

SiC IN GREENLAND LAKE SEDIMENTS; C.A. Prombo¹, R.H. Nichols Jr.¹, C.M.O'D. Alexander¹, P.D. Swan¹, R.M. Walker¹ and M. Maurette². 1. McDonnell Center for the Space Sciences, Campus Box 1105, Washington University, One Brookings Dr., St. Louis MO 63130. 2. CSNSM, 91406 Campus-Orsay, France.

Both melted extraterrestrial spherules and unmelted micrometeorites have been observed in dark sediments (cryoconite) from temporary ice lakes on the Greenland ice sheet [1,2]. The concentration mechanism in the melt zone of the Greenland ice cap has produced one of the highest known abundances of extraterrestrial material on earth. With the availability of such a potentially large reservoir of unmelted extraterrestrial material, a logical step was to search for pre-solar grains in this material. We report here the results of our initial search for SiC in Greenland ice lake sediment.

Cryoconite is composed of "cocoons" of blue-green algae filaments, terrestrial mineral grains, unmelted micrometeorites and melted extraterrestrial spherules. In previous studies, extraterrestrial particles were extracted through a combination of mechanical disaggregation of the cocoons to release the grains and subsequent handpicking [1,2]. In order to reduce the fraction of micrometeorites that are probably lost during the disaggregation, it was decided to use an alternative procedure and remove the algae with nitric acid.

Our sample of cryoconite came from Blue Lake III, which is 9 km from the margin of the Port Martin ice field, about 700 km north of Sondrestromfjord. Blue Lake III sediment was collected with a hand pump in July, 1988 from the bottom of the 20 cm deep holes that constitute most of the ice field surface at that site [2].

Twenty four grams of cryoconite were first treated with concentrated HNO₃ to oxidize the algae. The treated material, primarily silicates, was not weighed, but is estimated to be about half the starting weight based on experience with a pilot run. This residue was treated with HF-HCl to dissolve the silicates. SEM analysis showed that the HF-HCl residue (52 mg) consisted of carbon, zircon and kyanite (or one of its polymorphs). Twenty nine milligrams of this residue were again treated with HF-HCl, but in an acid digestion bomb at 180 °C for two weeks. This final residue consists primarily of carbon and Ti and Al oxides. X-ray mapping with the SEM (see [3] for details on the mapping technique) showed that it contains approximately 0.02 vol% SiC, 3.8 vol% spinel and 0.8 vol% corundum and hibonite. The SiC grains identified fall in the range 0.2 to 3 µm. SiC particles with a diameter of less than 0.2 µm cannot be identified using this technique. Particles with a diameter larger than 3 µm can be identified using this technique and were not observed.

A small fraction of the residue was subsequently oxygen ashed specifically for ion probe analysis. Six SiC grains have $\delta^{13}\text{C}$ values between -14 and -36 ‰. Fifteen additional SiC grains were examined briefly and were found to have $\delta^{13}\text{C}$ values that fall within the terrestrial range. These results strongly suggest that the SiC grains in the residue are not interstellar.

In addition to the ion microprobe analysis, we attempted to measure the Ne isotope composition of the final residue since SiC is known to be the carrier of the exotic component, Ne-E(H) [4,5]. An estimate for the mass of the final residue needed to observe a Ne-E(H) signal above the spectrometer background Ne (using step-wise heating and conventional noble gas mass spectrometry [6]) was based on: (i) a typical ²²Ne blank of 2.6×10^{-13} ccSTP, (ii) the estimated "canonical" Ne-E(H) concentration in SiC of 1.6×10^{-4} ccSTP ²²Ne /g [7] and (iii) the fraction of SiC in the residue (approximately 0.1 wt%). These numbers suggest an estimated "upper

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limit" of 1.7×10^{-13} cc STP ^{22}Ne per microgram of residue. Thus, at least 10 - 100 micrograms were expected to be necessary to observe a Ne-E(H) signal at least 10 times spectrometer background.

A sample of the final unashed residue (94 micrograms) was analyzed for Ne. No ^{22}Ne from the residue was discernable above spectrometer background Ne. However, this result is not inconsistent with the expected result, because our estimate for the concentration of Ne-E(H) in the residue is probably an upper limit. The presence of terrestrial SiC in the residue, an over estimate for the "canonical" concentration of Ne-E(H) in SiC or prior loss of Ne in SiC are factors which would reduce our chances for observing Ne-E(H) in this Greenland residue.

What is the origin of this terrestrial SiC? A possibility is that SiC entered the cryoconite during collection and handling. SiC is commonly used in industrial grinding and polishing applications. Many trace element studies in remote areas have been severely compromised by artifact contamination [8]. We cannot rule out that possibility here.

An alternative source of terrestrial SiC is pollution aerosol entering the Arctic. Atmospheric transport of pollution aerosol on the scale of 1000 to 10,000 km is recognized to be responsible for pollutants observed in remote areas [9]. The entire Arctic is polluted during winter by sources outside the Arctic [10]. The Greenland ice lake concentration mechanism should be as effective for aerosol pollutants as it is for extraterrestrial particles.

We observed no SiC grains larger than $3 \mu\text{m}$ in diameter. If this SiC were introduced during collection and handling of the cryoconite, one would expect to find larger grains, since SiC used in most grinding and polishing applications is coarser grained. For example, fine grained 600 mesh SiC used for final polishing of petrographic thin sections has a diameter of about $30 \mu\text{m}$. The absence of SiC grains larger than $3 \mu\text{m}$ in our sample, of course, does not rule out its introduction during collection and handling. However, a size range of $< 0.2 \mu\text{m}$ to $3 \mu\text{m}$ for our SiC grains does match nicely the particle size distribution of Arctic aerosol. Most of the mass of Arctic aerosol falls in the size range 0.1 to $1 \mu\text{m}$ [10].

To conclude, based on isotope measurements, SiC isolated from a bulk sample of Greenland cryoconite does not appear to be interstellar in origin. This SiC may have been introduced into the cryoconite during collection and handling. Alternatively, the SiC may have been deposited on the Greenland ice sheet as the result of Arctic aerosol pollution.

References:

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