VOLATILE RELEASE FROM CHONDRITES: CONSEQUENCES FOR EARLY PLANETARY ATMOSPHERES

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Introduction: Rocky material accreting to form the inner planets in the early stages of the solar system was the primary source of volatiles for primitive atmospheres on these bodies [1, 2]. Additionally, infalling meteoritic material would have been ablated in the atmosphere and devolatilized, further contributing to the overall composition [3]. It is clear therefore that the volatile contents of primitive bodies can indicate a sort of proto-habitability for the planets they form. The composition of various primitive bodies as volatile carriers is key and something we must understand. In this study, powdered samples of LL3 (Bishunpur and Chainpur) and CO3 chondrites (Ornans and Colony) were analyzed by quantitative pyrolysis-FTIR spectroscopy in order to assess the volatiles produced under conditions that simulate heating and ablation of meteoritic materials upon atmospheric entry.

Methods: The instrument used was a Thermo-Nicolet 5700 FTIR with MCT-A detector, coupled with a CDT 5200 pyroprobe. Background and sample spectra were generated from 64 scans at a resolution of 4 cm^{-1}. Approximately 7 mg of each sample were pyrolyzed in a Brill Cell with a helium atmosphere. Each sample was subjected to two stages of pyrolysis as described by [3]. In order to quantify, three samples from each meteorite were run, with the exception of Chainpur. Calibration curves for carbon dioxide were generated by direct injection of gas into the cell, and for water were created by thermal decomposition of sodium hydrogen carbonate.

Results: The main volatile products of pyrolysis were water and carbon dioxide. The yields of water at 250 ˚C and 1000 ˚C for each individual meteorite sample were similar, with the exception of Colony which showed significant variation across the three runs at 250 ˚C. Ornans released the least water, with the ordinary chondrites producing slightly greater yields. Colony released significantly more water at both temperature steps. Release of carbon dioxide at 1000 ˚C across the meteorites increased in the order Ornans, Chainpur, Bishunpur, Colony. There was no detectable carbon dioxide from any of the meteorites at the 250 ˚C step.

Discussion: Water yields are largely a reflection of clay mineral content and hence degree of aqueous alteration. Water released at 250 ˚C likely originates from loosely bound water on these minerals. A component of the water released during this desorption step may be indigenous, although it is difficult to distinguish this from terrestrially adsorbed water. Carbon dioxide would be sourced from both organics and alteration carbonate components in the meteorites. The high yields of water and carbon dioxide from Colony relative to the other meteorites is a result of the extensive terrestrial weathering it has suffered. Only chondritic material that had been aqueously altered before delivery and ablation in planetary atmospheres during the early stages of solar system evolution was likely to have contributed significant amounts of water and carbon dioxide.

References: [1] Kasting J. F. 1993. *Science* 259:920–926. [2] Schaefer L. and Fegley Jr. B. 2010. *Icarus* doi:10.1016/j.icarus.2010.01.026 [3] Court R. W. and Sephton 2009. *Geochimica et Cosmochimica Acta* 73:3512–3521.