ION MICROPROBE MEASUREMENT OF D/H RATIOS IN METEORITES.

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D/H measurements of hydrogen present within carbonaceous (1) and unequilibrated ordinary chondrites (2) have demonstrated that primitive solar system material is often enriched in deuterium and is isotopically inhomogeneous. The deuterium enrichments are extremely high (>5000°/oo) and cannot be produced by simple fractionation processes; a formation through ion-molecular reactions within interstellar gas and dust clouds has therefore been postulated (3,4). While some of the apparent variations in the measured D/H ratios may be due to terrestrial contamination, there would appear to be a D-rich phase(s) present within many primitive meteorites. Stepwise heating of bulk meteorites (2) and combustion of acid residues thereof (1) suggest that this D-rich phase may be an organic polymer, however, the identification of this phase and its location within the samples by these methods are not definitive.

Ion microprobe analysis is a more direct method of studying the distribution and isotopic composition of the various hydrogen bearing phases present within any meteorite. Further, since the major elements present within each volume/mineral analysed may also be recorded, the identity of the hydrogen bearing phases may be more readily determined.

Initial experiments to determine the feasibility of ion probe hydrogen isotope measurements of meteoritic material were made on two unequilibrated ordinary chondrites, Semarkona (LL3.0) and Parnallee (LL3.6). The former has a high deuterium enrichment while the latter gives essentially terrestrial values. The samples and standards were analysed using a 20nA, 30kv O_2^- primary beam focussed into a 15μm^2 spot, the hydrogen isotopes were recorded as H^+ and D^+. The secondary ion mass spectrometer was operated at a mass resolution of ∿1000 in order to separate H_2^+ from D^+. The precision was limited to ca. 5% by the low count rate of D^+; typically 1cps on the standard epidote (compared to a machine background of <0.01cps). The absolute D/H ratios recorded for the above two meteorites were standardised against hydrated terrestrial minerals (epidote or chlorite) run on the same day. While the absolute D/H ratio recorded on the standards was 1.15×10^{-4}, compared to a value of 1.56×10^{-4} for SMOW, this value was consistent from day to day.

As may be expected from the bulk meteorite analyses (2), Semarkona gave widely varying δD's of ∿+450°/oo to ∿+4000°/oo; the mean δD of the five points analysed was +2200°/oo. In contrast, analyses of the Parnallee opaque matrix gave values within error of the terrestrial standard and an overall mean δD of +50°/oo. These values can be compared with bulk values of +2260 to +2900°/oo and -80°/oo obtained by conventional stable isotope mass spectrometry for Semarkona and Parnallee respectively.

In Semarkona, the hydrogen appears to be concentrated within the fine grained opaque matrix and brown glass; the H^+ count from the chondrules was <2% of the highest H^+ count from the opaque matrix. Measurements made under poor vacuum conditions (i.e. with high partial pressure of water) suggest that the counts recorded on the chondrules are predominantly due to adsorbed

water and they are equivalent to the background expected for all points analysed under the same operating conditions.

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