Cold Curation and Handling of the Tagish Lake Meteorite: Implications for Sample Return. C. D. K. Herd[1], R.W. Hilts[2], D.N. Simkus[1], and G.F. Slater[3], [1]Department of Earth and Atmospheric Sciences, 1-26 Earth Sciences Building, University of Alberta, Edmonton, AB, Canada, T6G 2E3, herd@ualberta.ca. [2]Department of Physical Sciences, MacEwan University, Edmonton, AB T5J 4S2. [3]School of Geography and Earth Sciences, McMaster University, Hamilton, ON L8S 4K1.

Introduction: Meteorites collected within a few days of fall represent a unique opportunity both to study planetary materials that are relatively uncontaminated by exposure at the Earth's surface, and to examine and trace the source(s) of contamination. Such studies inform protocols and minimum standards for curation and handling of pristine planetary samples, including material from Solar System Sample Return missions. Here we highlight a unique example, that of the Tagish Lake meteorite, and outline the implications of its study for Sample Return.

Background: The Tagish Lake meteorite fell January 18, 2000 onto the frozen surface of Tagish Lake in northern British Columbia, Canada. Specimens of the meteorite were recovered within a week of the fall and kept frozen and untouched by hand. These are the world's most pristine meteorites, having been kept under near-optimum conditions of preservation of volatile elements and compounds. These pristine specimens, are in cold (< -25 °C), secure conditions at the University of Alberta and the Royal Ontario Museum.

Given the mobility of organic compounds and their ubiquitous presence at the Earth's surface, our research has focused on determining the suite of organic compounds in the pristine Tagish Lake specimens, includeng any terrestrial contaminants. Our focus has been primarily on the soluble organic compounds, with the hypothesis that these compounds are the most likely to have been affected by terrestrial contamination during collection and storage, and are also the most likely to be affected by curation and handling.

Tagish Lake is an organic carbon-rich, ungrouped type 2 carbonaceous chondrite with affinities to CI and CM meteorites [1]. We have analyzed several pristine Tagish Lake specimens for soluble organic compounds, complemented by studies of insoluble organic matter, mineralogy and petrology [2-4]. Soluble organic compounds were extracted using dicholoromethane (DCM), toluene-methanol or ultrapure water, with the solvent added to a cold sample in order to capture all volatile compounds. Methods are described in [5].

Terrestrial Contaminants: Analysis of the DCM extracts by GC-MS reveals variable complements of reduced organic compounds in the Tagish Lake specimens. Of 67 compounds identified in one specimen (11v), ten were unequivocally terrestrial contaminants. The second-most prevalent compound in specimen 11v is 9-octadecenamide, a plasticizer used in the manufacture of resealable plastic bags. The source of this contaminant was traced to the Ziploc bag in which the sample was stored after collection. Phthalates and other compounds that can be traced to exposure to plastics were also identified; however, these compounds are present at trace (ppm) levels. Limonene, a cyclic terpene produced in citrus fruits, was found in another specimen (11i). Isotopic analysis of this compound by GC-IRMS at McMaster University yields $\delta^{13}C = -28 \pm 1$‰ and $\delta D = -170 \pm 30$‰, having a composition consistent with that of terrestrial limonene. The source of this potential contaminant is not known.

Indigenous Organic Compounds: Among the non-contaminant (indigenous) organic compounds in the Tagish Lake meteorite are several that are reactive or volatile. Naphthalene was found within both DCM and toluene-methanol extracts. A detailed study of monocarboxylic acids [6] showed that formic acid is present in at unprecedented concentrations (up to 200 ppm). Both formic acid and naphthalene are volatile compounds, and would have been partially lost had the meteorite not been kept at low temperatures since its recovery.

Amino acids in Tagish Lake meteorite specimens determined by analysis by GC-MS [2, 7] yield concentrations greater than those found in Tagish Lake samples collected during the spring thaw that were exposed to meltwater [8], demonstrating the rapidity with which meteoritic samples can be contaminated with biological molecules at the Earth's surface.

Implications for Solar System Sample Return: Based on our Tagish Lake results, we recommend that low temperature conditions be considered for any returned samples in which organic compounds are expected. A facility in which the Tagish Lake specimens will be curated and handled under low temperature conditions (- 20 °C) in a neutral atmosphere is under construction, and provides a potential testbed for investigating curation and handling methods.

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