

ALTERATION PRODUCTS ON THE LEW 85320 H5 CHONDRITE; M.M. Grady, E.K. Gibson, Jr.<sup>†</sup>, I.P. Wright and C.T. Pillinger, Planetary Sciences Unit, Dept. of Earth Sciences, The Open University, Walton Hall, Milton Keynes MK7 6AA, U.K. <sup>†</sup>SN4, Experimental Planetology, NASA-JSC, Houston, Texas 77058, U.S.A.

The LEW 85320 H5 chondrite, one of the largest chondrites found in Antarctica with a recovered weight of over 110 kg, has small white crystallites of evaporite deposits covering its surface and lining the walls of fractures (1). A sample of these salts was scraped from the surface of the meteorite (split parent ,3) and subsequently identified by X-ray diffraction (J. Gooding, pers. commun.) as nesquehonite (trihydrated magnesite,  $MgCO_3 \cdot 3H_2O$ ). After transportation from Antarctica to the Johnson Space Center in Texas, the chondrite was kept in the usual clean curatorial facilities. However, it was noted that fresh crystallites continued to grow on the bare surfaces of the meteorite (JSC curatorial facility handling notes). A sample of this generation of carbonate (split parent ,1) was also identified as nesquehonite. As part of an investigation of the effect of weathering processes on Antarctic meteorites, we have analyzed both generations of carbonate from the surface of LEW 85320. In addition, two samples from a drill-core into the meteorite were measured. All samples were analyzed for carbon and oxygen isotopic composition of the carbonate by dissolution in 100% orthophosphoric acid. Results are given in the Table; interpretation of the results is subject to the provisos mentioned in the footnotes to this table.

**Interpretation:** no evidence for carbonates was found in either of the meteorite fractions taken from the drill-core, i.e. those located within the specimen - even the fragment from only 2mm below the surface was unaffected. It is clear therefore that the salts are secondary alteration products, and not indigenous to the meteorite. The problem now lies in identification of the provenance of the salts. It was considered that the salts may have been marine aerosol deposits on the exterior surface of the meteorite. Such materials are common on terrestrial Antarctic boulders and within soils, and are residues from wind-blown sprays. Both  $\delta^{13}C$  (= +7.9‰PDB) and  $\delta^{18}O$  (= +17.9‰SMOW) values of the first generation carbonate (,39) fall within the range of data acquired from calcite found as a surficial coating on rocks from the Wright Dry Valley region of Antarctica (2). However, several further observations argue against this explanation. The first is that the occurrence of large quantities of evaporite salts as surficial deposits on Antarctic meteorites is, in general, quite rare - if the above-mentioned process was responsible for their presence on LEW 85320, then it is difficult to rationalize the absence of similar salts on other meteorites recovered from adjoining localities. Secondly, evaporite salts on Antarctic rocks and in soils are generally sulphates (mostly gypsum,  $CaSO_4 \cdot 2H_2O$ ) and calcite, with minor dolomite (3). The salts removed from LEW 85320 are Ca-poor, almost exclusively the magnesian carbonate nesquehonite. Finally, and perhaps most significantly, the salts grow again as nesquehonite, while under storage at the Johnson Space Center, but with different carbon and oxygen isotopic compositions. This phenomenon is also not widespread amongst meteorites.

The second generation of nesquehonite is *ca.* 3 - 4‰ lighter in  $\delta^{13}\text{C}$  and 5 - 6‰ lighter in  $\delta^{18}\text{O}$  than the original Antarctic material. The reappearance of carbonate grains on the outer surface of LEW 85320, after several weeks, implies that the salts are generated *in situ*, presumably from  $\text{Mg}^{2+}$  cations leached from the meteorite with  $\text{CO}_2$  and  $\text{H}_2\text{O}$  from the atmosphere (alternatively, liquid  $\text{H}_2\text{O}$  may have been present around the meteorite). The difference in  $\delta^{13}\text{C}$  and  $\delta^{18}\text{O}$  isotopic compositions is presumably a result of incorporation of atmospheric  $\text{CO}_2$  of different isotopic composition, at different temperatures. The mechanism for the growth of the carbonate is likely to be one of dissolution and reprecipitation, as is fairly common during weathering processes. However, what is not clear is why this particular meteorite should exhibit such behaviour. The preliminary petrographic description of LEW 85320 (1) gives olivine and pyroxene compositions which are within the range of those for other H-group ordinary chondrites, *i.e.* there is no anomalously increased Mg concentration which might facilitate the formation of nesquehonite. Examination of the surfaces of other large ordinary chondrites found close to LEW 85320 might help to point out why this meteorite is so susceptible to alteration in this way.

**References:** (1) Antarctic Meteorite Newsletter (1986). **9**, 22-23; (2) Nakai *et al.* (1975). *Geochem. J.* **9**, 7-24; (3) Claridge, G.G.C. and Campbell, I.B. (1977). *Soil Sc.* **123**, 377-384

	LEW 85320 split	$\delta^{13}\text{C}_{\text{PDB}}$ ‰	$\delta^{18}\text{O}_{\text{SMOW}}$ ‰	Yield of Carbon
,39	First generation carbonate ( <i>i.e.</i> Antarctic)	+7.87 +7.86	+17.87 +17.95	8.60%
,15	Second generation carbonate ( <i>i.e.</i> Texan)	+4.31 +4.08	+12.05 +12.21	8.99%
,79	Sub-exterior fraction from drill-core ( <i>ca.</i> 2mm below surface)	nm	nm	69ppm
,80	Interior fraction ( <i>ca.</i> 4cm below surface)	nm	nm	5ppm

$\dagger\alpha$  for nesquehonite ( $\text{MgCO}_3 \cdot 3\text{H}_2\text{O}$ ) is not known, and the presence of three water molecules in this mineral introduces a further imponderable, since these are also capable of exchanging their oxygen with the oxygen in  $\text{CO}_2$ , therefore  $\delta^{18}\text{O}$  of the solid carbonate was calculated using a value of 1.01025 for  $\alpha$ , the oxygen isotope fractionation factor between  $\text{CO}_2$  gas and calcite at 25°C; Using a value of  $\alpha$  appropriate for magnesite ( $\text{MgCO}_3$ ) shifts  $\delta^{18}\text{O}$  values by *ca.* 2‰ to lighter values. Too many inferences should not be drawn from the actual  $\delta^{18}\text{O}$  values of the carbonate: it is sufficient to note that the first generation (*viz.* Antarctic) material is *ca.* 5-6‰ heavier than the second generation (*viz.* Texan) carbonate. NB. the carbon isotope values are not subject to this effect. nm - not measurable.