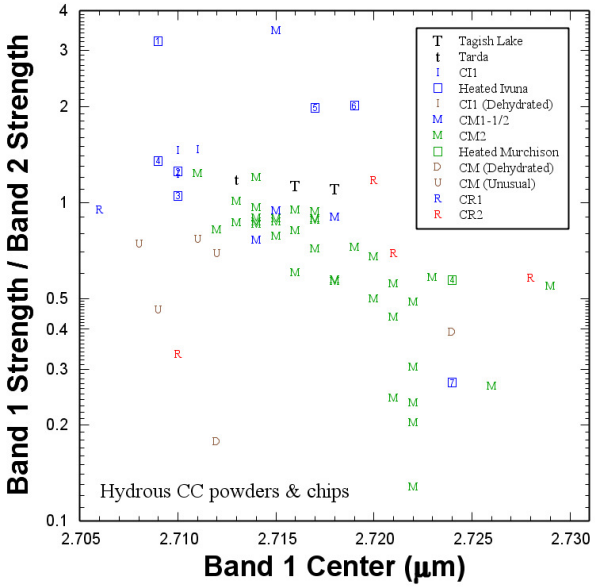

Fig. 7. Band 1 center and Band 1 / Band 2 strength ratio values obtained by Gaussian fits in Fig. 6 plotted with other hydrous carbonaceous chondrite data [4].

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