ANTARCTIC METEORITES: A STATISTICAL LOOK AT A UNIQUELY VALUABLE RESOURCE.

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Introduction: As of 2020, the U.S. Antarctic meteorite program has collected >23,500 meteorites. The systematic collection methods employed have provided meteorites of >40 types, many of which are the first of their type ever recognized. One of the early drivers for characterization of the entire U.S. Antarctic collection was to allow statistical comparisons. Early assessments examined mass distributions and the relative frequency of meteorite types as well as comparisons to a defined set of modern falls [1-3]. Using these statistics [4-6] argued that the flux of H chondrites changed over time. [7] used model size distributions to deconstruct the contribution of wind movement, meteorite supply and search losses to the Antarctic collection. Mass-based statistics [8] and size distribution comparisons were examined by [8,9]. [10,11] investigated various statistics, including comparison with modern falls/Saharan finds. [12, 13] discuss geospatial statistics. [14] provides a comprehensive overview of the statistics of the Antarctic collections for the first 35 seasons of U.S. collection by ANSMET. Here we build upon that assessment and that from [15].

Statistics of the U.S. Collection: One of the most important questions surrounding the collection of meteorites in Antarctica is whether the collection procedure is recovering a representative sample of what is actually present at each site. In >40 seasons of searching, we have collected samples from 50 named field sites. Sixteen sites have produced >100 meteorites, and nine have produced >1000 [14]. Field areas with smaller populations (<1000) appear to have an overabundance of unusual meteorite types. However, field sites from which >1000 meteorites have been collected have type populations that converge at approximately 90% ordinary chondrites (OC).

Antarctic meteorite populations show interesting trends when comparing certain classes and sizes of falls and hot desert populations. One of these shows large numbers of small samples of OCs, pointing to the possibility of preserved showers that may not have been taken into account in the overall numbers of parent meteorites [16]. These OC populations, combined with the unresolved issue of meteorite pairing, have a significant impact on a comprehensive statistical evaluation of the Antarctic meteorite population. Another visible trend between Antarctic meteorites, worldwide falls and hot desert meteorites is that there is a startling under-abundance of iron meteorites with low masses in the Antarctic collection [17]. Based on a theory that there should be a layer of iron meteorites stranded below the ice, [17] searched for clues to where these meteorites may be. Another obvious absence is CI chondrites. There may be a strength bias, but this is poorly understood as CMs are recovered and irons aren't overepresented.

Mass Distribution: An alternative approach is to examine the cumulative mass distribution of a population relative to the number of meteorites represented. [1,14,15,18] point out that the mass of meteorites found in Antarctic field sites peaks at ~10g, while those of modern witnessed falls peak at ~5kg. Saharan meteorite peak at ~300g.

As discussed by [18,19], systematic collection of meteorites in Antarctica and elsewhere recovers more small meteorites than do random searches. This remains logical in that small (<2 cm) meteorites are much easier to spot on Antarctic ice than they are in non-Antarctic locations. [18,19] show that the number of meteorites collected in various locations (including falls) has a wide variation when compared with total mass. However, if these meteorites were all thoroughly examined and put into pairing groups, the number of meteorites after pairing would certainly decrease, and if more small modern falls were actually recovered [18] this discrepancy would be minimized. When looking at total mass between Saharan and Antarctic meteorites, it can be seen that while there are ~3x fewer Saharan meteorites (~16000 classified) vs. Antarctics (~47000) [20], the mass of Saharan meteorites (~31.5 metric tons) vs. Antarctics (~6.1 metric tons) is ~5x higher. The major difference between these two populations is that the Antarctic meteorites, in all collections worldwide, are available to science.While we may never completely understand all mechanisms that impact the population of meteorites collected in Antarctica, we can be confident that Antarctic Meteorite Programs have exceeded expectations for providing a broad sampling of Solar System materials and have had a significant impact on meteorite science.

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