Geophysical Research Abstracts
Vol. 20, EGU2018-2094, 2018
EGU General Assembly 2018
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Novel proxy for regional terrigenous denudation extracted from deep-marine clays based on meteoric 10Be/9Be- A feasibility study

Anne Bernhardt (1), Marcus Oelze (2), Friedhelm von Blanckenburg (2), Julien Bouchez (3), Mahyar Mohtadi (4), and Hella Wittmann (2)

(1) Freie Universität Berlin, Institute of Geological Sciences, Berlin, Germany (anne.bernhardt@fu-berlin.de), (2) Helmholtz Centre Potsdam, GFZ German Research Centre for Geosciences, Potsdam, Germany, (3) Institut de Physique du Globe de Paris, 1 rue Jussieu, 75238 Paris 05, France, (4) MARUM-Center for Marine Environmental Sciences, Bremen University, Bremen, Germany

Marine sediments provide continuous archives of the sedimentary flux from the continents to the world's oceans. Developing quantitative tools to reconstruct the history of continental erosion from marine archives is hence paramount for deciphering feedbacks between climate, tectonics, erosion, and weathering. Cosmogenic nuclides provide such a tool, but so-called in situ-produced nuclides (10Be, 26Al) necessitate the presence of abundant quartz minerals in the sedimentary archive, a prerequisite that is in most cases not met. The ratio of meteoric cosmogenic 10Be to its stable counterpart 9Be (10Be/9Be) in contrast can be measured on fine-grained sediment and has recently been established as a quantitative proxy for terrestrial weathering and denudation, solving former restrictive issues of grain size and retentivity. In principle, after meteoric 10Be reaches the Earth surface, it mixes in soil solutions with 9Be released by mineral weathering and is partly incorporated into the secondary "reactive" phase of Mn-Fe-(hydr-)-oxides and into clay-mineral precipitates. Applying this system in the marine realm is however challenging because 10Be/9Be ratios of the reactive phase are dominated by 10Be that reaches the ocean from direct atmospheric deposition and thus overprints terrestrially-derived reactive 10Be/9Be signal.
In this feasibility study, we explore if the 10Be/9Be recorded in the mineral lattice of terrigenous authigenic clays during their precipitation from soil solutions yields information about terrestrial denudation rates. We successively leached marine sediment to remove organic content, carbonate, biogenic opal and the reactive phase and finally separated terrigenous clays from the silicate residual. We compared the obtained 10Be/9Be signal to that of residual fluvial clays that were separated using identical procedures from sediment sampled from onshore fluvial catchments feeding the marine realm.
This first test of using the 10Be/9Be ratio in terrigenous clays of marine surface sediments as a regional denudation proxy shows promising results. The 10Be/9Be ratios of isolated clays extracted from marine surface sediment marine clays are within a factor of 4 of those measured on clays from fluvial sediment. The difference may suggest incorporation of oceanic 10Be in the clay lattice in addition to terrestrially-derived 10Be but this may also well just reflect the high natural variability of 10Be in soil profiles and fluvial systems. Hence, we conclude that this novel proxy bears interesting potential for quantifying denudation rates from rapidly eroding and quartz-devoid terranes.