

Hybridized mantle sources of shergottites and ALH 84001

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Shergottite source ¹⁷⁶Lu/¹⁷⁷Hf and ¹⁴⁷Sm/¹⁴⁴Nd ratios span a range of 0.028 – 0.052 and 0.18 – 0.28 [e.g. 1-5], respectively, reflecting variable mixtures of enriched and depleted mantle source components. Source ¹⁷⁶Lu/¹⁷⁷Hf and ¹⁴⁷Sm/¹⁴⁴Nd ratios of ALH 84001 (ALH), calculated for the measured Lu-Hf age of 4.091 Ga, are 0.018 and 0.172, respectively [2]. Although ALH is distinct both in age and lithology, it's source is derived from a mixture of the same depleted and enriched components that produced the shergottites indicating that these same or similar mantle source materials produced magmas for nearly 4 billion years [2]. Furthermore, calculated source compositions of ALH indicate that it is derived from a source that has the highest proportion of the enriched component relative to recognized shergottites, thus better constraining the composition of this end-member.

To explain the formation of the mantle sources, we adopted a magma ocean crystallization model of [4]. The cumulate phases and trapped liquid in equilibrium with cumulate phases of the 200-750 km deep crystallizing section correspond to the depleted and enriched mantle components, respectively. This hybridized mantle source model does not require very late stage residual liquids after magma ocean crystallization (perhaps similar to lunar KREEP basalt sources) nor assimilated crustal components as an enriched end-member lithology.

Based on this magma ocean crystallization model and the ¹⁴²Nd/¹⁴⁴Nd – ¹⁴³Nd/¹⁴⁴Nd isotope systematics of shergottites and ALH [5], the average ¹⁴⁷Sm/¹⁴⁴Nd ratio of their integrated mantle source is ~0.225. It is important to note that this modeled mantle source represents only about 30% of the silicate portion of the planet making constraints on bulk-planet Sm/Nd ratios difficult. It is possible that primordial crust and uppermost mantle that developed during the last stages of magma ocean crystallization may account for the enriched component not sampled during partial melting of shergottite sources.

[1] Borg & Draper (2003) *MAPS* **38**, 1713–1731. [2] Lapen *et al.* (In Review). [3] Borg L. *et al.* (2003) *GCA* **67**, 3519–3536. [4] Debaille V. *et al.* (2008) *EPSL* **269**, 186–199. [5] Debaille V. *et al.* (2007) *Nature* **22**, 525–528.

Mechanisms influencing hydrate dissolution rates in undersaturated systems: Lessons from field observations and laboratory results

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Methane is a potent greenhouse gas, twenty times more infrared-active than CO₂, and an important energy source. For these reasons, methane hydrate, one of the largest potential reservoirs of methane on earth, is of considerable interest to scientists and industry alike. In particular, questions relating to the stability of methane hydrate are becoming more important as concern about the release of methane into overlying ocean (and eventually the atmosphere) and interest in the recovery of methane from this resource increase. Hydrates are stable under predictable temperature, pressure, and salinities under methane saturated conditions. When conditions are not favourable, methane hydrate should dissociate or dissolve into the surrounding water. Measurements made *in situ* of shallow buried hydrates indicate that surrounding waters are not methane-saturated. Although undersaturated conditions should favor rapid dissolution of the hydrate, observations indicate little apparent change in these formations over years. We are interested in examining the factors that contribute to hydrate stability in natural conditions allowing them to persist in undersaturated environments. We hypothesized that the presence of mixed-gas hydrates may be stabilizing these structures. To test this, we used laboratory measurements of methane concentration gradients near artificial hydrate to evaluate the dissolution rates of mixed-gas hydrate and pure methane hydrate. Our second hypothesis was that the presence of microbial biofilms or oil may be slowing methane hydrate dissolution in natural environments by increasing the boundary layer. We will present the results of our mixed-gas and methane hydrate dissolution rate observations and report on experiments examining the influence of protective oils on artificial hydrate stability.