A SEARCH FOR MARTIAN SEDIMENTS. I.A.Franchi, I.P.Wright and C.T. Pillinger, Planetary Sciences Research Institute, The Open University, Milton Keynes, MK7 6AA, UK.

Recent interest in the possibility that the martian meteorites EET A79001 and ALH 84001 contain evidence of biological processes, in the form of organic residues [1] and putative fossil organisms [2] associated with deposits indicating the passage of liquid water [3], makes it vital that we identify the rocks of low-temperature sedimentary origin which must surely be falling on Earth from our neighbour in space [4]. Until we have such materials, the debate will continue about whether carbonates present in martian samples, like EET A79001 [1], ALH 84001 [3] and Nakhla [5] are part of the high temperature geochemistry, or the result of subsequent processing at or below 100˚C. Of course we could wait until a space agency implements an appropriate martian sample-return mission, but intense scientific and public interest in the subject requires a more immediate response. The opportunity to study specimens recovered by spacecraft from regions of Mars showing fluid processing might be more than a decade away. Even if the will presently exists, space programmes and missions have been cancelled before. The potential for doing exciting research concerning whether life is pandemic in the Universe or confined to just one planet means that every avenue, no matter how remote the chance, must be explored.

If we are correct in our interpretations of the photogeology of Mars and our assumptions about how martian meteorites arrive on Earth, then sedimentary rocks from the planet must certainly be present in the vast meteorite resources on terrestrial deserts (*e.g.* Antarctica, Sahara, Nullarbor *etc.*). The problem lies in recognising them for what they are; samples might even be in collections already.

For this reason we are scrutinising the suggestion made by Brandenburg [8,9] that type I carbonaceous chondrites originate from Mars. Bradenburg's thesis, that Mars is the parent body of the CI chondrites, is based on several lines of thought and both isotopic and geochemical arguments. Top of the list is the similarity in the D^{17}O displacements for martian samples and the CI chondrites relative to the terrestrial fractionation line. This is the subject we will return to below. Other favourable comparisons made by Brandenburg concern the dD, d^{13}C, d^{15}N and noble gas isotopic compositions of martian samples and various components in carbonaceous chondrites. He points out too that chemical analyses of the Mars regolith by Viking call for an input of CI material and makes the point that Urey [10] suggested that CI meteorites might have come from an extinct planetary seabed. The list of similarities is ostenibly formidable and the longer it gets the less chance there would appear to be that serendipity is involved. With this in mind we would point out that martian meteorites also contain both sulphide and sulphate minerals which behave not dissimilarily during stepped combustion to their carbonaceous chondrite counterparts [11], an observation overlooked by Brandenburg. Both the relevant Brandenburg papers [8,9] appeared just prior to the revelations regarding putative martian fossils [2] so the most obvious comparison, with the work of Nagy and co-workers on Orgueil [12,13] was also not mentioned. The suggestion in the 1960s, that Orgueil contains extraterrestrial fossil organic compounds and organisms, was greeted with an almost identical fervour when it first appeared to that surrounding the revelations from ALH 84001. If the link between CIs and martian meteorites was confirmed, the whole question of what was, or was not, seen during investigations of Orgueil would need re-evaluation by modern technology.

Notwithstanding all the comparisons made above, we have decided to evaluate that involving oxygen isotopes. For close to twenty five years, samples concordantly defining lines of slope 0.52 on a plot of d^{17}O versus d^{18}O have been considered as potentially genetically linked. It is therefore important to establish just how well the oxygen isotopic data for martian meteorites compares to that of carbonaceous chondrites. The figure shows the literature values [14, 15] for the two groups of specimens plotted herein as D^{17}O versus d^{18}O. The results for CI meteorites includes matrix separates as well as whole rock samples. From the new format it can be seen that the two groups of meteorites have D^{17}O in the same range as reported by [8] but are 10-15‰ different in d^{18}O. The spread in D^{17}O, which is possibly a function of the errors of the measurements, coupled with terrestrial weathering or isotopic exchange effects, is about a factor of three greater in the case of CI analyses, but never the less, the means and the modes of the datasets approximately correspond and would appear to justify the claims of [8]. However, from newly acquired data, using laser induced fluorination [16], we know that the spread in D^{17}O for martian samples is greatly reduced so that a value of $+ 0.321 \pm 0.013$ (n=32 samples, 10 meteorites) is now our best estimate for the oxygen isotopic composition of Mars compared to Earth. The same technique has been applied to the three readily available CI chondrites Orgueil, Ivuna and Alais. The preliminary results for these suggest a D^{17}O for the

CIs of +0.64±0.03 with d^{18}O between +12.5 and +14.5‰. The reason for the discrepancy between the d^{18}O values and the earlier results shown in the figure is possibly due to the reactivity of volatile components under the conditions employed for laser fluorination. In particular, the exposure of all the samples to BrF_5 during pre-fluorination and each analysis. However, this effect must be relatively small as the oxygen produced by the first pre-fluorination was indistinguishable from the normal terrestrial, predominantly atmoshpheric, oxygen produced from sample trays containing only anhydrous, resistant phases. A second pre-fluorination produced very little oxygen above blank level. For interest we also analysed Y82162 which has a D^{17}O indistinguishable from that of the other samples but with a d^{18}O value of +22.7‰ which is significantly higher than any of the other CI chondrites.

The immediate conclusion from the preliminary work herein is that martian meteorites and CI chondrites are significantly different based on oxygen isotope results of greater precision. However, it would be wrong to make such an instantaneous response without replicating the results for the CIs, examining dehydrated specimens, and considering separated minerals fractions. The latter may be of particular significance because it is known that magentite, isolated from carbonaceous chondrites, has a higher D^{17}O than the bulk specimens, with d^{18}O values which approximate the mean of martian meteorites [15]. Further work is therefore in progress to address the important question of identifying martian sediments and whether or not these have any relationship to CIs.

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