ISRU CHALLENGES FROM HEATING CARBONACEOUS CHONDRITE MATERIAL FOR WATER

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Introduction: Carbonaceous chondrite meteorites are some of the oldest Solar System planetary materials available for study. Of particular interest in carbonaceous chondrite compositions are labile elements, which vaporize and mobilize efficiently during post-accretionary parent-body heating events. Here we characterize the thermally induced movements of the labile elements S, As, Se, Te, Cd, Sb, and Hg in carbonaceous chondrites by conducting experimental simulations of volatile-element mobilization during thermal metamorphism. This process results in appreciable loss of some elements at temperatures as low as 500 K. Elements such as S and Hg have the most active response to temperature across different meteorite groups. This work is also critical for constraining the concentrations of contaminants in vaporized water extracted from asteroid regolith as part of future in situ resource utilization for sustained robotic and human space exploration.

Water Extracted from Carbonaceous Chondrites: For future *in situ* resource utilization, knowing the abundance of volatile elements in a primitive meteorite, along with the percentage of water, would be useful for water purification processes to create both drinking water and rocket propellant. Heating primitive meteorites to release water vapor will also release high concentrations of labile elements, many of which exceed EPA limits for contaminants in drinking water (Kelsey & Lauretta, 2013; Table 1). Water mined from extraterrestrial sources has long been predicted to be polluted with labile elements such as Hg (Reed, 1999); however, this could be mitigated by adsorption via ion exchange resins (Chiarle et al., 2000). Producing water with high concentrations of Hg to make hydrogen gas for fuel could cause metal failure from brittle fracture in the hydrolyzer system, considering that Hg can cause brittleness in aluminum in natural gas processing plants (Nichols & Rostoker, 1961).

Concentrations of Labile Elements in Water Vapor. Heating Murchison can yield concentrations of 50,000 mg/L for sulfur in the resulting water. High concentrations of sulfur in water vapor can poison platinum electrodes in traditional electrolyzers used to purify water vapor, leading to irreversible losses in platinum electrode performance (Kelsey & Lauretta, 2013). The deactivation of Pt sites is independent of the type of sulfur contamination (Sethuraman and Weidner, 2010). Purification systems using substances such as Nafion should be theoretically impermeable to sulfur compounds resulting from vaporization of primitive meteorite material (Yeo et al., 1980). For future in situ resource utilization, more work is needed to enable purification of water from heavy metals and sulfur without damaging the purification apparatus.

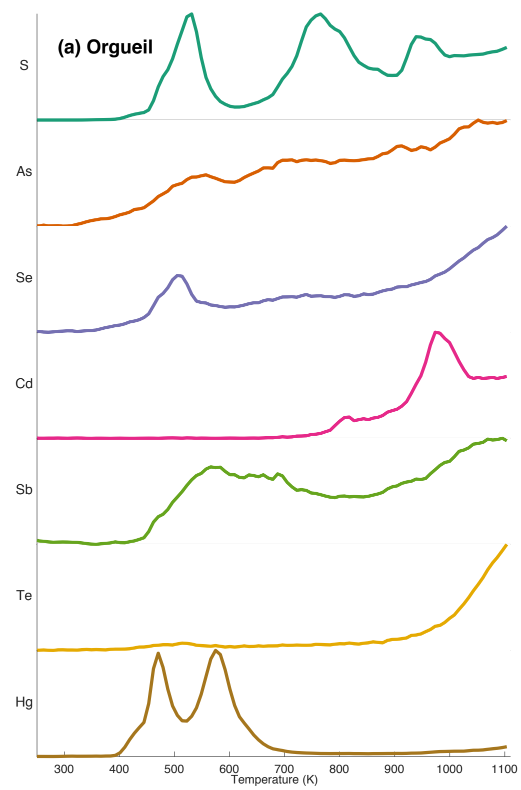

Fig. 1: Element release with temperature for Orgueil

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