Accretion and differentiation processes in the ureilite parent body

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Ureilite are carbon-rich meteorites which provide a wealth of information about early Solar System processes. The ureilite parent body (UPB) accreted from a carbon-rich precursor, but our new step-combustion $\delta^{13}C$ and $\delta^{15}N$ values for pristine ureilite samples strongly support the suggestion [1] that this precursor was not a known type of carbon-rich chondrite. A strong correlation between Fo in olivine and $\delta^{18}O$ is interpreted to result from heterogeneous accretionary mixing between two nebula-derived end-member compositions.

Heat derived from decay of short-lived radioactive isotopes caused the UPB to heat up and to differentiate into an metallic partial melt and silicate mantle. Little evidence of the metallic partial melt remains, other than frozen Fe-Ni metal droplets in some ureilites [2]. These metal droplets often contain Si, indicating extremely reducing conditions [3]. Depletion in Ge, As, Au, Pd, Ni, and enrichment in Ir, Os, Re [4], suggest that these metals may be restites from core formation.

LREE-depletion of the residual silicate mantle, together with silicate melt droplets, melt inclusions, and pyroxene-rich mantle lithologies, suggests that the UPB mantle underwent partial melting to form basaltic magmas. However, the UPB did not heat up sufficiently to reach a magma ocean stage and hence did not homogenize in terms of its mg# and $\delta^{18}O$ [5].

While it was undergoing heating and partial melting, the UPB was disrupted by a major impact. Graphite was transformed to diamond by this event [6]. Following this disruption, a single daughter rubble-pile asteroid formed by reaccretion [7]. This body is sampled by present-day ureilites, providing a fossilised example of early asteroidal accretion and differentiation processes.

[1] Warren (2011) *GCA* **75**, 6912-6926. [2] Herrin *et al*.. (2007) *LPSC*, Abst 3345. [3] Smith *et al*. (2010) 73rd Ann Met Soc Meeting, Abst 5221. [4] Herrin *et al*.., (2008) 71st Ann Met Soc Meeting, Abst 5327. [5] Downes *et al*. (2008) *GCA* **72**, 4825-4844. [6] Ross *et al*.. (2011) MAPS 46, 835-849. [7] Herrin *et al*. (2010) MAPS 45, 1789-1803.

Iron and manganese reduction and associated phosphorus release in coastal Baltic Sea sediment

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The long-term release of phosphorus from sediments is considered the central problem for eutrophication of the Baltic Sea. In this study the sedimentary pools and long-term release rates of sediment-bound phosphorus were assessed in relation to iron and manganese reduction rates in the topmost 8 cm of coastal Baltic Sea sediment. We report porewater and solid-phase data of dissolved iron, manganese, inorganic and organic phosphorus from sediment from a near-shore station on the Eastern Swedish coast of the central Baltic with oxygenated bottom water. Rates of iron and manganese reduction were determined from porewater gradients and from anaerobic bag incubations at in-situ temperatures. Anaerobic bag incubation experiments were conducted over 33 days to quantify the changes in pool size of reactive Fe and Mn and phosphorus (ascorbic acid-extractable, citric-acid dithionite extractable, and oxalate-extractable) fractions.

The data indicate high initial rates of iron reduction in the topmost 5 cm, which decreased substantially after 18 days. Manganese reduction rates were insignificant below 1 cm depth. Rates of iron reduction were highest between 1 and 2 cm depth and decreased sixfold to 5 cm depth. Ascorbic acid extractable iron comprised about 50% of the total reactive iron in the topmost cm of sediment and decreased linearly over time. There was a pronounced lag effect of 8 days between the disappearance of reactive iron compounds and the increase in free dissolved iron and phosphorus in the topmost cm of sediment suggesting an intermediate accumulation of an iron-phosphorus complex that was not accessible to the extractions and spectrophotometric analytical methods employed here. Possibly phosphorus accumulated as an iron polyphosphate complex that was subsequently broken down under more reducing conditions. Operationally defined dissolved organic phosphorus (DOP) comprised 50% of the total dissolved phosphorus in the topmost cm of sediment. The initial rates of DOP and DIP release were equal in the topmost two centimeters, but DOP accumulation was significantly slower below 3 cm depth consistent with lower overall carbon degradation rates at depth. These data provide new quantitative constraints on the pool size and rates of phosphorus release from sediments and will improve our predictions of long-term eutrophication effects in the Baltic Sea.

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