

REDOX CONDITIONS IN ORDINARY CHONDRITES. O. N. Menzies¹, P. A. Bland¹, and F. J. Berry². ¹PSSRI, The Open University, Milton Keynes, MK6 7AA, U.K., ²Department of Chemistry, The Open University, Milton Keynes, MK6 7AA, U.K.

We have used Mössbauer spectroscopy to investigate thermal metamorphism in the ordinary chondrites (OCs). The results indicate a convincing trend of increasing metamorphism in the UOCs. Because this technique allows comparisons to be made between UOCs and EOCs, our reduction sequence can be combined with recent evidence showing progressive oxidation in the EOCs [1,2]. This yields an integrated model of changing redox conditions on equilibrating OC parent bodies.

Such conditions have long been the subject of controversy. Larimer [3] was among the first to suggest that some reduction may have occurred during OC metamorphism. However, Heyse [4] argued that lower petrologic types are more reduced. Measurements of intrinsic oxygen fugacity suggested that EOCs were more reduced than UOCs [5]. Finally McSween [1] concluded that despite some evidence of reduction in UOCs, progressive oxidation with metamorphism dominated in the EOCs, more recently using silicate ratios to confirm that oxidation increases with metamorphism in L and LL EOCs [2].

We have shown that the Mössbauer parameter, quadrupole splitting (Δ), increases with increasing forsterite content [6] and that Δ increases with increasing petrologic type in the UOCs [7]. Assuming that the measured values of Δ represent an average of all the olivine compositions present in a meteorite, it follows that olivine becomes more forsteritic with increasing petrologic type in the UOCs – a trend of increasing reduction which does not continue into the EOCs. Mössbauer spectroscopy can also be used to provide relative amounts of silicate minerals. When the olivine/pyroxene abundances in OCs are plotted against petrologic type, there is a clear decrease in the silicate ratio from type 3 to type 4, which increases again in higher petrologic types. This supports the suggestion that oxidation occurs in the EOCs [1,2] but also shows that reduction dominates throughout UOC metamorphism.

Other meteoritic components that support this conclusion are decreasing C content, decreasing $\delta^{18}\text{O}$ and increasing $\text{Fe}^0/\text{Fe}_{\text{total}}$ with petrologic type. These data all show that there is a clear hiatus in redox conditions between the UOCs and EOCs. McSween [1] asserted that confusion over what redox conditions prevailed on meteorite parent bodies arose from making comparisons between UOCs and EOCs. Our data makes it possible to reconcile both end-members of equilibration and to explain the apparently conflicting evidence seen by previous workers.

C is a postulated reducing agent. However the reduction reaction is calculated experimentally to occur above 1350°C [8], which is incompatible with UOC metamorphism, 400 - 600°C [9]. It has been suggested that oxidation of EOCs occurred by oxidising vapours [1]. This vapour should have similarly affected the UOCs. It is necessary to find either an alternative reducing agent or a method of replacing reducing with oxidising conditions. Reduction coincides with progressive dehydration of phyllosilicates. The temperature at which both dehydration and reduction cease, coincides at between 600 - 700°C [10]. This may be worthy of further investigation.

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