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Overview of carbonaceous chondrites in the US Antarctic meteorite collection: implications for understanding Bennu and Ryugu.

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Introduction: Spectral studies of the target asteroids of the OSIRIS-REx and Hayabusa2 missions - Bennu and Ryugu - have included comparisons to several samples from the US Antarctic meteorite collection including MET 00639 (CM2), MET 01072 (CM2), ALH 83100 (CM1/2), and LAP 02277 (CM1)[1-3]. The fact that these four samples provide insight into understanding these asteroids leads one to wonder what carbonaceous chondrites (CCs) are represented in the US collection and are there others that might also be helpful for comparison? Here is an overview of the CCs in the collection (n=930) and a demonstration of the great diversity of samples available as a resource to these missions.

CM chondrites: There are 344 CM chondrites in the US Antarctic meteorite collection, including large pairing groups from the ALH, EET, LEW, LAP, MET, MIL, and QUE dense collection areas. Several areas have been visited over the course of numerous seasons and/or over a decade, thus making pairing a challenge as the groups emerge over long periods of time. We are examining pairing in a number of groups with small masses, to preserve as much material as possible, while also making material as widely available as possible. CM2 chondrites are the most common of the CCs in the US collection; their mineralogy is fine grained and difficult to study using standard optical microscopy, but x-ray diffraction studies indicate their major mineralogy is cronstedtite, olivine, pyroxene, calcite, magnetite, and sulfide [4,5]. CM1 chondrites are more rare in the collection, typically of small size (<10 g), and have Mg-rich serpentine forming at higher degrees of aqueous alteration. There are transitional CM1/2 that represent intermediate degrees of aqueous alteration. An excellent example is ALH83100, which is comprised of ~50 pieces paired together in the field for a total of 3.019 kg. Because this sample is readily available, it has been relatively easy to allocate as part of many studies. The MET pairing group of CM chondrites has visible layering or foliation that resembles layering observed on some boulders on Bennu [6].

CR chondrites: There are 80 CR chondrites in the collection, including a large EET pairing group (50), small and scientifically precious QUE 99177, LAP 02342, GRA 95229, MET 00426, and more recent and larger MIL 15328, LAR 12247, and GRO 17063/64 samples. CRs share some spectral features with Bennu in that it has regions of higher reflectivity [1], which is a characteristic of the CRs [7]. Aqueously altered CR1s are rare in our collection, but include GRO 95577, a focus of many studies of hydrated CRs.

CM ungrouped or anomalous chondrites: Some CM anomalous or ungrouped chondrites share spectral features with Ryugu, which has a small hydration peak [3]. This peak is argued to be due to hydrated minerals left after either heating or shock in carbonaceous chondrites. PCA 91008, WIS 91600, QUE 99038, and LEW 85311 are all anomalous CCs that have experienced heating from shock or metamorphism [8]. These samples may hold clues to understanding the mineralogy of Ryugu, or interpretations of its spectral properties.

CK chondrites: There are 117 CK chondrites in the collection – these represent the only major group of carbonaceous chondrites that has experienced metamorphic temperatures analogous to the ordinary chondrite groups. Although magnetite is common in CM chondrites (see above), it is also present in significant modal percentage in CK chondrites. Magnetite has been observed in both the general [2] and local [9] spectra of Bennu. Thus, consideration of CK chondrites in interpretation of the diverse lithologies present on Bennu and Ryugu may be prudent. Large CK chondrite pairing groups have been recovered in the LAR, QUE, and EET areas; the CK group was initially established with heavy reliance on US Antarctic finds [10]. CKs may be worth characterizing in more detail to set a baseline for magnetite-bearing or magnetite-rich samples, and to better understand the distinction between magnetite features in CM and CK chondrites.

Other C chondrites: CO (248), CV(115), CB(11), and CH (8) chondrites are all robust groups in the collection, but these samples do not share much in common with the spectra from Bennu or Ryugu. There are no CI chondrites in the US collection.

Summary: The diversity of textures, mineralogy and composition represented within the CM, CR, CK, and C ungrouped meteorites within the US Antarctic meteorite collection should serve as a very useful resource in interpreting spectral data, comparing to returned samples, and ultimately to allow stronger connections between meteorites and asteroids.

References: [1] Lauretta, D.S. et al. (2019) *Nature* 568, 55-60; [2] Hamilton, V.E. et al. (2019) *Nature Astronomy* 3, 332-340; [3] Kitazato, K. et al. (2019) *Science* 364, 272-275; [4] Howard, K. et al. (2011) *GCA* 75, 2735-2751; [5] Howard, K. et al. (2015) *GCA* 149, 206-222 [6] Antarctic Meteorite Newsletter, volume 24, number 2; MET 00431; [7] Garenne, A. et al. (2016) *Icarus* 264, 172–183; [8] Choe, W.H. et al. (2010) *MaPS* 45, 531–554; [9] Jawin, E. et al. (2019) *50th LPSC*, abstract #1577; [10] Kallemeyn, G.W. et al. (1991) *GCA* 55, 881-892.