Meteoric 10Be/9Be- new avenues for quantifying weathering and erosion in mafic and carbonate lithologies

Hella Wittmann*[1], Adrien Folch[1], Nicholas Iff[2], Chiara Bazzucchi , Christoph Gruetzner[3], Julien Bouchez[4], Anne Bernhardt[2], and Friedhelm Von Blanckenburg[2]

[1]Helmholtz Centre for Geosciences GFZ – Germany
[2]Freie Universität Berlin – Germany
[3]Universität Jena – Germany
[4]Institut de Physique du Globe de Paris – External envelopes geochemistry – France

Abstract

The chemical weathering of rocks is a major regulator of atmospheric CO2 and plays a crucial role in the long-term regulation of Earth's climate. Basalt rocks weather efficiently and withdraw CO2 over geological timescales. Although carbonate rocks do not exert a long-term control on atmospheric CO2, their rapid dissolution kinetics make carbonate weathering sensitive to anthropogenic climate change and associated shifts in vegetation.
Quantifying denudation and weathering rates in basalt and carbonates has relied in the past on decadal-scale dissolved river gauging or, where suitable target minerals such as quartz, calcite, magnetite or olivine are present, on traditional in-situ cosmogenic nculide methods. Meteoric 10Be/9Be is a mineral-independent method, as it is measured in secondary iron-oxy(hydroxide) phases adsorbed to any fine-grained sediment. This provides a major advantage for quantifying millennial-scale denudation and weathering rates in basaltic and carbonate landscapes.

We show the versatility of the 10Be/9Be system across several case studies spanning temperate to tropical climate zones. In mafic terrains, we document the high efficiency of basalt weathering. In a pure carbonate setting, we explore the influence of vegetation and deep weathering on denudation, while in a mixed carbonate-siliciclastic landscape, we investigate how selective mineral dissolution affects the 10Be/9Be system.
Across all investigated settings, 10Be/9Be-derived rates are very similar to both decadal-scale rates from river gauging and in situ-denudation rates over a wide range of tectonic settings, soil thicknesses, and climate conditions. This consistency underscores the substantial utility of this method for quantifying Earth surface processes.

Keywords: meteoric 10Be, denudation, weathering

*Speaker