Geophysical Research Abstracts
Vol. 16, EGU2014-9714-1, 2014
EGU General Assembly 2014
© Author(s) 2014. CC Attribution 3.0 License.

Chemical weathering in response to tectonic uplift and denudation rate in a semi-arid environment, southeast Spain

Yolanda Ameijeiras-Mariño (1), Sophie Opfergelt (1), Jérôme Schoonejans (2), Veerle Vanacker (2), Philippe Sonnet (1), and Pierre Delmelle (1)

(1) Earth and Life Institute, Environmental Sciences, Université catholique Louvain, Croix du Sud 2 bte L7.05.10, 1348 Louvain-la-Neuve (yolanda.ameijeiras@uclouvain.be, sophie.opfergelt@uclouvain.be, philippe.sonnet@uclouvain.be. pierre.delmelle@uclouvain.be), (2) Earth and Life Institute, George Lemaître Center for Earth and Climate Research, Université catholique Louvain, 3 Place Louis Pasteur, 1348 Louvain-la-Neuve (jerome.schoonejans@uclouvain.be, veerle.vanacker@uclouvain.be)

Soil thickness reflects the balance between soil production and denudation by chemical weathering and physical erosion. At topographic steady state, the soil weathering intensity is expected to be higher at low denudation rate (transport-limited) than at high denudation rate (weathering-limited). We tested this hypothesis for the first time in a semi-arid environment where chemical weathering processes are generally slow.

The study site is the Internal Zone of the Betic Cordillera in Southeast Spain, Almeria province. The lithology is mainly mica-schist and quartzite with local presence of phyllite. Three catchments (EST, FIL, CAB) were selected upstream local faults along a gradient of increasing uplift rates (10-170 mm/kyr) and increasing denudation rates (20-250 mm/kyr), following the sequence EST<FIL<CAB. In each catchment, two soil profiles were sampled down to the bedrock. The presence of secondary pedogenic carbonates (in the CAB catchment) was taken into account to estimate soil weathering intensity.

Three independent indices were used to compare soil weathering intensity across the EST, FIL and CAB catchments: the Total Reserve in Bases (TRB = [Ca2+] + [Na+] + [K+] + [Mg2+]); the soil Fed/Fet ratio that reflects the formation of secondary Fe-oxides, and the Cation Exchange Capacity (CEC) that varies with the amount of secondary clay minerals and organic matter. The difference in TRB between the soil and the bedrock (ΔTRB = TRB soil - TRB bedrock) should be more negative as weathering increases, whereas the Fed/Fet ratio is expected to augment with the intensity of weathering. Since these soils have low organic carbon content, the CEC should increase with weathering degree.

Our results indicate that the ΔTRB (cmolc.kg-1) is -8$\pm$14 (n=8), -79$\pm$2 (n=8) and -51$\pm$38 (n=9) for CAB, FIL and EST, respectively. The Fed/Fet ratio for CAB, FIL and EST is 0.20$\pm$0.05 (n=8), 0.20$\pm$0.03 (n=8) and 0.29$\pm$0.05 (n=9), respectively. The CEC (cmolc.kg-1) increases from 3.3$\pm$1.7 (n=8) to 8.2$\pm$1.3 (n=8) and 10.4$\pm$3.0 (n=9) from CAB to FIL and EST.

Based on the CEC, and to a lesser extent the ΔTRB values, the soils from the CAB catchment appear less weathered than those from the two other catchments. However, using the Fed/Fet ratio, both CAB and FIL soils seem less weathered than EST. Overall, the intensity of soil weathering tends to increase from CAB to EST.

Given that the uplift and denudation rates increase from EST to CAB, these results support the hypothesis that a stronger uplift and denudation rate result in a less intense chemical weathering in soils in this semi-arid environment. Mineralogical investigations on the clay fraction are in progress to better constrain the secondary products of chemical weathering in these soils.