Dissolved ultra-trace REE+Y geochemistry of particulate-poor Icelandic river waters

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Knowledge of the dissolved flux from mafic rock weathering is important to better detecting and understanding its role for climate change and nutrient delivery to the oceans through deep geological time. The diminishing proportion of exposed mafic rock at the surface is known [1], but reconstructing the soluble riverine flux from weathering mafic rock remains challenging. It is either inferred from chemical sedimentary rocks, or approximated from modern dissolved river water data. However, REE+Y data from mafic rock catchments are too limited at present to use these elements as a proxy.

Here, the dissolved REE+Y in the ≤0.22 µm fraction of ~50 samples are reported for young streams and rivers, ponds and lakes, and snow melt from Iceland. Concentrations were determined with a direct-measurement quadrupole ICP-MS method. Samples represent three basaltic catchments, with emphasis on the rift zone containing high-Mg tholeiites and in areas with poor soil development (e.g., leptosols) where waters are inferred to capture incipient chemical weathering signatures. This choice was informed by the lack of plant cover during most of geological history and the observation of higher Mg content in ancient basalt. The REE+Y concentrations are ultra-low, in some cases close to the procedural blank. River and stream ΣREE+Y (n=39) range from 4 to 400 pg/g with highest concentrations near geothermally active areas. Upper continental crust normalized REE patterns remain coherent until <8 pg/g, at which point more analytical scatter, especially in the HREE, appears. The river and stream samples show prominent LREE/HREE depletion (mean±1s Pr_n/Yb_n: 0.35±0.07), positive Y (mean Y/Ho: 31.5±1.8), and consistently negative Ce anomalies, and suggest predominance of inorganic REE complexes (e.g., with CO_3^{2-}).

The REE+Y patterns are proposed to represent a basalt weathering flux proxy that can be used to model the effects of decreasing subaerial exposure of mafic rocks with time [1].

[1] Condie, K.C., 1993. Chemical composition and evolution of the upper continental crust: Contrasting results from surface samples and shales. Chem. Geol. 104: 1-37.