RECOVERY AND CONTAMINATION MITIGATION OF METEORITES: IMPLICATIONS FOR ADVANCED CURATION METHODS.

L. D. Tunney[1], P. J. A. Hill[1], C. D. K. Herd[1], R. W. Hilts[1,2], and A. B. Regberg[3], [1]Department of Earth and Atmospheric Sciences, University of Alberta, 1-26 Earth Sciences Building, Edmonton, Alberta T6G 2E3, Canada, ltunney@ualberta.ca, [2]Department of Physical Sciences, MacEwan University, Edmonton, Alberta T6J 4S2, Canada. [3]Astromaterials Research and Exploration Science Division, NASA JSC, Houston, Texas 77058, USA.

Introduction: The intrinsic properties of meteorites can provide valuable information about the solar system and potentially the origin of life [1]. However, these intrinsic characteristics are at risk of biological or geologic alteration or destruction once a meteorite falls to the surface of the Earth [2]. Due to the potential for rapid contamination of meteoritic material, distinguishing possible contaminants from intrinsic properties becomes critical. Here, we summarize the best practices for preserving meteorites in their most pristine states possible, based on recent studies of freshly fallen meteorites, and laboratory materials and components.

Methods: Work used to infer best practices can be found in publications [3-6]. These studies included eighteen Buzzard Coulee specimens [3], five Aguas Zarcas samples [4], two Tarda specimens and a sand sample from the Tarda strewn field [5], three Bruderheim samples, three Peace River samples, and one Redwater sample. Organic contamination was documented using GC-MS of dichloromethane and hot water extractions, whereas the biological contamination study used two different DNA extraction kits: PowerSoil and QIAamp. In addition, a study of the potential for detecting freshly fallen meteorites on a snow-covered field using drone-based thermal imagery was conducted [6].

Results: The soluble organic compound and microbial studies yield ten key contamination trends:

(1) Colder temperatures hinder the accumulation of organic contaminants.
(2) Soluble organic contamination is best detected immediately following collection [3].
(3) The properties of the meteorite itself may impact the degree of contamination; for example, the fusion crust appears to protect against the transfer of contamination to the interior; conversely, the abrasive texture of an exposed interior surface may aid in the transfer of contaminants.
(4) The derivatizing agent chosen greatly impacts the types of organics detected [4,5].
(5) Inter-specimen heterogeneity is the primary control on the intrinsic compounds detectable [4,5].
(6) Terrestrial organic contaminants fall within one of four categories: agricultural products, fuels, pharmaceuticals, and polymers [3,4,5].
(7) Microbial communities that contaminate meteorites and laboratory surfaces are typically either sourced from soils or human contact.
(8) Microbial communities detected on meteorites may produce or destroy organic compounds of interest.
(9) A combination of thermal and visible imagery, up to 40 m altitude, can be used to aid in the rapid collection of meteorite falls on snow-covered terrain [6].

Conclusions: A standardized procedure is necessary to mitigate the rapid contamination that meteorites experience on the surface of the Earth. From our studies we have derived six key recommendations when recovering, handling, and curating meteorites, in particular, freshly fallen meteorites:

(1) Meteorites should be collected as rapidly as possible to minimize the damage or contamination it may experience. This could include utilizing the a meteorite camera network and/or thermal imagery.
(2) Characteristics of the strewn field and meteorite specimens should be carefully recorded.
(3) Terrestrial samples from the strewn field and surrounding areas should be taken to characterize contamination sources.
(4) Baseline contamination from materials and laboratory environments should be thoroughly documented prior to introducing meteorite specimens.
(5) Records of how the meteorite specimens are handled after collection should be kept, including: processing, materials used, and the temperature of storage. Cold curation (-15 to -20 °C) is highly recommended for specimens that have the potential to contain volatile organic compounds.

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