On the duration and rates of fluid release from a dehydrating slab

T. JOHN[1], Y. PODLADCHIKOV[2], N. GUSSONE[1], G. BEBOUT[3], R. HALAMA[4], T. MAGNA[1] AND R. KLEMD[5]

[1]Institut für Mineralogie, Universität Münster, Germany (timm.john@uni-muenster.de)
[2]Institut de Géophysique, University of Lausanne, Switzerland
[3]Lehigh University, Bethlehem, PA 18015, USA
[4]Institut für Geowissenschaften und SFB 574, Universität Kiel, Germany
[5]GeoZentrum Nordbayern, Universität Erlangen-Nürnberg, Germany

At subduction zones, seawater-altered oceanic lithosphere recycles back into the mantle, heats up during descent and releases fluids by devolatilization of hydrous minerals. Large-scale fluid flow resulting from this dehydration is implicit in recent models for the formation of arc magmas and appears to be linked to intraslab seismicity and non-volcanic tremors. However, the mechanisms as well as spatial and temporal scales of this fluid flow are only poorly known.

Exposures of veins (mineralized fractures) in oceanic lithosphere, metamorphosed at high pressures in subduction zones, provide direct evidence for fluid mobility within subducting slabs. We quantify the duration of dehydration-related fluid flow through subducting oceanic plates by investigating a high-pressure vein and its reaction selvage. Using a novel approach employing an array of radiogenic (Sr) and stable (Li, Ca) isotope data combiend with Li-diffusion and reaction kinetic modelling, we demonstrate that large amounts of fluid can be transported along major conduits over km distances in a pulse-like manner through slabs over surprisingly short time periods of ~170 to as little as ~6 years.

This indicates that even though the overall slab dehydration is a continuous process, dehydrating slabs release their fluid by short-lived, channelized fluid-flow events, involving aseismic mobile hydraulic fractures that rapidly traverse the subducting slabs. Furthermore, the time for mineral reactions to reestablish thermodynamic equilibrium in rocks along the flow pathways is estimated to be at least three times shorter than that of the overall fluid-rock interaction. This indicates that local thermodynamic equilibrium is indeed a valid assumption for understanding fluid-mediated processes at high fluid-rock ratios and sluggish reaction kinetics are negligible.

Sedimentary basin acid sulfate weathering: Its recognition and palaeo-environmental implications in the Eucla Basin, South Australia

ASHLYN JOHNSON[1]*, S.M. HILL[1], D. CHITTLEBOROUGH[2] AND D. MITCHELL[3]

[1]Deep Exploration Technologies Cooperative Research Centre. School of Earth and Environmental Sciences. University of Adelaide. SA 5005 (*correspondence: ashlyn.johnson@adelaide.edu.au)
[2]School of Earth and Environmental Sciences. University of Adelaide. SA 5005
[3]Iluka Resources Limited, 11 Dequetteville Tce, Kent Town, Adelaide, SA 5067

‘Acid Sulfate weathering' broadly describes soil and regolith materials that typically had an abundance of iron sulfides that have oxidised to sulphates. This redox process as well as other processes such as ferrolysis and microbiological functions are important producers of protons and therefore acidity within the regolith. Although previous studies have tended to focus on the soil management and sediment diagenesis and weathering geochemical implications, this study considers the significance of these processes from a sedimentary basin geochemical perspective. As such, further insights into basin-hinterland palaeo-environments and controls and the stratigraphic implications for the resulting regolith materials are gained. The study basin is the Eucla Basin, which is one of the world's largest on-shore Cainozoic basins, extending across Australia's central southern continental margin.

One of the major controls on palaeo- and contemporary acid-sulphate weathering within the Eucla Basin is the setting of regional groundwater systems within the Eocene marginal marine sediments in the basin. In geochemically reduced settings, typically below the watertable, the sediments contain an abundance of pyrite, whereas where these sediments have been oxidised, typically above the watertable, the pyrite has been oxidised and sulphates (which are now widely expressed as alunite found under many playa lake beds) and iron oxides (especially hematite but also goethite) are prevalent. These processes also have a profound influence on the mobility and reorganisation of Al and Si, largely derived from clay minerals such as smectite and kaolinite. This has resulted in the formation of authigenic clays (e.g. halloysite) and phreatic silicification (ie. groundwater silcretes) hosting abundant termite bioturbation preserved in the basin's geological record. Palaeo-watertables that may be linked to eustatic, climatic and tectonic variations are now being interpreted across large parts of this basin.