Biological versus chemical sulfide oxidation in *Beggiatoa* inhabited sediment

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We investigated the contribution of metal cycling and biological processes in the oxidation of sulfide in organic-rich marine sediments, covered with *Beggiatoa* mats. *Beggiatoa* are large gliding filamentous sulfur bacteria, that can store high concentrations of nitrate in vacuoles. They use their nitrate stores to oxidise sulfide in the 2-4 cm thick suboxic zone, which is their typical habitat. We evaluated the importance of *Beggiatoa* to chemical oxidation of sulfide, i.c. by metal cycling.

The sulfide oxidion rate by *Beggiatoa* was quantified from their distribution and cell-specific activity, and by ^{15}N-tracer experiments. Microsensors for H_2S, pH, NO_3^- and O_2 were used to characterize the microenvironment and to calculate fluxes of sulfide, NO_3^- and O_2. The sulfide supply into the suboxic zone was determined from sulfate reduction rates and sulfide fluxes from deeper sediments, determined with microsensors.

The sulfide input in the suboxic zone was dominated by a diffusional flux from deeper sediments, while the local production by sulfate reduction was low. The total influx of sulfide was much higher than the sulfide oxidising capacity of the *Beggiatoa* community. Thus most of the sulfide was removed by chemical processes, mainly binding to Fe^{2+} and oxidation by Fe(III). This was confirmed by highly characteristic pH profiles, showing a maximum value in the zone where sulfide dissappeared. The Fe^{2+} formed by Fe(III) reduction diffused upward where it was oxidised by Mn(IV), detected by a strong pH decrease. Indeed geochemical analyses showed a distinct Mn(IV) peak in the upper sediments, and the distributions of Fe^{2+} and Fe(III) confirmed this scenario.

Thus the steep sulfide gradient and high sulfide flux, a typical characteristic of *Beggiatoa* habitats, is not needed for their metabolic performance. *Beggiatoa* can glide long distances before nitrate is depleted. We concluded that the free sulfide below the suboxic zone is used as a chemotactic cue by the highly motile filaments to avoid getting lost at depth in the sediment. This means that the distribution of *Beggiatoa* is a response to- rather than a determinant of the sulfide distribution.

Low-density geochemical mapping in Australia: Pilot projects and outline of a continental-scale geochemical survey

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Pilot projects

Over the past few years, CRC LEME and GA have carried out 4 pilot geochemical surveys aimed at developing and field-testing a low-density sampling strategy adapted to Australian landscapes and climatic conditions. Further, protocols for sample collection, preparation and analysis were developed to ensure quality data were acquired.

The pilot projects were undertaken in the Curnamona region of western New South Wales (NSW) and eastern South Australia (SA), and in the Riverina (southern NSW and northern Victoria), Gawler (central SA) and Thomson (northern NSW) regions. We tested various:

- sampling media (soils, overbank/floodplain sediments, 'outlet sediments', groundwater, vegetation),
- sampling depths ('top:' 0-10 cm, 'bottom:' a 10 cm interval at ~60-95 cm depth, complete profiles),
- fractions (<2 mm, 2-1 mm, 1000-500 µm, 500-180 µm, <180 µm, 180-75 µm , <75 µm, heavy minerals),
- digestions (total, multi-acid, aqua regia, Mobile Metal Ion Technology®, sequential extractions), and
- analytical methods (INAA, XRF, ICP-MS, GF-AAS, ISE, XRD, PIMA).

The National Geochemical Survey of Australia

Based on lessons learned from the pilot projects, a National Geochemical Survey of Australia (NGSA) project was developed, which recently received funding through the Australian Government's Onshore Energy Security Initiative. The aim of the NGSA project is to provide pre-competitive data and knowledge to support exploration for energy resources in Australia. The survey will sample sediments at the outlet of ~1400 catchments covering >90% of the Australian mainland, giving an average sampling density of ~1 site/5500 km^2. Materials will be collected from 2 depths (0-10 cm and ~60-70 cm) and separated into 2 size fractions (<2 mm and <75 µm). Analysis of these materials, mostly by XRF and ICP-MS, will yield total concentrations for ~60 elements. The project will result in Australia's first continental-scale, internally consistent geochemical data layer. The data will be useful for an array of applications, such as identifying geological domains likely to host specific uranium and thorium deposit types, and correlating geochemical data with airborne radiometrics data. The NGSA project will run from 2007 to 2011 and will deliver a publicly available geochemical database and atlas on the web.