Iron microbial mat formation from deep continental brines

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Iron oxidizing microorganisms are distributed globally and have been identified as major contributors to iron cycling and mineral formation from diverse geochemical settings – freshwater seeps to deep-sea vents – where ever opposing iron(II)-oxygen gradients prevail. A study of iron microbial mat formation from deep continental groundwaters along anoxic-oxic boundaries has been undertaken. The goals of the research are to define microbial niches created at acute geochemical gradients, and determine how microbial activity alters the mineralogy of mat deposits.

Iron microbial mat processes occur at 700 m depth where anoxic brines emerge from exploratory boreholes into an oxic, mined environment (Soudan Underground Mine State Park, Soudan, MN, USA) within a 2.7 Ga Banded Iron Formation. These sodium-calcium chloride brines are characterized by 100 mS conductivity, pH 6+, -650 mV oxidation-reduction (redox) potential, and total dissolved iron concentrations of 100 mg/L. As the brines equilibrate with the atmosphere in shallow flow channels over ~100 m distance, the pH decreases to 2.8, redox potential increases to +50 mV, and total dissolved iron decreases to less than 40 mg/L. Along these gradients, iron mat formations with diverse facies characteristics and mineralogy are observed.

For minerals from the first 100 m of the channels, iron 1s extended X-ray absorption fine structure spectroscopy and X-ray scattering measurements reveal the presence of akaganeite in all samples, as well as a transition from a biogenic iron oxyhydroxide to ferrihydrite/goethite. Scanning electron microscopy of critical point dried samples shows that microbial biomass is a substantial component of the mat at 0.3 m from the borehole where low redox potential is observed. From this low redox area, cultured isolates from the genus *Marinobacter* and genus *Idiomarina* were obtained. In seeps having lower conductivity, different cultivars and minerals are observed. These results point to salinity as an important factor in the geomicrobiology of the iron mats.

Late Cretaceous hydrocarbon seep carbonates from Kardoi village, Tibet, China

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One of the most common signs of the hydrocarbon seeps is the precipitation of carbonates close to the seafloor. Ancient hydrocarbon seeps are increasingly recognized, and occur in a variety of different marine settings and on different regional scales. However, such hydrocarbon seeps are rarely found in ancient strata of the mainland China. Here, we report two isolated carbonate bodies that have been interpreted to represent hydrocarbon-seep deposits. These deposits are in the upper Cretaceous strata at the southern and the northern Kardoi village of Xigaze, Tibet, China. The upper Cretaceous strata here consist of turbidites of a forearc basin, which has been uplifted into Yarlung Zangbo suture zone. The seep carbonates at the southern Kardoi section are about 30 vol% of the strata, occurring as nodules and chimneys while the seep carbonates at the northern Kardoi section mainly occur as nodules and account for about 10 vol% of the turbidite strata. Carbonate rocks from both sections are mainly composed of calcite, in sharp contrast to the host rocks which primarily are felsic minerals. The matrix of the carbonates mainly consists of micritic calcite. Framboid pyrites are frequently observed in the matrix. The carbonates exhibit $\delta^{13}C$ values as low as -32‰ relative to the V-PDB standard, suggesting that they are predominantly hydrocarbon derived, probably thermogenic methane. Overall, the carbonate fabrics and isotope signatures provide unequivocal evidences for a seep origin of the Xigaze deposits. Additional geochemical, mineralogical and petrographic studies of all micritic carbonates are underway. The obtained results will be used for constraining the controlling processes of the two geographically separated southern and northern sections.

We thank Prof. Chi-yue Huang (GIG) for helpful discussion. This work was partially supported by the NSFC (40872079 and 40725011) and Guangzhou Institute of Geochemistry of CAS (GIGCX-07-13).