Geophysical Research Abstracts,
Vol. 10, EGU2008-A-01509, 2008
SRef-ID: 1607-7962/gra/EGU2008-A-01509
EGU General Assembly 2008

The Atzbach-Schwanenstadt gas field (Upper Austrian Molasse Basin): Retracing bacterial methane gas generation and filling history by mass balancing of organic carbon conversion applying hydrogeochemical modelling

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In the Austrian Molasse Basin biogenic methane gas accumulations occur in Upper Oligocene to early Miocene deepwater clastic sediments. Methane gas is produced from the Upper Puchkirchen Formation (Aquitanian) in the Atzbach-Schwanenstadt gas field which is one of the largest gas fields in this basin. Reservoir rocks of this field wedge out to the north and represent dam break-through (splay) sediment. Claystone layers intercalating and sealing the reservoir sediments contain kerogen type II-III organic matter and are regarded as source rocks for methane gas. The diagenetic pathways of the reservoir cements (pyrite, dolomite, calcite, ankerite, siderite) were controlled by the conversion of metabolizable organic carbon incorporated in the fine-grained sediments. Retracing these pathways by hydrogeochemical modeling enables the resolution of relative timing of coupled processes gas generation and precipitation/dissolution of cements. The labile organic material was decomposed via fermentation and subsequent CO_2 reduction. CO_2 released via these reactions was nearly completely fixed as carbonate cement. Methane generated during early diagenesis (10s to max. 100m sediment depth) was dissolved within pore water until saturation. After exsolution as a free gas phase, methane was probably fixed as hydrate within pore space due to the prevailing paleoceanographic conditions at the sediment/water inter-

face ($\sim$1000 mbsl; $\sim$4°C). The temperature increase, the rapid basin subsidence and high sedimentation rates led to the decomposition of the hydrates and to charging of the reservoir by methane still during the Aquitanian. A further consequence of hydrate decomposition was dilution of pore water salinity.

According to the results, the presented approach offers (a) a tool to retrace the biogenic methane potential by analysis of diagenetic cement as a quantitative indicator, and (b) to predict interaction between porosity development and reservoir charging by methane. Additionally, (c) gas field water salinity and hydrochemistry may be applied in similar architectural elements in deepwater channels as tracers for gas hydrate formation as low chloride concentrations are result of dilution by pure H_2O due to gas hydrate dissociation.