CARBONATES IN THE LOS ANGELES 001 METEORITE. G. A. Graham[1,2,3], A. T. Kearsley[2], I. P. Wright[1], M. M. Grady[3], and C. T. Pillinger[1], [1]Planetary Sciences Research Institute, Open University, Milton Keynes MK7 6AA, UK (g.a.graham@open.ac.uk), [2]Space Science Research Unit, School of Biological and Molecular Sciences, Oxford Brookes University, Oxford OX3 0BP, UK, [3]Mineralogy Department, The Natural History Museum, London SW7 5BD, UK.

Introduction: Carbonates in carbonaceous chondrites have been subject to extensive study by chemical, petrographic [1], and isotopic [e.g., 2] methods. However, since the controversy surrounding investigation of ALH 84001 [3], there has also been renewed interest in the nature and origin of carbonates in non-chondritic meteorites [e.g., 4], especially SNC meteorites, e.g. [5,6].

Preliminary petrographic investigations of the Los Angeles 001 meteorite (a basaltic shergottite) indicated that there were no carbonate grains within the predominately maskelynitized plagioclase and pyroxene mineral assemblages [7]. This makes it a potentially interesting sample for carbon studies, because the apparent lack of carbonate indicates that the sample has not suffered from low-temperature geological processes on Mars and, as such, may provide an important constraint in defining the nature of Martian mantle C.

Herein we discuss the significance of isotopic measurements and SEM observations from the analysis of broken chips from the meteorite.

Experimental: 7.402 mg of sample was stepped combusted using MS86, a high-sensitivity static vacuum mass spectrometer [8]. This gave information on the carbon components and the isotopic composition within the meteorite. Broken surface chips of the meteorite were given an thin carbon coat and investigated using a JEOL 840 SEM fitted with an Oxford e-XL energy dispersive X-ray spectrometer, and using a Philips XL FEG-SEM for high-resolution and stereo imaging in secondary electron mode.

Results and Discussion: The mass spectrometric analysis of the chip identified a release of a carbonate component at around 550°–650°C with a $\delta^{13}C$ of 0.8‰ (assuming the carbonate to be calcite, this would be present at a level of 0.15 wt%). Previous investigations of meteorites [9] suggest that such an isotopic composition is indicative of a terrestrial origin. It is interesting to note that it has been previously suggested that Los Angeles 001 only shows limited evidence of weathering [7].

In order to address the nature of the carbonates, detailed X-ray elemental mapping was carried out on two small chips of the meteorite. The maps identified areas enriched in calcium (Ca) on the fracture surfaces of both the plagioclase glass and the pyroxene grains. High-resolution secondary electron and back-scattered electron imaging of the areas showed that the grain surfaces contain a coating of carbonate structures.

Apart from the calcite crystals, the Ca-rich areas also contain several other interesting features: (1) nodules which may or may not have crystal growth associated with them; (2) rosette structures which may or may not be biogenic and (3) an elongate worm-shaped structure of approximately 10 µm in length, which again may be biogenic in origin. The preliminary EDS analysis of the worm-shape has shown that it is not composed of carbonate.

The terrestrial chemical weathering of meteorites that leads to the formation of carbonates has previously been examined extensively in Antarctic meteorites, [e.g., 10,11]. The Los Angeles 001 meteorite was found in the Mojave Desert and previous research [10] has indicated that there are substantial differences between hot and cold desert environments in terms of weathering. However the recent detailed investigations of the Tatahouine meteorite [4,12] have shown how a meteorite in a hot desert environment can be subject to rapid weathering, and particularly the formation of carbonate structures over a short period of time. The percolation and subsequent evaporation of ground water containing carbonate ions through the meteorite, whilst it was resident in the Mojave Desert, is the most likely mode of formation for the carbonates.

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