In vitro simulation of oscillatory redox conditions in intertidal sediments

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Experimental results that are environmentally relevant are needed to predict transient diagenetic processes. For that, we developed a designed reactor for the examination of diagenetic processes [1]. We present here the results from two independent experiments with sediment slurries collected the Arcachon bay and the macrotidal Adour estuary. Slurries and in-situ water were mixed to give a SPM concentration of 150 g/l. Sediments were submitted to redox oscillations at the tidal and neap-spring time scales to assess the diagenetic mechanisms that affect N, P, Fe, Mn and S species. The experiments started in anoxic conditions during one week. Then oxic conditions were obtained by purging with air. After one week of oxic conditions, anoxic conditions were recovered by purging with N2.

From anoxic to oxic conditions : We observed rapid oxidation of dissolved Fe(II). Dissolved phosphorus was trapped with new Fe-oxides. It was totally titrated in Arcachon sediments, but not in Adour sediments. Because of the strong control of P by Fe, the N/P ratio was never constant and did not reflect the N/P of the mineralized organic matter. Mn(II) was slowly oxidized. A major part of Mn(II) was rather adsorbed on new Fe-oxides. In Arcachon sediments, ammonium remained constant in oxic conditions. Nitrate was produced from organic-N mineralization. In Adour sediment nitrate was produced from ammonium nitrification.

From oxic to anoxic conditions : A part of newly precipitated Fe-oxides was reduced, another part was trapped with sulfides. Dissolved P concentrations were not recovered. P was probably trapped in an authigenic phase. In Adour sediments, high concentrations of Mn-oxides prevented Fe(II) accumulation. In Arcachon sediments, direct reduction of nitrate to ammonium, rather than denitrification occurred. Anammox probably occurred in anoxic conditions of Adour sediments. Anaerobic production of nitrate also occurred in Adour sediments, probably because the concentration of Mn-oxides was high

These experimental results show that nutrient dynamics in oscillatory redox enviromnents such as estuary turbidity zone, bioturbated sediment or tidal permeable sediments strongly depend on reactive Fe and Mn content.

[1] Abril *et al.*, (2010) Estuar. Coast. Shelf Sci. **88**, 279-291.

Foreland view of the extruding Himalayan metamorphic core, West Nepal

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We have studied the deformation, metamorphic, and cooling history of the Himalayan suprastructure (Tethyan sedimentary sequence – TSS) and infrastructure (Greater Himalayan sequence – GHS) preserved in the most southward and foreland part of the orogen in west Nepal, to better understand the relationship between hinterland and foreland deformation in a mid-crustal flowing orogen.

The studied N-S profile (28 km) transverses the Dadeldhura klippe. The klippe is characterised by an early to late Miocene syncline structure bound to the north and south by the folded Dadeldhura Thrust, regionally correlated to the Main Central thrust. The northern limb is characterised by medium metamorphic -grade rocks (mylonitic augen gneiss ± garnet, mica-schist ± garnet ± staurolite, muscovite bearing quartzite) with south-dipping foliation and down-dip elongation lineation. The southern limb exposes ca. 4 km-thick medium metamorphic-grade rocks, structurally overlain by ca. 9 km-thick meta-igneous rocks (augen gneiss) with north-dipping and down-dip elongation lineation. Rocks of both limbs are regionally correlated to the GHS and are characterized by pervasive S-C-C´ fabrics, σ and δ porphyroclasts, and mica-fish consistent with top-to-the-south shear. Close to the contact with the overlying TSS meta-pelites, the GHS displays top-to-the-north sense of shear, which is likely related to the southern extent of the South Tibetan Detachment system. Microstructural analyses of quartz-rich units suggest the GHS underwent non-coaxial top-to-the-south sense of shear at temperatures between 450 ºC and 550 ºC.

Meso and microstructural analyses performed on the TSS meta-pelites outcropping in the core of the syncline highlights a polyphase deformation history characterized by two main cleavage development phases. Illite crystallinity measured on <2 μm and <0.2 μm size fractions and the corresponding $^{40}K/^{40}Ar$ ages of the meta-pelites show that the samples are dominated by newly formed white mica. Illite crystallinity values range from Kübler Index 0.136 to 0.238 suggestive of epizonal conditions to lower greenschist facies (min. 350 ºC). Illite-muscovite $^{40}K/^{40}Ar$ ages are interpreted as cooling ages after peak metamorphic conditions and range between 18.2 ± 0.8 Ma close to the STDS to 26.6 ± 1.3 Ma in the core of the syncline.

Despite its structural similarity, the Dadeldhura GHS rocks differ from the GHS rocks described in the higher Himalaya 100 km to the north by the absence of migmatite and sillimanite-bearing rocks. This difference might be a field expression of telescoped and folded metamorphic isograds at the frontal part of the extruded GHS. Future work in the Dadeldhura GHS, including U-Pb in-situ dating of deformation fabrics and ^{40}Ar-^{39}Ar analyses, will assist in testing links between hinterland-style deformation (e.g. channel-flow) in the higher Himalaya with foreland-style deformation (e.g. critical-taper) in the external klippes of the Himalayan system.