Geophysical Research Abstracts
Vol. 19, EGU2017-12047, 2017
EGU General Assembly 2017

The past 1-Myr of erosion in Fennoscandia via inverse modelling with CNs

John Jansen (1), Mads Knudsen (1), David Egholm (1), Jane Andersen (1), Bo Jacobsen (1), and Jakob Heyman (2)

(1) Dept of Geoscience, Aarhus University, Aarhus, Denmark, (2) Dept of Earth Sciences, University of Gothenburg, Gothenburg, Sweden

Cosmogenic nuclide (CN) abundances at Earth's surface reflect the balance of accumulation during intervals of cosmic-ray exposure and loss via erosion and radioactive decay. Analyses of remnant CN inventories accumulated prior to the last glaciation (viz, CN inheritance) have granted valuable insights to the erosional legacy of polythermal ice masses. Simple exposure ages that match the timing of deglaciation imply >2–3 m of subglacial erosion via warm-based ice, whereas significant CN inheritance implies minimal erosion due to the development of frozen-bed patches. By comparing a compilation of simple 10Be bedrock exposure ages (n=355) to a recently published deglaciation chronology of Fennoscandia (±0.5 kyr) we find that 54% of samples contain appreciable (>2σ) CN inheritance, whereas just 7% of samples contain zero (>2σ) inheritance.

With the aim of extracting deeper landscape history information from inherited CNs, we devised a Markov Chain Monte Carlo (MCMC) inverse approach that matches present-day CN (10Be-26Al) abundances with the most probable permutation of exposure history and erosion rates over multiple glacial and interglacial periods. Shifts in ice cover (and therefore cosmic-ray exposure) over successive glacial cycles are simulated via a free parameter threshold applied to a benthic δ18O record. Our MCMC model yields two key outputs integrated over the past 1-Myr: mean erosion (denudation) rate, and the ratio of burial to exposure. In addition, we propose a new measure of surface erosion history termed the 10Be-memory: the time since 1–1/e (~63%) of 10Be atoms were accumulated, which effectively marks the starting point for landscape history recorded by 10Be. We apply our MCMC model to a subset (n=72) of Fennoscandian CN data spanning four bedrock landscape types: tors, blockfields, glacial troughs, and areally-scoured terrain.

Our preliminary results (given as 1st–3rd quartile ranges) reveal that median erosion rates among all four landscape types overlap considerably at the lower-end of the spectrum: tors 1.5–3.0 m/Myr; blockfields 3.0–7.3 m/Myr; glacial troughs 8.8–12 m/Myr; and areally-scoured terrain 7.2–21 m/Myr. The data as a whole suggest that roughly one-quarter (233–292 kyr) of the past million years was ice-free. The 10Be-memory among each of the landscape types also shows considerable overlap: tors 213–350 kyr; blockfields 109–212 kyr; glacial troughs 10–119 kyr; and areally-scoured terrain 9–84 kyr. All landscape types include at least one sample with 10Be-memory >300 kyr, and tors and blockfields both include sites with the maximum recorded 10Be-memory ~400 kyr.

A few outliers in our dataset indicate erosion during the last glaciation, but the majority of our results reveal remarkably similar histories of erosion across the four landscape types over the past 1-Myr. This is unexpected and suggests that present-day landscape morphology is an imperfect guide to the deeper history of glacial erosion. Spatial patterns of subglacial thermal regime interpreted from the products of the last glaciation in Fennoscandia are apparently not representative of those earlier.