Geophysical Research Abstracts
Vol. 13, EGU2011-8782, 2011
EGU General Assembly 2011

Weathering flux sensitivity to short time scale climatic variability: out of steady-state modelling study (Mule Hole watershed, South India)

Aurélie Violette (1), Yves Goddéris (2), Jean-Christophe Maréchal (3), Jean Riotte (2,4), Muddu Sekhar (5), Jean-Jacques Braun (2,4)

(1) Ecolab, CNRS - Université Toulouse III- INP Toulouse, 31326 Castanet-Tolosan, France (aurelie.violette@lmtg.obs-mip.fr; aurelie.violette@ensat.fr), (2) GET, CNRS - Université Toulouse III - IRD, 31400 Toulouse, FRANCE, (3) BRGM, Service EAU, 34000 Montpellier, France, (4) Indo-French Cell for Water Sciences, IRD, Indian Institute for Science, 560 012 Bangalore, India, (5) Indian Institute of Science, Department of Civil Engineering, Bangalore 560 012, India

The current global climate change is expected to influence the SW monsoon rainfall system (Anderson et al., 02; Goswami et al., 06). This system drives the climate of the Peninsular India, with a steep climatic gradient from humid to semi-arid lying on the Karnataka plateau. The small Mule Hole watershed (4.3 km^2) is located in the sub-humid transition zone, particularly sensitive to climate variations (Braun et al., 09; Violette et al., 10a).
In a previous study (Violette et al., 10b), we investigated the weathering processes in the Mule Hole watershed and the transfer of chemical elements using a lumped hydrogeological model coupled with the geochemical model Witch (Goddéris et al., 06). Modelled weathering flux and groundwater contents in dissolved silica and major cations are in good agreement with the data from 2004 to 2006, with the notable exception of Na+. The Na+ flux and content are under-estimated as albite weathering is inhibited by the high silica content in soil solutions, supplied by smectite dissolution.
Annual precipitations of the three modelled years (1270 mm/yr) are similar to the mean precipitations of the last 25 years (1120 $\pm$ 250 mm/yr). Hence the hydrogeochemical system in Mule Hole watershed was assumed to be in equilibrium with the climate, as often in geochemical field studies. However, the years preceding the modelling period were particularly dry (700 mm/yr). Given the hydrological resilience of the watershed, the assumption of equilibrium between the hydrogeochemistry of the watershed and the current climate may not be true for the three modelled years. The watershed is probably relaxing its hydrological system following a transition from a dry to a more humid system. Several sets of atmospheric precipitation are used as forcing parameters of the hydrological model. They extend from half (635 mm/an) to twice (2540 mm/yr) the observed precipitation in the watershed, which represent a realistic range of the rainfall variability over the last century in the Mule Hole area (Climate Research Unit data, Norwich, UK). A first set of simulations are run until steady-state is reached and steady-state solutions are investigated (Eq solutions). But we also explored the numerical solutions just after the perturbation in the rainfall regime, and thus before equilibrium is reached (Non-Eq solutions). In Eq solutions, simulated weathering fluxes always increase with rainfall (for example 460 mol Si /ha/yr for the current climate, 600 mol/ha/yr for 1500 mm/yr of rainfall and 1300 mol/ha/yr for 2500 mm/yr). Most of the simulated weathering fluxes in Non-Eq solutions are even greater than those obtained in Eq solutions (for example 975 mol Si/ha/yr for 1500 mm/yr and up to 3400 mol Si/ha/yr for 2500 mm/yr). We found that our model is able to reproduce the weathering export of all the major cations, including Na+, only when the weathering flux are assumed to be out of steady-state with respect to the climatic conditions. This work highlights the need for considering out-of-equilibrium state when reconstructing the weathering budget of a watershed.
Anderson et al./ Science 297 (2002) 596-598. Braun et al./ Geochimica et Cosmochimica Acta 73 (2009) 935–961. Goddéris et al./ Geochimica et Cosmochimica Acta 70 (2006) 1128-1147. Goswami et al./ Science 314 (2006) 1442-1445. Violette et al./ Geochimica et Cosmochimica Acta 74 (2010a) 7059–7085. Violette et al./ Chemical Geology 277 (2010b) 42-60.