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**CHEMICAL AND ISOTOPIC DIVERSITY OF ORGANIC PARTICLES IN CHONDRITES: PARENT BODY VS. NEBULAR PROCESSES**

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**Introduction:** Insoluble organic matter (IOM), the main organic constituent in chondrites, has been extensively studied after HF/HCl isolation techniques. Bulk isotopic compositions and elemental ratios show variations between chondrite groups, whereas they are quite homogeneous within each class [1]. Recent isotopic measurements by ion probes have revealed that IOM is heterogeneous at the sub-micron scale [2, 3]. Does this heterogeneity reflect parent body evolution or reactions in the gas phase prior to accretion? To answer this question, we have studied in situ organic matter in Orgueil (CI), Tagish Lake, Murchison (CM), Cold Bokkeveld (CM), Allende (CV), Renazzo (CR) and Chainpur (LL) by NanoSIMS imaging. We have determined D/H ratios and chemical composition (C, H and N contents) of organic particles in the matrices of these meteorites.

**Results and Discussion:** Organic matter occurs as isolated, randomly distributed, micron size particles in the matrices of the studied chondrites [4]. The organic grains exhibit a large range in compositions. No clear trend is found between C/H, N/C and D/H ratios. Moreover, within each group, these ratios also show a large range of variations: for instance D/H =  $2.55 \times 10^{-4}$  to  $35.02 \times 10^{-4}$  in Orgueil (bulk IOM D/H =  $3 \times 10^{-4}$ ), C/H = 0.3 to 2 for Murchison (bulk IOM C/H = 1.4); this range exceeds the reported range from bulk analyses. Mixing with inorganic matrix occurs during the measurement, as shown by C/Si and C/O ratios, but it cannot explain alone the diversity of measured compositions.

Some chondrites of different groups seem to contain similar organic particles, as indicated by their elemental and isotopic ratios, whereas their IOM has a different bulk composition. Then, we have to consider that each parent body has accreted a population of organic grains rather than one unique type of organic matter. These grains may have different chemical and isotopic compositions, probably due to their pre-accretion history. Moreover, the parent body evolution did not rehomogenize the composition of the organic matter, keeping the initial heterogeneity.

**Conclusion:** The isotopic and elemental ratios of chondritic IOM results from the accretion of different pools of organic particles that have been subjected to and/or synthesized in different environments prior to accretion. Turbulent motion [5] of particles in the protosolar nebula could have gathered together these particles. As shown by the D/H ratio [4], some organic particles have been exposed to the outer irradiated areas of the solar system, whereas the others remained in the neutral mid-plane. Synthetic processes specific to some regions (like ion/molecule reactions in the irradiated areas) may also result in different elemental compositions. Another possibility is that the organic precursors (CH<sub>4</sub>, HCN . . . ) were heterogeneously distributed in the protosolar nebula, leading to the synthesis of different macromolecules depending on the location.

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**CONTROLS ON HIGHLY SIDEROPHILE ELEMENT CONCENTRATIONS IN MARTIAN BASALT: SULFIDE SATURATION AND UNDER-SATURATION**

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**Introduction:** Highly siderophile elements (HSE; Re, Au and the platinum group elements) in shergottites exhibit a wide range from very high, similar to the terrestrial mantle, to very low, similar to sulfide saturated mid ocean ridge basalt (e.g., [1]). This large range has been difficult to explain without good constraints on sulfide saturation or under-saturation [2]. A new model for prediction of sulfide saturation places new constraints on this problem [3].

**Shergottite Data:** For primitive shergottites, pressure and temperature estimates are between 1.2–1.5 GPa, and 1350–1470 C [4]. The range of oxygen fugacities is from FMQ-2 to IW, where the amount of Fe<sub>2</sub>O<sub>3</sub> is low and thus does not have a significant effect on the S saturation values. Finally, the bulk compositions of shergottites have been reported in many recent studies (e.g., [5]). All of this information will be used to test whether shergottites are sulfide saturated [3].

**Modeling Values and Results:** The database for HSE partition coefficients has been growing with many new data for silicates and oxides [6–8] to complement a large sulfide database [9–11]. Combining these data with simple batch melting models allows HSE contents of mantle melts to be estimated for sulfide-bearing vs. sulfide-free mantle. Combining such models with fractional crystallization modeling (e.g., [12]) allows HSE contents of more evolved liquids to be modeled. Most primitive shergottites have high HSE contents (and low S contents) that can be explained by sulfide under-saturated melting of the mantle. An exception is Dhofar 019 which has high S contents and very low HSE contents suggesting sulfide saturation. Most evolved basaltic shergottites have lower S contents than saturation, and intermediate HSE contents that can be explained by olivine, pyroxene, and chromite fractionation. An exception is EET A79001 lithology B, which has very low HSE contents and S contents higher than sulfide saturation values – evidence for sulfide saturation during late fractional crystallization. These results show that shergottite HSE contents are controlled by silicates, oxides, and sulfides. In addition, the mantle producing the most primitive shergottites did not contain near chondritic relative ratios of the HSEs like the terrestrial mantle, and did not experience a late chondritic veneer.

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