4.5.45

High elevation cosmogenic ^{3}He production rates (Central Nepal) determined from ^{10}Be cross-calibration

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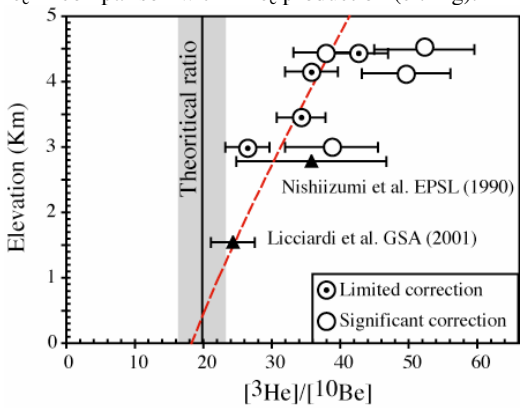
In the framework of a more general study of erosion rates in the Himalayas, we have developed the measurement and use of cosmogenic ^{3}He ($^{3}He_c$) in garnets from glacial polished surfaces and moraines in the Narayani basin, Central Nepal. As a reference we also measured $^{10}Be_c$ in coexisting quartz from the same samples. $^{3}He_c$ concentrations have been derived from helium measured in garnet, corrected for inherited ^{3}He. After corrections, $^{3}He_c$ and $^{10}Be_c$ concentrations display a good linear correlation, which supports the validity of applied corrections for inherited components.

However, beside the correlation of cosmonucleides concentrations with relative chronology of glacial events, the exposure ages derived from $^{3}He_c$ are roughly two times higher than those derived from $^{10}Be_c$ (from < 500 yr to ~5000 yr) when using the classical production rates and scaling factors. He and Be measurements have been checked for possible analytical bias by cross-measurement with the ETH Noble Gas Lab (Zurich) and by independant ^{14}C dating. We propose to explain this $^{3}He_c$ and $^{10}Be_c$ age difference by an underestimated production rate of $^{3}He_c$ at high altitude. Indeed our results show an altitudinal dependent exess of production of $^{3}He_c$ in comparison with $^{10}Be_c$ production (cf. Fig).



The apparent atmospheric attenuation length necessary to fit these data between 3000 and 5000 m is about 100-116g/cm^2 which is strongly less than the one used in common scaling procedures.

4.5.46

Controls on chemical weathering rates of carbonates: Clues from the Jura Mountains

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At the surface of the Earth, the majority of carbon is stored as carbonates. The amount of C stored in carbonates is 100,000 times larger than the amount of C present in the atmosphere. As a consequence, even small imbalances in the carbonate cycle at the surface of the Earth can have important consequences on the level of CO_2 in the atmosphere. Our goal is to better constrain the rates and controlling parameters of present day carbonate weathering.

As a first step, we sampled the main springs and rivers from the Jura Mountains, France. This area offers the possibility to test the influence of parameters such as temperature, runoff and vegetation on carbonate alteration within a limited area comprised solely of pure limestone terranes. From West to East, as a function of elevation, there are steep gradients in temperature, precipitation and vegetation, while the geology does not change too much. Plain regions have mean temperature and runoff values close to 11°C and 400 mm/yr, respectively, while mountainous regions are characterized by mean temperature and runoff values of 4 °C and 1500 mm/yr, respectively.

Ca^{2+} and HCO_3^- concentrations of the water samples vary significantly with temperature, elevation and runoff. Concentrations decrease by a factor 2 between 280 and 1000 m altitude. Following the same trend, the concentrations also decrease with increasing runoff, but the observed variation cannot be attributed to dilution effects as all rivers and springs are oversaturated with calcite. Moreover, the obtained temperature-concentration correlation is in contradiction with thermodynamic modeling which predicts the opposite. The only parameter that can explain observed concentrations is a drop in soil pCO_2 between plains and mountains. pCO_2 is up to 100 times higher in soils than in the atmosphere and it is directly linked with vegetation and biological activity, which decreases with decreasing temperature.

The calculated weathering rates of carbonates range from 140 to 380 t/km^2/yr (70 to 190 mm/1000 yr) with a mean value of 200 t/km^2/yr (100 mm/1000 yr) for the Doubs river. The Doubs river is taken as the reference average because it drains the entire French Jura mountains. This value corresponds to a CO_2 consumption of some 1900.10^3 mol/km^2/yr by carbonate weathering. This result is 4 to 5 times higher than that for Seine river system in France, and 2.5 times higher than the estimated world average for temperate climate. We suggest that this difference results from the high amount of runoff in this region.