Thermophilic anaerobic oxidation of methane performed by novel microbial consortia

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The anaerobic oxidation of methane with sulfate (AOM) controls the emission of the greenhouse gas methane from the ocean floor and is performed by microbial consortia of archaea (ANME) associated with bacterial partners [1]. So far, *in vitro* propagation of AOM was documented for temperatures up to approx. 25°C, but the presence of molecular ANME markers in hydrothermal sediments suggests higher temperature ranges for this process [2, 3]. In natural enrichments from Guaymas Basin hydrothermal sediments we show *in vitro* propagation of AOM up to 70°C with a growth optimum of 50°C and doubling times of around 60 days. We performed microbiological experiments and genetic, microscopic and mass spectrometric analyses to characterize the key agents in thermophilic AOM. The hot Guaymas enrichments are dominated by filamentous ANME-1 archaeal cells, which form individual sheaths around their bacterial partners. These belong to the deep-branching HotSeep-1 cluster which closest relatives are thermophilic sulfur reducers, e.g. *Desulfurella*. So far the interaction between these novel ANME-1 types and their bacterial partners is not resolved, but the highly structured consortia support previous hypotheses of an obligate syntrophic partnership. Furthermore, our results indicate that AOM might be more widespread than previously assumed including hot subsurface sediments and gas reservoirs [4,5] .

[1] Knittel & Boetius (2009) *Annu Rev Microbiol* [2] Teske *et al* (2002) *AEM* [3] Schouten *et al* (2003) *AEM* [4] Speed & Clayton (1975) *Geology* [5] Werner *et al* (1988) *Chem Geol*

Spinels under elevated pressures and temperatures – A synchrotron study

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Spinels have the general formula AB_2O_4 and crystallize in the cubic spacegroup Fd-3m. They play important roles in geosciences and technical applications. The aim of this study was to make simultaneous high-pressure/high-temperature (HP/HT) measurements to find out how the thermal expansion behave under high pressure.

In this study, the three different spinels magnetite ($FeFe_2O_4$), franklinite ($ZnFe_2O_4$) and gahnite ($ZnAl_2O_4$) were investigated with energy-dispersive powder XRD using two different multi-anvil-presses at HASYLAB. Isothermal experiments were performed up to 15 GPa using MAX200x, thermal experiments up to 5 GPa and 1100 K using MAX80. Diffraction data were evaluated with the Rietveld-method to obtain the cell parameter of the sample and the pressure medium. Pressure-volume-data were fitted to second and third order Birch-Murnaghan equation of state to obtain the bulk moduli of each sample. In addition, the thermal expansion coefficient were calculated at different pressures.

Evaluation of the HP measurements yielded the following bulk moduli. For magnetite: K_{T2nd} = 187(6) GPa, K_{T3rd} = 184(7) GPa with K' = 4.5(2), for franklinite K_{T2nd} = 180(5) GPa, K_{T3rd} = 178(6) GPa with K' = 4.6 and for gahnite K_{T2nd} = 207(7) GPa, K_{T3rd} = 204(9) GPa with K' = 4.9. HP/HT experiments showed a linear pressure dependence of the thermal expansion at least up to 5 GPa ($-1.3*10^{-6}$ $(KGPa)^{-1}$ for magnetite, $-1.7*10^{-6}(KGPa)^{-1}$ for franklinite and $-3.0*10^{-6}(KGPa)^{-6}$ for gahnite). There seems to be an additional connection to the iron content of the spinels whereat the increase of the iron content decreases the slope of the pressure dependence.