

Bulk Composition and Mineralogy of Micrometeorites from Greenland.

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The collection of micrometeorites in Greenland and Antarctica provides extraterrestrial material less effected by alteration and sampling biases compared to extraterrestrial material extracted from deep sea sediments (1). But similar to deep-sea-spheres, most of the micrometeorites from Greenland are melted during atmospheric entry. Mineralogical information about their parent bodies is lost in totally melted particles. But fortunately a small fraction of the micrometeorites studied contain relic mineral grains, and therefore provide information on the mineralogy of the parent object.

The particles studied were extracted from Greenland cryoconite following the procedure outlined by Robin et.al. (2). 141 particles are so far analyzed by SEM for their bulk elemental composition. Only particles with bulk chondritic composition are referred to as micrometeorites.

Five subgroups can easily be distinguished among the particles studied: (a) barred spheres (63), (b) porphyritic spheres (32), (c) glass spheres (29), (d) single pyroxene particles (8), and (e) finegrained porous particles (6). In parenthesis are given the numbers of particles in each subgroup and three particles could not be associated with one of the groups.

Among the particles with barred and porphyritic textures are 24 micrometeorites containing relic forsterites and/or enstatites. The percentage of partly melted particles is about 27% (24 particles with relic grains, 8 pyroxene particles and 6 finegrained porous particles) and comparable to the numbers reported by Maurette et al. (3).

The finegrained porous particles are aggregates of submicron grains which prevented mineral identification in the SEM. Texture and bulk chemistry of the finegrained micrometeorites suggest that they escaped melting in the atmosphere. Figure 1 shows that the finegrained particles are the only ones with measurable amounts of sulfur on the order of 0.5 to 2.5 wt%, and they all contain sodium. Being very volatile elements, S and Na are usually not present in measurable amounts in melted micrometeorites.

The data presented in Fig. 1 are normalized to CI-chondrite composition. Common to all four subgroups are overabundances of Mg, Al, Si and Ca compared to CI meteorites. Titanium seems to be even more enriched, but in most of the particles Ti was below detection limit (which is at about 1xCI chondrite abundances). The majority of particles has Na and Ni abundances below our detection limit.

Abundance patterns of barred, porphyritic and glass spheres are almost identical except for some minor differences. Porphyritic spheres have lower Fe than barred spheres. Nickel abundances in barred spheres are about 0.5 -0.7 x CI, whereas only very few porphyritic spheres had measurable Ni. This difference in bulk chemistry could be inherent in the parent material or a result of melting and recrystallization processes.

Glass spheres are enriched in Al and Si, but depleted in Fe and Ni. Siderophile element depletion is known from deep-sea-spheres and most likely due to the loss of metal or sulfide cores during melting in the atmosphere.

Calcium depletion of the finegrained particles could be explained if they are phyllosilicate-rich micrometeorites like the hydrated class of Interplanetary Dust Particles (4). The porous finegrained particles found, are texturally and chemically (Al-enrichment 2x CI) similar to the group of chondritic finegrained particles described by Robin et. al. (2).

In general, the pattern of major refractory elements of all micrometeorites in Fig. 1 is unlike CI composition and fits better CM or CV meteorite abundances.

Several Greenland micrometeorites are only partly melted and contain relic forsterites and/or enstatites. These grains are usually zoned with Mg-rich cores (Fa 1-2) and Fe-rich rims (Fa 15-30) which equilibrated with an iron-rich melt. Some of the relic grains contain micron-sized Fe-Ni metal inclusions. The histogram of Fe/Fe + Mg ratios of olivines in partly melted Greenland micrometeorites (Fig.2) shows a high abundance of forsterites. Olivines and pyroxenes of ordinary chondrite composition were so far not found in our study.

Cr, Mn and Ca contents in relic olivine grains seem to be diagnostic indicators of their origins. Steele (5) demonstrates a match of forsteritic olivine compositions in deep-sea-spheres and CM meteorites. Our Cr, Mn and Ca data of forsterites in Greenland micrometeorites, (Fig.3), support a close relationship to deep-sea-sphere forsterites and Murchison (CM2) forsterites. Most of the partly melted or unmelted particles seem to be associated with carbonaceous chondrite-like material rather than ordinary chondrites. This is consistent with the overabundance of C-type asteroids compared to ordinary chondrite-like asteroids in the main asteroid belt (6).

References: (1) Maurette M. et.al.,(1986), Nature 233, 869-872; (2) Robin E. et.al.,(1990),EPSL 97, 162-176; (3) Maurette M. et.al.,(1987), Nature 328, 699-702; (4) Schramm L.S. et.al.,(1989),Meteoritics 24, 99-112; (5) Steele I.M. et.al.,(1985), Nature 313, 294-298; (6) Gaffey M.J. et.al.,(1989),in "Asteroids II" Eds.:R.P.Binzel, T.Gehrels and M.S.Matthews,p.98-127. University of Arizona Press.

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Fig. 1

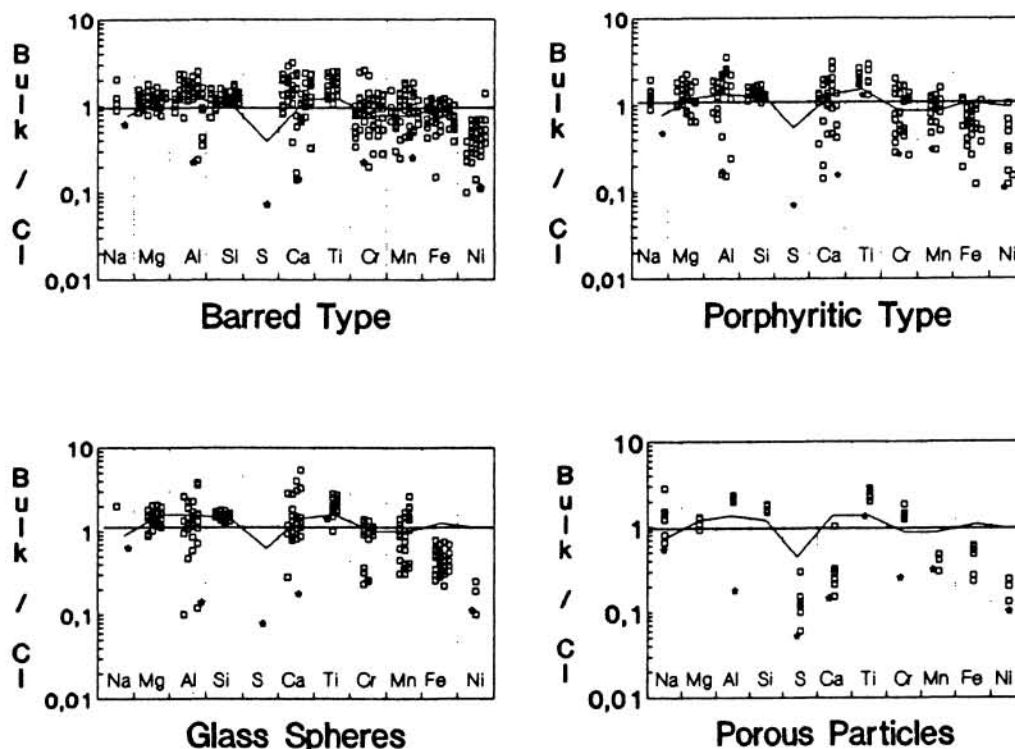


Fig. 2

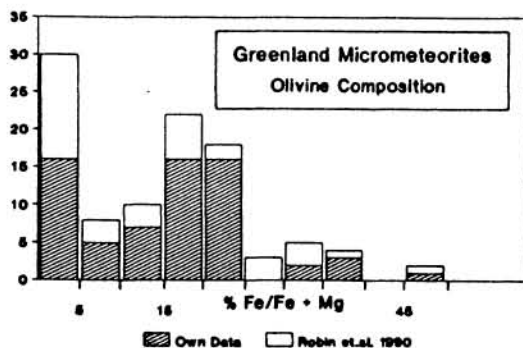


Fig. 3

Relic Forsterites
Cr - Mn Diagram

