

Alteration History of Type 3 Ordinary Chondrites. Andrew D. Morse,¹ Derek W. G. Sears,² Robert Hutchison,³ R. Kyle Guimon,² Conel O. Alexander,¹ Ian P. Wright¹ and C. T. Pillinger.¹ ¹Planetary Sciences Unit, Open University, Milton Keynes MK7 6AA, UK. ²Cosmochemistry Group, University of Arkansas, Fayetteville, AR 72701 USA. ³British Museum (Natural History), London SW7 5BD, UK.

Metamorphism has obscured the nebula record of most of the type 3 ordinary chondrites, however a few of the type 3 ordinary chondrites show little metamorphism (1). Thermoluminescence (TL) has been used to define a scale of metamorphism for the type 3 ordinary chondrites ranging from 3.0, least metamorphosed to 3.9, most metamorphosed (2). Semarkona (type 3.0) and Bishunpur (type 3.1) show the least degree of metamorphism. Semarkona has many other unusual properties as determined by thermoluminescence, cathodoluminescence (CL) (3) and isotopes (4). These unusual properties could reflect nebula processes not obscured by metamorphism, or have been later imparted by other secondary processes.

Aqueous alteration has been observed by petrographic analysis in Semarkona and to a lesser extent in Bishunpur (5). This could explain properties of these two meteorites. Many of these properties are associated with chondrules and these two meteorites are heterogeneous, so to explore the relationship between these properties a combined study was performed of three different techniques on individual chondrules; thermoluminescence, petrology and mass spectrometry.

Chondrules and matrix samples were hand picked under a low powered binocular microscope from Semarkona, Bishunpur and as a link with other type 3 ordinary chondrites Chainpur (type 3.4). Each sample was split into three fragments, one fragment each for TL, petrology and isotope analysis. Fragments used for TL have been retained as reserve material for other studies.

Mass spectrometry was used to determine the water content and the D/H ratios of the water released by stepped pyrolysis at 200 °C and 1100 °C. The 200 °C step was an attempt to remove terrestrial contamination. The water released from the pyrolysis was reduced to hydrogen by a zinc furnace at 320 °C or uranium furnace at 620 °C and then entered directly into the mass spectrometer to increase sensitivity. The amount of water released by each chondrule fragment was ~1 µg for each step (<1% by wt.). For the chondrules the water released during the low temperature step had δD ranging ~600‰ to +3200‰ and the water released during the high temperature step had δD ranging from 0‰ to +7800‰. The matrix fragments released a greater amount of water for both steps 2–4 wt.%. The δD values for the matrix samples were around terrestrial values for the low temperature step and ranged from +1000‰ to +3000‰ for the high temperature step.

There is a suggestion of a relationship between TL and δD measurements. Chondrules with $\delta D < +3800$ ‰ tended to have a lower TL sensitivity than those with $\delta D > +3800$ ‰. Petrographic studies indicate the chondrules with low TL sensitivity and low δD values may be contaminated by matrix fragments attached which would reduce the D/H ratios.

Due to the small sample size and instrument technique used there were large errors in determining the δD values and water content of the samples. Recently a new inlet system has been built for the mass spectrometer. The water released from pyrolysis is converted to hydrogen in a zinc capillary furnace and then injected into the mass spectrometer by helium using a capillary flow technique. Using this technique it is hoped that more accurate measurements can be obtained using the posterity samples of particularly interesting chondrules where necessary. We intend to use the petrographic description to allow similar chondrules be grouped to obtain a larger sample size. References: (1) Dodd *et al.* (1967) *GCA* **31**, 921–951. (2) Sears *et al.* (1980) *Nature* **287**, 791–795. (3) DeHart *et al.* (1986) *LPS* **17**, 160–161. (4) McNaughton *et al.* (1983) *Proc LPSC* **13th**, A297–A302. (5) Hutchison *et al.* (1987) *GCA* **51**, 1875–1882. (6) Morse *et al.* (1987) 50th Meteor. Soc. Mtg. (7) Sears *et al.* (1988) *LPSC*.