Geophysical Research Abstracts
Vol. 20, EGU2018-15178, 2018
EGU General Assembly 2018

What is the best strategie to invert the basin average denudation rates from the cosmogenic concentration measured in sediments ?

Julien Charreau (1), Pierre-Henri Blard (1), Jéna Zumaque (1), and Léo C.P. Martin (2)
(1) CRPG, Université de Lorraine, (2) Department of Geosciences, University of Oslo

Denudation is a critical parameter controlling the evolution of landscape, mountain building and climate. It can be estimated at the basin scale from the concentration of terrestrial cosmogenic nuclides (TCN) measured in sediments collected at the outlet of the rivers. However, the calculation of the denudation rate from the measured concentration is theoretically impossible because the attenuation length of muons in the rocks and the equivalent time of exposure throughout the basin are both function of the denudation itself. To overcome these issues two different methods are possible. The first method assumes the attenuation length of muon as constant and neglects the time variations of the earth magnetic field. The denudation is hence directly inverted from the measured concentrations. The second method accepts variable attenuation lengths of muons and can correct the production rates for magnetic changes. It must assume homogeneous denudation rates throughout the basin. The cosmogenic concentration is calculated based on an a piori known denudation rate which is then adjusted iteratively in order to minimize the mismatch between the measured and the calculated concentration. Both methods require a rigorous calculation of the cosmogenic production rates at the basin scale which can be estimated using two main scaling models (Lal/Stone and LSD) that may differ by up to 30% in some regions. To investigates the ability of the two methods to invert the true denudation rates and the sensitivity of the results to the scaling models we analysed several natural basins where the denudations rates have been imposed as a linear function of the slopes and the cosmogenic concentrations calculated accordingly. The denudation rates were then inverted from the calculated basin average concentration using the two methods and scaling models and finally were compared to the theoretical true values.
We found that neglecting the variations of attenuation length of muons in the rocks has little impact on the derived denudation. The iterative method yields systematically to larger discrepancy from the reference denudation values even if the time is integrated. Moreover this method is yet computationally very long especially if the scaling factors are calculated using the LSD model to account for time variations of the magnetic field.
Based on these results we develop and describe new ArcGIS® and QGIS toolboxes. They include a first tool which computes the basin average scaling factors and 10Be cosmogenic production rates according. They averages the cell-by-cell local scaling factors and 10Be production rates calculated following the Lal/Stone or LSD schemes. They can calculate automatically and in few minutes these average parameters on several tens of drainage basins together. They also provides several optional tools to correct for topographic shielding, ice cover and lithology. We also developed an original approach to correct the 10Be cosmogenic rates for past variations in the Earth's magnetic field. A second tool computes the 10Be basin average denudation rates based on the 10Be cosmogenic production rates and includes both the spallogenic and the muonic productions.