The role of basalt chemical weathering on the CO_2 cycle

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After discovering the role of runoff, T and physical erosion on chemical weathering, recent studies have shown the very important role of basalt weathering on the climate and CO_2 cycle. The aim of the presentation is to summarize the main existing arguments and to illustrate the effect of basalt's weathering.

Recent data have shown that chemical weathering of basalt is 5or 10 time more efficient than the weathering of acidic silica rocks (granite, gneiss).

Second, a simple law is propose by Dessert et al., (Chem.Geol.2002
$f_w = R_f \times 18.41 \exp(0.0553\ T)$ where f_w is the specific silicate weathering rate (t/km^2/yr) and. R_f is the runoff. This law is derived from compilation data of Iceland Reunion, Deccan, Java, Columbia, Massif Central (France) Cameroon, Parana, Sao miguel.
From these relationships and digital maps (temperature,runoff and surfaces of basalts), Dessert et al. (Earth; Planet. Sci. Lett. 188, 459-474 2002) have determined a CO_2 consumption rate of about 4.36 10^{12}mol/yr, that represents between 32% and 37% of the flux derived from continental silicate determined by Gaillardet et al. (chem. Geol. 159 3-30 1999). As a consequence, the volcanic activity acts not only as a major CO_2 source, but also creates strong CO_2 sinks which cannot be neglected when attempting to improve our understanding of the geochemical and climatic evolution of the Earth.

Another example of the role of basaltic chemical weathering comes from the modelling trap eruptions such as the Deccan traps (Dessert et al E.P.S.L 188, 459-474). Two main effects are observed: first global air temperature increases during the emission of CO_2 into the atmosphere, then global climate is getting cold after the eruption. In the case of Deccan traps the global cooling effect approaches 0.5°.

The succession of basaltic emplacements that occurred during the Cenozoic may explain at least part of the climatic cooling recorded over the same period. Model simulations investigating the possibility that sharp cooling or glacial periods are linked to the formation of large basaltic provinces (Grard et al., EGS 2002), will be presented

Groundwater influences on the chemical budget of river water : clues from U isotopic ratios

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Quantifying the influence of groundwater on the chemical budget of rivers waters remains an open question in Surface Earth Sciences. Here we propose to illustrate the potential of $^{234}U/^{238}U$ activity ratio to answer this question, with the case of the Rhine graben hydrosystem. Major and trace elements, $^{87}Sr/^{86}Sr$ isotopic ratios and ($^{234}U/^{238}U$) activity ratios, were analysed in the dissolved load of water samples collected in the main reservoirs, i.e. the Rhine river, its main tributaries, the shallow and deep ground-waters. Variations of major elements, trace elements and Sr isotope ratios of the water samples correlate with the lithological variations of the watersheds. By contrast $^{234}U/^{238}U$ ratios does not follow the same trend. Important variations are observed in waters draining a single lithology as illustrated with the Lauter stream, in the northern of the studied area. This stream flows on the lower Triassic sandstone. The sandstone reservoir contains numerous layers of more or less enriched clay minerals. Such a lithology allows a superposition of more or less developed aquifers. Three levels of these aquifers have been recognised and sampled. Each of them has specific U isotopic composition. The figure clearly demonstrates that U of the dissolved load of the Lauter water is influenced by contribution of these aquifers. U activity ratios of the dissolved load of the rivers does not only represent the ^{234}U-^{238}U fractionations resulting from the meteoritic weathering of surface rocks, but is also modified by inputs from groundwater to rivers. $^{234}U/^{238}U$ ratios become a good tracer to calculate influence of groundwater on the global chemical budget of stream water.

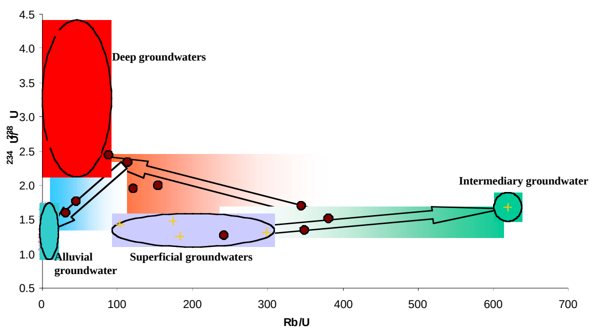

Figure : U-Sr variations in the Lauter river (a tributary of the Rhine river). Evidence from contribution of several aquifers.