HIGH TEMPERATURE ELECTRICAL CONDUCTIVITY OF THE CARBONACEOUS CHONDRITES ALLENDE AND MURCHISON

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The electrical conductivity of the carbonaceous chondrites Murchison and Allende is unusually high and time-dependent when compared with that of single crystal olivine (1) or rocks such as basalt (2) and ultramafics (3). This behavior is similar to that observed for oil shale which has been attributed to the breakdown of hydrocarbons producing a carbon-rich residue coating grain boundaries, thus increasing the electrical conductivity of the shale (4). Figure 1 compares the electrical conductivity of Murchison and Allende up to about 900°C with that of single crystal olivine (1). Below about 700°C, the conductivity of Murchison is 5 or more orders of magnitude greater than that of single crystal olivine plotted in Fig. 1, and 4 or more orders of magnitude greater than that of terrestrial rocks (2,3). One indication of the time-dependence of the conductivity of carbonaceous chondrites is illustrated in Fig. 1 by vertical lines depicting conductivity increases while temperature remained constant for 8 to 12 hours. These conductivity increases were noted at temperatures less than 200°C in both meteorites, consistent with heating results on carbonaceous chondrites which show polymer degradation at temperatures as low as 150°C (5). The other feature of Figure 1 which indicates that some reaction product is affecting conductivity is the dependence of conductivity on heating rate. Allende sample #1, heated at a rate of about 3°C/hour, is more conductive at all temperatures than Allende sample #3, heated at a rate of about 90°C/hour. The inverse dependence of conductivity on heating rate is again similar to results obtained for oil shale (4). The conductivity of Murchison, heated at an intermediate rate of about 10°C/hour is higher than that of Allende, an indication of the higher carbon content of this C2 chondrite. Because the conductivity of these meteorites is so high, postulated inductive heating of carbonaceous chondrites in a T-Tauri-like solar wind could proceed at lower background temperatures than those envisaged for lower conductivity terrestrial rocks and minerals (6). However, because conductivity of carbonaceous chondrites is so dependent on the carbon content and temperature-time history of the material, careful consideration needs to be given to the thermal history of chondritic bodies in order to model conductivity and, hence, the effectiveness of inductive heating. Additional detailed measurements of conductivity at various heating rates, such as those presented here, for candidate materials will be necessary input for the induction models. High conductivity in Lance and Allende carbonaceous chondrites has previously been attributed to contained free metal (7). Since the metal occurs as discrete particles in these materials and not as a continuous phase, this interpretation is less likely than the carbon-bearing, grain-boundary phase proposed by Duba and Shankland (8,9).

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