Baffin Island picrites contain normal terrestrial ^{142}Nd/^{144}Nd: Implications for the source of high ^{3}He/^{4}He in deep Earth

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The short-lived ($t_{1/2}$ = 103 My) radiogenic isotope system ^{146}Sm-^{142}Nd has been used to infer early differentiation of the Earth. Compared to chondrites, most terrestrial rocks are enriched in ^{142}Nd by about 20 ppm. One explanation for this is that bulk Earth did not start off with a chondritic Sm/Nd. However, the magnitude of the enrichment requires bulk Earth Sm/Nd beyond the range observed in chondrites. An alternative explanation is that the Earth experienced differentiation during the lifetime of ^{146}Sm that isolated a complementary low Sm/Nd reservoir (the early enriched reservoir (EER)) which is able to balance the apparent ^{142}Nd excess. Thus, in a chondritic bulk Earth, non-chondritic ^{142}Nd/^{144}Nd signatures require that early enriched and early depleted reservoirs separated from the primitive undifferentiated mantle. The highest ^{3}He/^{4}He in basalts is conventionally interpreted as requiring the existence of a mantle reservoir that has been convectively isolated for over 3 billion years, and it has previously been proposed that the EER might be the source of elevated ^{3}He/^{4}He in the deep Earth. As there is uncertainty about the relative partition coefficients of U and He there is the possibility that high ^{3}He/^{4}He may also be hosted in the early depleted reservoir (EDR). Here we present ^{142}Nd/^{144}Nd for a suite of proto-Iceland plume picrites from Baffin Island that have the highest mantle ^{3}He/^{4}He (c. 50 R_a) yet measured. For all samples ^{142}Nd/^{144}Nd is identical, within analytical precision, to the terrestrial standard giving a mean ε^{142}Nd value of -0.03 ± 0.05 (n = 11). Thus, the high ^{3}He/^{4}He source has a super-chondritic ^{142}Nd/^{144}Nd signature which does not appear to be derived from primitive undifferentiated mantle. The data are consistent with the addition of primordial He into the Icelandic plume source which contains modern ^{142}Nd/^{144}Nd values.

The effect of mineral surface geometries on the structure of interfacial water

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Water plays a crucial rôle in many geological, physical, biological and chemical processes, which practically always occur at surfaces and interfaces rather than in the bulk material. For example, water-rock interactions in geochemistry, cross-membrane transport in cell biology, heterogeneous catalytic reactions, the application of chemical sensors and the removal of contaminants in wet chemical cleaning processes all involve surface-mediated processes, and the solid-water interface is hence an important field of research.

In view of the importance of mineral surfaces, in this study we have applied classical Molecular Dynamics simulations to explore the effect of the surface geometries of a number of important minerals on the structure and properties of interfacial water. Whereas some highly regular surfaces, such as the MgO (001) and alpha-quartz (0001) surfaces significantly affect the structure of the interfacial water up to several nanometers away from the surface, showing a clear layering effect, more complex surface geometries influence the structure of the interfacial water to a much lesser extent. This may be due to the irregularity of the actual surface geometry, as exemplified by the introduction of steps on the MgO (001) surface, or the greater complexity of the crystal structure, shown by hydroxy-apatite Ca_{10} $(PO_4)_6$ $(OH)_2$, where the interfacial water shows no regular adsorption pattern at the surface, although the coordination of the water molecules to the surface sites is found to be very similar to the hydration shell of the free Ca, PO_4 and OH ions in solution. Chemisorbed surface water is also found to affect strongly any structuring of the interfacial water layer, which suggests that the structure of near-surface water would be pH dependent.

Finally, we have investigated the adsorption from solution of a number of organic molecules – growth modifyers and peptides – onto different hydroxyapatite surfaces, where the competition of pre-adsorbed water at the mineral surface sites significantly affects both the configurations and energies of adsorption of the organic molecules.