ELECTRICAL CONDUCTIVITY OF CARBONACEOUS CHONDRITES AND T-TAURI (ELECTROMAGNETIC) HEATING OF THE ASTEROIDS*; A. Duba, E. Didwall, G.J. Burke E.L. Arnold (Lawrence Livermore National Laboratory, P.O. Box 808, Livermore, CA 94550) and C. Sonett (University of AZ, Tucson)

The electrical conductivity of the carbonaceous chondrites Allende and Murchison has been measured to 900°C at controlled oxygen fugacity. The observed conductivity at any temperature is dependent on the carbon content and the temperature history of the sample. Below 700°C the conductivity of Murchison, the more carbon-rich chondrite is one to two orders of magnitude greater than that of Allende. Above 700°C, as both materials lose carbon, this difference disappears. At temperatures $\leq$ 800 C, the conductivity of both carbonaceous chondrites is 3 to 8 orders of magnitude greater than has been reported for non-carbon-bearing rocks and silicates measured at similar temperature and oxygen fugacity. However, the decrease in conductivity accompanying carbon loss, which occurs with increasing temperature and begins around 600-700°C, causes the conductivity of both meteorites to approach within two orders of magnitude of the conductivity of rock-forming minerals such as pyroxene and olivine.

We have applied these measurements to the problem of the differentiation of asteroidal objects. A major restriction on electromagnetic heating of planetary matter has been the very low electrical conductivity of rock-forming minerals which for unipolar (TM) heating requires that the background temperature be 400-500°C (1). For eddy current (TE) heating this restriction is not present, but low conductivity causes an excessive heating time (2). Our calculations of electromagnetic heating of asteroids of carbonaceous chondritic composition indicate that 500 km radius bodies as distant as 2.8 AU would attain the melting temperature of anhydrous basalt ($\sim$1100°C) in 3 x $10^5$ years using the solar and T-Tauri parameters of Sonett et al.(1,2) but, with a background temperature of only 140°C. Smaller bodies of similar conductivity would attain this temperature in shorter times as would 500 km radius bodies less distant than 2.8 AU. Since T-Tauri phases of stellar mass loss are postulated to last about $10^6$ years, differentiation of asteroids out to about 3 A.U. appears to be easily achieved via electrical induction if some 5 - 25% of the mass of the asteroidal object were carbonaceous chondrite. From these results, we conclude that electromagnetic heating of asteroids with a significant carbonaceous chondrite component during a T-Tauri phase of the sun could produce the present-day distribution of C and S asteroid types inferred from spectral data (3).

References:

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