

MG-CARBONATES AND SULFATES ON ANTARCTIC METEORITES.

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Seven of the approximately 300 stony meteorite specimens collected in the Allan Hills area during the 1977-78 season were found to be partially coated with white surface deposits when they were unpackaged in the laboratory at Houston. We have begun optical, x-ray, and SEM studies of these deposits, with the following preliminary results. SEM pictures show that some deposits consist of smooth gels and others are aggregates of crystals with a platy habit (Fig. 1). Mean indices of refraction range from $n = 1.450$ to 1.495 . X-ray films indicate that the most common minerals present are the hydrated Mg-carbonates hydromagnesite $[\text{Mg}_4(\text{OH})_2(\text{CO}_3)_3 \cdot 3\text{H}_2\text{O}]$ and nesquehonite $(\text{MgCo}_3 \cdot 3\text{H}_2\text{O})$, and the Mg-sulfate epsomite $(\text{MgSO}_4 \cdot 7\text{H}_2\text{O})$. Some patterns include extra lines representing as yet unidentified phases. Carbonates occur on some stones, sulfates on others. SEM dispersive analyses show Mg as the only major cation in all samples studied to date; minor amounts of Ca, K, Si, Fe, or Ni are sometimes also present.

The stones bearing white deposits include five ordinary chondrites (H3, H4, H5, L3, and L6), one C3 chondrite, and one ureilite. Only the L3 chondrite is severely weathered and stained with iron oxide. The H4 chondrite is moderately weathered, with rust halos around metal grains and extensive oxidation along cracks. The other 5 stones appear essentially unweathered, with inconspicuous iron oxide stains around metal grains and in cracks. Nevertheless the distribution of the white deposits, which occur on fusion crusts and fractured surfaces, is clearly related to minute channelways for percolating waters. We conclude that Mg, S, and minor elements are leached from the meteorites. The source of carbon is probably atmospheric CO_2 . Two of the stones are carbon-bearing, but they are encrusted with completely different types of salts: the ureilite with Mg-carbonate (which also occurs on some of the chondrites) and the C3 with Mg-sulfate. Although windblown salts from the ocean have been detected on Antarctic boulders located considerable distances inland, we doubt that such materials have contributed to the deposits on the Allan Hills meteorites, partly because of the remoteness of the site and partly because of the composition of the deposits. Cobbles of diorite and other mafic rocks in morainal deposits near the Allan Hills acquire white, yellow, or brown deposits on their undersides when they rest on soils. Samples that we have studied of these materials consist of illitic clays and gypsum $(\text{CaSO}_4 \cdot 2\text{H}_2\text{O})$. Thus they differ completely from those on the meteorites.

We suggest that the deposits on the meteorites formed in situ and represent an early stage in the weathering of some meteorites after they are exposed on the surface on the

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Antarctic icecap. In contrast to the oxidation of iron, which is a universal process in meteorites, the formation of carbonates and sulfates evidently requires conditions that are achieved only rarely. Once formed, these salts are probably destroyed when iron oxides subsequently become the dominant weathering products.

Water for leaching the meteorites probably forms from snow that melts when it is blown against them during hours of high sun-angle. Field workers in Antarctica observe that the sun-facing surfaces of many black rocks are wet. Some rocks even have icicles dripping from them on summer days. The salt deposits probably formed on damp meteorite surfaces warmed to a few degrees above 0°C.

In order to gain information on the sources of the carbon and the temperature of formation of the white deposits we have arranged for isotopic measurements of carbon, oxygen, and deuterium. Any available results will be reported.



Figure 1. Hydromagnesite crystals on ureilite ALHA77257. (SEM photograph; magnification 900x).