

Modeling cosmogenic nuclide accumulation during sediment transport in the upper Amazon basin

H. WITTMANN^{1*}, F. VON BLANCKENBURG¹,
J.-L. GUYOT², AND P. W. KUBIK³

¹Institut für Mineralogie, Universität Hannover, Callinstr. 3,
30167 Hannover, Germany

²Institut de Recherche pour le Développement, IRD, UR 154
LMTG, Casilla 18, Lima, Peru

³PSI/ Institute of Particle Physics, ETH Hönggerberg, 8093
Zürich, Switzerland

To date, cosmogenic nuclides in detrital material have been used to determine denudation rates, but determination of cosmogenic nuclide accumulation during sediment storage in large depositional basins has received little attention. We have designed a cosmogenic nuclide-based accumulation model for depositional regimes along a river as it actively migrates across its floodplain. The feasibility of the model was tested in the Beni catchment in Bolivia, a large (~ 70.000km²) Andean foreland basin draining the northern Bolivian Andes. On its way to the Amazon the river traverses through ~50.000km² of floodplain, thereby depositing ~100 Mt of sediment per yr. The storage of sediment debouched from the source areas has been studied in great detail in terms of migration rate, sediment exchange between floodplain and channel, and therefore of sediment residence time scales^[1].

To resolve irradiation of sediment during transport and storage in the floodplain, the input of material from source areas was characterized cosmogenically. Samples from the High Andes, Andean foothills, and Cratonic shields give mean SLHL-scaled ¹⁰Be concentrations of 5*10⁴, 1*10⁴, and 4*10⁵ats/g, respectively, which correspond to mean denudation rates of 0.14, 0.5, and 0.02mm/yr for these three areas. However, cosmogenic nuclide measurements on bedload from the active Beni channel (n= 20; mean SLHL-scaled concentration of 3.7*10⁴ats/g) show neither significant accumulation nor decrease of nuclides.

Our accumulation model assumes erosion of sediment from river cut banks due to lateral migration, and an admixture of sediment conveyed directly from the previous reach. Sediment deposition is simulated by forming point bars from portions of the mixed material. Model parameters are most sensitive to initial concentration of the erosion products, channel migration velocity, channel remobilisation depth, and the relative magnitude of upstream sediment discharge to that of floodplain reworking. The model indeed predicts no significant gain in nuclide concentration from floodplain sediment remobilization for Beni river conditions. Therefore, even for a source area with erosion rates as high as the Andes, the cosmogenic erosion rate signal is preserved throughout residence in the depositional zone of the basin.

Reference

[1] Aalto *et al.*, 2003, *Nature*, 425, 493-497.

Oxygen Fugacity in the Laboratory and in Terrestrial Systems

E. WOERMANN¹, G.C. ULMER², G.ERIKSSON³ AND
S.K. SAXENA⁴

¹Inst.f.Kristallographie, RWTH, D-52056 Aachen, Germany,
(woermann@xtal.rwth-aachen.de)

²Geology Dept., Temple University, Philadelphia, Pa., 19122,
(gulmer@temple.edu)

³GTT-Technologies, D-52134 Herzogenrath, Germany,
(ge@gtt-technologies.de)

⁴CeSMEC, University Park, Miami, Fl., 33199,
(saxenas@fiu.edu)

Several different synthetic phase assemblages – so called oxygen buffers – were devised by Eugster, 1957 in order to adjust defined oxygen fugacities in laboratories for experimental petrology at given temperatures and pressures. The “oxygen buffers“– and the corresponding acronyms – soon became popular and are now applied universally also to express fO₂ levels in natural systems where, however, a correlation with the phase assemblages of the originally defined buffers is not evident. A typical example is presented by the numerous analyses of basalts with oxygen fugacities of (QFM) (see Ulmer *et al.*, 2007).

From the fact that the fO₂-data of the majority of basalts worldwide are arranged in a narrow belt along QFM (see Basaltic Volcanism Study Project, 1981) it is concluded that their redox state must be buffered. What may the properties and the quality of the buffers involved be? It must be realized that

-an oxygen buffer is a phase assemblage containing a certain element in different oxidation states. The entire periodic system was scanned and elements capable of coexisting in various oxidation states were marked.

-any buffer assemblage may react with any other one until one phase from buffer assemblage is quantitatively consumed and the latter buffer is thus annihilated. Eventually thus only one complete buffer assemblage can survive and will thus be dominating.

From the conditions cited above it is concluded that only the reaction: $2 \text{H}_2\text{O} = 2 \text{H}_2 + \text{O}_2$ may provide the required buffer. By thermodynamic calculations the oxygen fugacity of dissociating pure water close to QFM is confirmed for temperatures above 800 K, kinetically above the closing temperature of a reaction between basaltic magma and water, *i. e.* for conditions prevailing for the eruption of MORBs.

The correlation between the oxidation state of a rock and the activity of water during its formation may be extended to further systems. Thus the fact that analyses of Nakhllites were showing an oxidation state close to QFM indicates that during their formation on Mars water must have been involved – although at present neither water nor hydrous components in Mars minerals directly seem to support this conclusion.

Reference

Eugster, H.P., (1957), *J.Chem.Phys.* **26**, 1760-1761

Ulmer, G.C. & Woermann, E. (2007), *Goldschmidt 2007* (this volume).

Basaltic Volcanism Study Project, 1981