WEATHERING OF METEORITES AND ICE FLOW AT THE ALLAN HILLS. P. A. Bland1, A. J. T. Jull2, T. B. Smith3, F. J. Berry4, S. Cloudt5, and C. T. Pillinger6, 1Western Australian Museum, Francis Street, Perth, Western Australia 6000, 2National Science Foundation, Accelerator Facility for Radioisotope Analyses, University of Arizona, Tucson, AZ 85721, USA, 3Department of Physics, 4Department of Chemistry, 5Planetary Science Research Institute, The Open University, Walton Hall, Milton Keynes, MK7 6AA, UK.

Despite a large amount of research on Antarctic meteorite accumulations, there has been little progress toward a unified understanding of processes such as weathering rate, pairing, or estimating a catchment area for samples: pre-requisites to calculating the flux of meteorites over the lifetime of the accumulation, or making meaningful comparisons to other meteorite population.

We have previously shown that an estimate of flux over ca. 40 ka is possible using hot desert meteorite accumulations [1]. By quantifying oxidation over time, \(R(t)\), (using Mössbauer spectroscopy and \(^{14}\)C terrestrial ages), and modeling the effect of oxidation in destroying samples [from oxidation-frequency distributions, \(R(n)\)] we derive a decay-rate for meteorites in an accumulation. Hot desert OC’s typically show a peak in \(R(n)\) at 40%: until this point oxidation is accommodated by available porosity; after this point porosity is exceeded and the sample erodes. If describes the response of OC’s to a given amount of chemical weathering, and should be similar between different sites. Given a decay-constant and the number of individual meteorites in an area, a calculation of flux is possible. This abstract discusses the application of this methodology to meteorites from the Allen Hills Main Icefield.

At the Allan Hills H chondrites (HC), despite their far longer residence times, are found to have a peak in \(R(n)\) at 20–25% lower than hot desert HD’s. In addition, we observe some correlation between weathering and terrestrial age \([R(t)]\), leaving an (approximate) estimate of the rate of weathering over time (large symbols are binned data, grouped and averaged by terrestrial age). The results indicate that on average >1 Ma would be required to weather an HC upto 40% weathering. Using the hot desert \(R(n)\) distribution to approximate ‘static’ chemical weathering of a population of HC’s, this rate of weathering implies a decay constant \((\lambda - \text{see [1] for definition})\) of 0.05 yr\(^{-1}\) for Antarctic HC’s, ca. 3 orders of magnitude lower than values typical for hot desert HC’s (ca. 66 yr\(^{-1}\) [1]).

Although processes of physical weathering need to be constrained, this analysis would tend to suggest that (in contrast to hot deserts) weathering is not a major factor in removing samples from Antarctic accumulation sites. Given that blue ice regions are not static zones of accumulation [2] but subject to some horizontal flow, we propose a model in which the observed \(R(n)\) distribution is largely a result of ice movement, rather than weathering: samples are not allowed to remain in an area long enough to acquire a ‘mature’ weathering signature. If this model is realistic then a comparison of the \(R(n)\) distribution of the \(R(t)\) plot would allow a lifetime for an accumulation to be estimated, and should provide some information on averaged horizontal ice flow. The \(R(n)\) distribution shows a cutoff in the region of 25% for Allan Hills HC’s, which from the \(R(t)\) plot suggests an age of approximately 200–300 ka for this population: in broad agreement with the age of the oldest ice at this site. That this age is younger than some terrestrial ages in the Allan Hills population is not a major cause for concern: old terrestrial age meteorites are found within a narrow region [3] and may indicate a region of trapped and stagnant ice that is not representative of the population as a whole. Given that the distance to the nearest ice divide is approximately 200 km, an age of 200–300 ka would suggest an average horizontal ice flow integrated over the lifetime of the population of approx. 1m yr\(^{-1}\): of a similar order to other estimates [2]. An expanded \(^{14}\)C terrestrial age dataset for meteorites from the Far Western and Middle Western Icefields at Allan Hills indicates that there may be a gradient of increasing accumulation age towards the Main Icefield. The \(^{14}\)C age dataset, combined oxidation data, may allow us to constrain variations in ice flow in this region, and estimate a catchment area for these samples.

This discussion illustrates a method of estimating a decay-constant for Antarctic meteorites, and suggests one approach to the problem of calculating ice flow (and thus catchment area). Although the pairing problem remains, in a companion abstract (this volume) we discuss a possible solution. If an improved dataset confirms the \(R(t)\) correlation, this work may allow a comparison between Antarctic meteorites and other populations, and an estimate of the flux of meteorites over ca. \(10^5\)–\(10^6\) years.

Fig. 1.