A NEW METHOD OF CLASSIFICATION OF U.S. ANTARCTIC ORDINARY CHONDRITES.

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Introduction: Over the last 40 field seasons, the Antarctic Search for Meteorites (ANSMET) program, as part of the U.S. Antarctic meteorite program, has collected over 22,000 meteorites from the Antarctic ice. One of the many valuable features of the U.S. collection is that it is classified in its entirety. The systematic methods employed to collect the meteorites on the ice have provided meteorites of more than 40 types, many of which are the first of their type ever recognized [1].

As one of three member agencies of the U.S. Antarctic Meteorite program (the other two are NASA and the National Science Foundation), one of the responsibilities of the Smithsonian Institution (SI) is to classify all of the meteorites returned from Antarctica within two years, as required by the U.S. Federal Regulations on Antarctic Meteorites. Timely classification of new meteorites requires that limited resources be strategically applied. The goal of our program is to provide robust classifications of these meteorites to the scientific community that enable researchers to request material relevant to their work. However, robust and timely classification does not include an exhaustive description of each new meteorite. That is ultimately the role of interested scientists [2].

Background: Meteorites from the U.S. collection are initially processed by the Astromaterials Curation Department at the NASA Johnson Space Center (JSC) and a small (~1 x 1 cm) chip is sent to the Smithsonian for use in classification. If a meteorite is deemed to be scientifically interesting upon initial inspection, it is made into a thin section (one inch round) at JSC or at the SI, and are subsequently classified using petrographic and electron microprobe analyses. Those that resemble equilibrated ordinary chondrites (EOC), are classified by a separate methods.

The process by which the Smithsonian is classifying these ordinary chondrites and other small meteorites has changed. For the first 38 seasons of the Antarctic program the EOCs were classified by the oil immersion (OI) method (OI) developed by Brian Mason, which divided the meteorites into the chemical groups (H, L, and LL) based on the composition of their olivine grains [3-6]. The method was very useful and served us well for a long period of time but had some flaws including that the preliminary examination didn't always flag all non-EOC meteorites; the refractive index of the immersion oils changed over time and had to be regularly calibrated; terrestrial weathering of the meteorites could affect the oil immersion reading; shocked olivines made Becke lines used in oil immersion methods difficult to observe [2]. In addition, reproducibility required the entire process to be repeated, as opposed to providing any archival analytical data.

New Method of Classification: The FEI Nova NanoSEM 600 at the Smithsonian Institution is equipped with quantitative energy dispersive x-ray (EDS) capabilities. Suspected EOC meteorites are now being classified using this technique. Thirty-six (2 x 2 mm) holes are drilled into garolite wafers (2.5 cm by 5 inches), a phenolic resin-based material, and each is filled with a chip of meteorite. Each hole is filled with epoxy and the surface of the wafer is polished. Two wafers can be put into the SEM at the same time and therefore 72 meteorites can be classified in a single run using an automated method. The user chooses one reference point on the northwest corner of each hole in the wafer. A 5 x 5 grid of analytical points extends to the south and east of the reference point. Once points are chosen, the analyses are run automatically in a grid of set distances. Fayalite (Fa) and Ferrosilite (Fs) values are calculated from olivine and pyroxene grain analyses (not all 25 points in the grid always produce successful analyses – some hit epoxy or cracks and some hit other minerals) and a classification for each meteorite is made. Multiple non-EOC meteorites have been both purposefully and non-purposefully placed into the grids and have been identified as such successfully (including low petrologic type OCs, carbonaceous, and enstatite chondrites). To date, three issues of the U.S. Antarctic Meteorite Newsletter (Spring and Fall 2016 and Spring 2017) have provided classification with these data, and the process will be considered the norm going forward.

The benefits of this new method are many. Each grid will be archived in our collections and can be re-analyzed at any time. Each analysis is also archived, and all of the data used to classify each meteorite can be reinspected if deemed necessary. As discussed in [1,7] and references therein, the benefits of such an enormous collection of ordinary chondrites as are present in the U.S. Antarctic collection lend themselves to statistical analyses of the populations of types of meteorites present in Antarctica. In addition, having analytical data in hand for each and every EOC going forward will allow the examination of the variations of thousands of meteorites within chemical groups.

References: [1] Corrigan et al. (2017), this volume. [2] Corrigan et al. (2010) *LPSC XXXI* #2332. [3] Lunning et al. (2012) *LPSC XXXIII*, #1566. [4] Gomes & Keil (1980) *Brazilian Stone Meteorites*, University of NM Press, Albuquerque [5] Kallemeyn et al. (1989) *Geochim. et Cosmochim. Acta*, 50, 2747. [6] Mason B. (1963) *Geochim. et Cosmochim. Acta* 27, 1011. [7] Corrigan C. et al. (2014) *35 Seasons of U.S. Antarctic Meteorites (1976-2010) AGU* SP 68, Eds. Righter, Corrigan, McCoy & Harvey, 173-187.