4.5.73

A comparison of the chemical weathering rates in the Caribbean Islands rivers derived from the U-decay series and from the major elements

S. RAD, J. GAILLARDET, G. MANHES, B. BOURDON AND C. ALLEGRE

IPGP, 4 place Jussieu, 75252 cedex 05, France (rad@ipgp.jussieu.fr)

The Caribbean Islands constitute a particularly interesting location for studying the denudation of volcanic arc relief. Guadeloupe and Martinique are characterised by a uniform andesitic lithology. They are located in a tropical climate with high temperatures (24 to 28°C), high precipitation and very dense vegetation. There are large variations in precipitation (1200 mm/year to 14000 mm/year), runoff (4600 mm/year on the east coast, 2500 mm/year in the west coast) and bedrock ages (0 to 5 Ma, north-south gradient) over short distances (<100 km). These variations influence the evolution of weathering rates from one basin to another.

We have sampled the main streams of Guadeloupe and Martinique for dissolved phase and sediments. The concentrations of dissolved elements in the rivers yield a mean chemical denudation rate of 39t/km^2/year and a mean associated atmospheric CO_2 consumption rate of 1.35 10^{6}mol/km2/year. Guadeloupe has a lower weathering rate than other basaltic islands with a similar climate such as Java. Paradoxically, weathering rates in Guadeloupe are closer to Iceland and Kamtchatka whose climate is much cooler (5°C and -5°C). This may be explained by very thick soils and the importance of rainwater infiltration that slows down the effect of runoff.

U-series have been analysed by TIMS in the sediments and in the dissolved phase in order to calculate chemical erosion rates more precisely. During alteration of the minerals U is soluble whereas Th is insoluble. The bedrock is assumed to be in secular equilibrium ((^{234}U/^{238}U) = 1) and chemical weathering induces fractionnation of U-decay series (e.g. (^{234}U/^{238}U) $\leq$ 1 in sediments and always > 1 in water of Caribbean rivers). The activity ratios of these radionuclides in sediments permit us to calculate the time that has passed since the beginning of the erosion. On the other hand, dissolved major elements provide us an instantaneous estimation of chemical weathering. We will compare the chemical weathering rates based on U-series nuclides with the measurements of the major elements provides a test of steady-state erosion models and allows us to evaluate time of sediment transfer from the island arcs to the ocean.

4.5.74

U-series in Icelandic rivers

N. VIGIER[1], K.W. BURTON[2], S.R. GISLASON[3], N.W. ROGERS[2] AND E. HODGE[4]

[1] CRPG, 15 rue ND des pauvres, 54501 Vandoeuvre les Nancy, France (nvigier@crpg.cnrs-nancy.fr)
[2] Earth Science Dept, the Open University, UK
[3] Science Institute, University of Iceland, Iceland
[4] School of Geographical Sciences, Univ. of Bristol, UK

Rivers carry the products of continental erosion as dissolved and solid species and therefore can provide information on mechanical and chemical erosion rates on a large scale. Nevertheless, the timescales over which these calculated erosion rates apply are still poorly known while it is essential when considering steady-state processes and estimating paleovariations of oceanic supplies.

U-series nuclides measured in rivers provide powerful tools for studying weathering timescales because of their short half-lives and of their contrasted mobility during weathering. Recently, models of particle continuous leaching have been developed and applied to a recently glaciated area in Canada [1], to a tropical tectonically stable area in the Deccan and to Amazonian basins [2]. Estimated weathering timescales for these sites are consistent and highlight the key roles of mechanical erosion rates and of the presence of ice sheets.

Here we present (^{234}U/^{238}U) and (^{238}U/^{230}Th) measured for the main Icelandic rivers. The dissolved phases are strongly enriched in ^{234}U relative to ^{238}U, in agreement with α–recoil effects, and in U relative to Th. By contrast, suspended particles and sands display activity ratios close to secular equilibrium value. These first results suggest that the timescales of basalt weathering in Iceland is extremely recent. For these monolithological basins, the roles of chemical erosion rates (inferred from TDS*$_{cat}$) and the percentage of glacier cover are explored (Fig. 1).

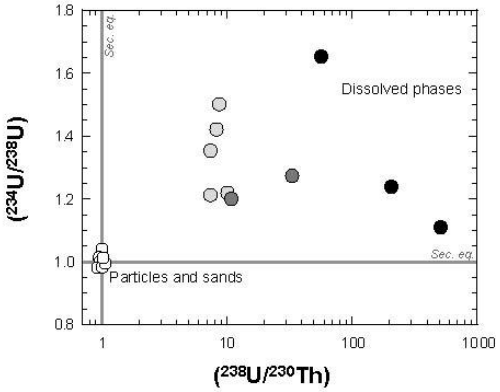

Fig. 1: (^{234}U/^{238}U) and (^{238}U/^{230}Th) measured for Icelandic rivers. Light grey circles indicate TDS*$_{cat}$ (TDS*$_{cat}$=sum of cations corrected from atm. inputs) ranging between 4 and 10mg.l^{-1}, dark grey circles between 10 and 15 mg.l^{-1} and black circles between 15 and 50mg.l^{-1}.