Anaerobic oxidation of methane at Hydrate Ridge (OR)

T. TREUDE[1], A. BOETIUS[1,2], K. KNITTEL[1], K. NAUHAUS[1], M. ELVERT[1], M. KRÜGER[1], T. LÖSEKANN[1], K. WALLMANN[3], B.B. JØRGENSEN[1], F. WIDDEL[1] AND R. AMMAN[1]

[1]Max Planck Institute for Marine Microbiology, Celsiusstr. 1, 28359 Bremen, Germany (ttreude@mpi-bremen.de)
[2]Alfred Wegener Institute for Polar and Marine Research, 27515 Bremerhaven, Germany (aboetius@awi-bremerhaven.de)
[3]GEOMAR Research Center for Marine Geosciences, Wishofstr. 1-3, 24148 Kiel, Germany (kwallmann@geomar.de)

At Hydrate Ridge, Cascadia convergent margin, gas hydrates occur within the topmost meter of the sediment at water depths between 600 and 800 m. The hydrates are formed from methane and fluids that arise along faults from a deeper source. High concentrations of methane and sulfate in the surface sediment favour the microbial process of anaerobic oxidation of methane (AOM), removing between 30 and 90% of the upward transported methane. During AOM methane is oxidized with sulfate as electron acceptor via the following net equation: $CH_4 + SO_4^{2-} \rightarrow HCO_3^- + HS^- + H_2O$. AOM reaches a maximum of 100 µmol m^{-2} d^{-1} representing one of the highest rates known from marine systems. The process is mediated by a consortium of archaea and sulfate-reducing bacteria which comprise more than 90% of the microbial biomass in the surface sediments. Highly ^{13}C-depleted biomarkers verified methane to be the only or main carbon source of the archaea. In vitro experiments demonstrated that sulfate reduction is increasing with methane concentration, and occurs at a 1:1 ratio to AOM, if methane is the sole carbon source. AOM activity at Hydrate Ridge is limited to the sediment and was not detected within the hydrates. The high production of hydrogen sulfide during AOM favours different chemosynthetic communities of sulfur-oxidizing bacteria and symbiotic bivalves that are characteristic for Hydrate Ridge. This talk summarizes the current knowledge on AOM at Hydrate Ridge, based on biogeochemical, microbiological, and molecular investigations.

The onset of hydrothermal circulation in a fossil slow-spreading center (Northern Apennine ophiolites, Italy)

R. TRIBUZIO[1,2] A. ZANETTI[2] AND L. DALLAI[3]

[1]Dipartimento di Scienze della Terra, Università di Pavia, Italy (tribuzio@crystal.unipv.it)
[2]C.N.R. - Istituto di Geoscienze e Georisorse - Sezione di Pavia, Italy (tiepolo@crystal.unipv.it)
[3]C.N.R. - Istituto di Geologia Ambientale e Geoingegneria, 00185 Roma, Italy (l.dallai@igag.cnr.it)

The Northern Apennine ophiolites are lithosphere remnants of the Late Jurassic - Early Cretaceous Ligurian Tethys. The lithostratigraphy of these ophiolites is similar to that of modern slow-spreading centers. In the Bonassola area, a km-scale gabbroic body provide evidence for interaction between igneous and hydrothermal systems. The body mostly consists of olivine-bearing gabbros of cumulus origin, which are locally crosscut by widespread hornblende ± plagioclase veins (thickness < 0.1 cm) occurring as parallel swarms. These veins are post-dated in places by thick (up to 1.3 cm) extensional veins. All veins show changes in the modal hornblende/plagioclase ratio as a function of the local wall mineral. The development of the hornblende veins is correlated with coronal hornblende growth at the expenses of igneous clinopyroxene in the host gabbro. Scattered, elongated bodies of pegmatoid hornblende-bearing albitites also crop out. The albitites consist of albitic plagioclase and hornblende, and contain accessory ilmenite, zircon and apatite. Two different generations of albitite bodies (Alb1 and Alb2) have been recognised. Alb1 bodies display irregular contacts against the host gabbro, characterised by hornblende-rich reaction zones. Alb2 bodies have sharp contacts against the host gabbro and show the same elongation direction of the thick hornblende veins. These albitites locally contain elongated pods consisting of coarse-grained hornblende.

Hornblende from both veins and albitite bodies has been analysed for major, trace and halogen elements and oxygen isotope values. The results have allowed us to reconstruct the following sequence of events: (i) development of Alb1 bodies from late-stage hydrous silicate liquids or from exsolved magmatic fluids, when the gabbro was not completely solidified; (ii) consolidation of the gabbro and subsequent brittle deformation that permitted the infiltration of seawater-derived fluids. The onset of hydrothermal circulation is recorded by the thin hornblende veins, which can be ascribed to a high-temperature (amphibolite-facies) hydrothermal event; (iii) mechanical extension resulting in the concomitant development of thick veins and Alb2 bodies, which both provide evidence for interaction between igneous and hydrothermal systems.