

Fluid-rock interaction along plate boundary shear zones: insights from modern and ancient examples

VANNUCCHI P

paola.vannucchi@rhul.ac.uk

Field observations and geophysical investigations on modern and ancient plate boundaries reveal that these shear zones are several 100's to 1000's m thick. Marine geophysicists usually see this zone as a low p-wave velocity horizon that implies high fluid content. Onland, ancient plate boundaries are characterized by evidence for incorporation of unlithified, fluid-rich sediments into the fault zone. A better idealization of this dynamic system should consider rock/sediment and fluid supply to the channel, the heterogeneity of deformation, and the evolution of PT conditions as the deeper parts of the shear zones are reached. The upper and lower boundaries of this system can migrate towards the upper or lower plate, defining the main tectonic processes shaping the margin, but also influencing the processes that are responsible for earthquake nucleation, rupture and propagation. Within the shallow, <15 km deep part of the plate boundary shear zone, a gradual change of physical properties defines three subregions; zone 1 of rapid fluid dewatering, zone 2 of overpressure, and zone 3 with metamorphic fluid release. These implications are that a subduction shear zone is a dynamic feature with along-strike and down-dip variations caused by changes in channel material, in trapped fluids, and in interplate boundary geometry.

Release of solid-bound phosphate during the sulfidization of lepidocrocite

K. VAN RIEL¹, T. BEHREND^{1*}, R. T. BUSH²
AND E. D. BURTON²

¹Utrecht University, Faculty of Geosciences, NL-3508 TA Utrecht, The Netherlands (t.behrends@uu.nl)

²Southern Cross GeoScience, Southern Cross University, Lismore, NSW 2480, Australia

Natural ferric iron (oxyhydr)oxides often carry oxyanions such as phosphate or arsenate either adsorbed onto their surfaces or incorporated inside their structure. As a consequence, reductive dissolution of iron (oxyhydr)oxides can lead to the release of the initially solid-bound oxyanions. This link between iron reduction and the mobility and bioavailability of oxyanions is widely recognized but little is known about the kinetic coupling of oxyanion mobilization and iron reduction as well as the underlying mechanisms. Here, we investigated the release of phosphate from lepidocrocite (γ -FeOOH) during its reaction with dissolved sulfide in flow-through reactor experiments at pH values around 7.5 and 8.5. Two types of lepidocrocite were used: One containing structurally bound phosphate, and a second with only adsorbed phosphate. The release of structurally bound phosphate followed the progress of sulfidization and the rates of sulfide consumption were linearly related to the rate of phosphate release. In general, the reaction with sulfide proceeded faster at pH 7.5 than at pH 8.5 and, in turn, phosphate was mobilized faster at pH 7.5. In experiments with adsorbed phosphate, addition of sulfide to the inflow solution led to a pronounced phosphate pulse in the outflow. This quick release can be attributed to ligand exchange reactions in which dissolved sulfide replaces phosphate in surface complexes. However, not all of the adsorbed phosphate was instantaneously removed from the surface. The mobilization of the remaining adsorbed phosphate followed the progress of lepidocrocite sulfidization similar to the behavior of structurally bound phosphate. Furthermore, the fraction of instantaneously released phosphate was smaller at pH 7.5 than at pH 8.5. We propose, that these phenomena can be explained by the different reactivity of bidentate and monodentate phosphate complexes, whereas the latter are more abundant at pH 8.5. That is, phosphate in monodentate complexes readily undergoes ligand exchange with sulfide while bidentate phosphate complexes are relatively inert towards the attack by sulfide. Our results show that the pH effect on phosphate release in anoxic environments can be oppositional depending on the binding form of phosphate.