New approaches to analyze the preferential loss of elements from the continental crust

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Lithological information can be combined with geochemical data to estimate differences between the terrestrial surface and the upper continental crust[1]. In addition, lithological characteristics influence the evolution of the continental crust and its differentiation because they control global chemical weathering. The preferential depletion of elements of the terrestrial surface by chemical weathering can be estimated spatially explicitly using information on lithology, climate and further Earth surface properties[2].

Application of models based on recent available geodata suggest that a large proportion of land-ocean dissolved element fluxes originate from small, highly active areas, which represent only a minor part of the Earth's surface[3]. It is found that the accurate quantification of the fluxes from these areas is crucial to explicate the influence of chemical weathering on the chemical differentiation of the upper continental crust. Specifically the estimation of land-ocean fluxes of Ca and Mg relies on adequate lithological information. To represent relevant, but small areas adequately at the global scale, new global geodata, like improved lithological maps (e.g. the global lithological map, GLiM), are needed. GLiM consists of more than one million polygons, assembled from more than 65 geological maps. In combination with recently developed weathering models it can be used to quantify the preferential loss of elements from the surface of the upper continental crust.

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Influence of soil shielding on local to global chemical weathering rates

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Chemical rock weathering rates vary spatially, following lithological and hydroclimatic patterns, which have been identified as important controls on chemical weathering rates at the local to global scale. Chemical weathering rates of tropical-continental or permafrost regions can, for comparable runoff and lithological conditions, be lower than than those of island arcs with relatively young rocks and/or "young" terrestrial surfaces.

One of the factors leading to a decrease in chemical weathering rate is the shielding effect of deeply weathered soils above the bedrock [1]. Further, permafrost- or peatland-areas can shield the underlaying bedrock, leading to lower weathering rates if compared to those of island arcs like the Japanese Archipelago.

To quantify this shielding effect at the local to global scale, multi-lithological weathering-functions [2] were applied to river catchments in tropical and permafrost regions. Some of these regions were proposed to yield high chemical weathering fluxes [3].

For comparable lithologies and runoff conditions a reduction of chemical weathering rates by ~50% relative to the weathering rates of island arc regions was identified for certain soil types overlaying the bedrock (Gleysols, Histosols, and deeply weathered tropical soils like Ferrasols). A large regional variability of the reduction factor can be observed.

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