Further Investigations of BIT-58: A Meteoritic Event Recorded in Antarctic Ice

C. Hanson, R. Harvey (Case Western Reserve U.), and G. Flynn (SUNY, Plattsburgh)

Abstract No. hans1900
Beamline(s): **X26A**

The accretion of extraterrestrial material constitutes the greatest mass input to Earth. Of this material, objects in the microscopic range (from 60 to 1200 microns in diameter) account for around 80% of the material accreted annually (Flynn et al., 1993). These extraterrestrial particles yield valuable information about the composition of other materials in our solar system-- such as asteroids, comets, and other planets—and provide clues as to the early structure and composition of our solar system.

Although it stands to reason that some portion of this microscopic meteoritic material is spallation debris from larger objects, it is uncommon and difficult to identify debris that appears to stem from a single source body or event. Hence the importance of BIT-58, a debris layer in glacial ice that was discovered during routine stratigraphic investigations of volcanic ash (tephra) layers in the Antarctic Allan Hills ice field. The Allan Hills site is located where the East Antarctic ice sheet meets the Transantarctic Mountains; here the glacial ice is tilted upwards and undergoes deflation by the katabatic winds, thus exposing glacial ice stratigraphy as well as meteorites (Harvey et al., 1998). BIT-58 is therefore doubly unique in that it is a datable meteoritic event, which seems to derive from a single lithological precursor.

Initial investigations of the BIT-58 sample suggested a chemical and mineralogical affinity with H-chondrite meteorites (Harvey et al., 1998). These prior studies included electron microprobe, mass spectrometry, optical mineralogical and morphological analyses that indicated an H-chondrite-like abundance of the major elements. Our current investigation of the BIT-58 sample is intended as an adjunct and an expansion of previous work, by extending the range of analyzed elements, and by pursuing additional lines of inquiry.

Work conducted at the Brookhaven National Laboratory's National Synchrotron Light Source included Synchrotron X-Ray Fluorescence (SXRF) analyses of BIT-58 particles, fusion crust from confirmed H-chondrite meteorites, and Antarctic terrestrial materials. We took advantage of SXRF's ability to detect ppm concentrations of the heavier elements—in this case, volatiles from Cu through Br as well as the more refractory elements Ca, Cr, Sr and Ni—to fuel our inquiries: to confirm or disprove BIT-58's similarity to H-chondrites; to compare BIT-58 results with those of H-chondrite fusion crust; and to pursue the specter of Antarctic contamination (additions and/or deletions of volatile elements.) SXRF analysis is a non-destructive method that has a detection sensitivity of approximately 10 femtograms per element analyzed, and allows us to "see" elements that are "invisible" to electron microprobe analysis and other technologies.

Elemental analyses of BIT-58 and other samples were performed using Beamline X26A's X-Ray Microprobe. These analyses were performed in air using a 16.7 keV monochromatic X-Ray beam of approximately 15 microns diameter. With this method data can be obtained for the K-lines of elements up through strontium, and contaminants (from the air and sample mounts) can be easily identified and accounted for. Specifically, SXRF allows us to focus on the abundance of elements such as Cu, Zn, Ga, Ge and Se, heavier volatiles that are important for meteorite class determinations but which can be easily lost (through a heating event, such as atmospheric entry) or added during residence time on Earth.

The initial results of our SXRF analyses are intriguing: agreement of the BIT-58 sample with other meteoritic materials appears to bifurcate, with an H-chondrite-like major element composition and volatiles more in line with CI-type chondrites. Efforts are currently underway to interpret these new findings in light of current theories regarding the ablation of meteoritic material in the Earth's atmosphere and the possible mineralogy of the original parent body.

References: G. Flynn, S.Sutton and W. Klock, "Compositions and Mineralogies of Unmelted Polar Micrometeorites: Similarities and Differences with IDPs and Meteorites," Proc. NIPR Symp. Antarct. Meteorites, **6**, 304-324, 1993.

R. Harvey, N. Dunbar, W. McIntosh, R. Esser, K. Nishiizumi, S. Taylor, M. Chaffee, "Meteoritic Event Recorded in Antarctic Ice," Geology, **26**, 7, p. 607-610, 1998.