

The late-stage evolution of oceanic gabbros - Combined experimental and *in situ* isotope study on gabbros from Southwest Indian Ridge

R.E. BOTCHARNIKOV, J. KOEPKE, I. HORN AND F. HOLTZ

Institut Mineralogie, Callinstr.3, Leibniz Universitaet
Hannover, 30167 Hannover, Germany
(r.botcharnikov@mineralogie.uni-hannover.de)

Gabbroic rocks from Hole 735B at the Southwest Indian Ridge (SWIR; Legs 118 and 176), represent the longest continuous section of oceanic lower crust ever drilled by ODP (Ocean Drilling Program). About 25% of the core is strongly influenced by late-stage magmatic processes leading to Fe-rich (ferrogabbros) and Si-rich (plagiogranites) compositions as end-members. The study of natural ferrogabbros from SWIR reveal that the typical ferrogabbroic paragenesis is ilmenite - pargasite \pm magnetite \pm apatite \pm orthopyroxene. Phase equilibria experiments at P=200 MPa and T=900-1050°C show that Fe-Ti oxides are the liquidus phases, even at reducing conditions, leading to dramatic depletion of residual melts in FeO and TiO₂ from the beginning of crystallization. Thus, it is very unlikely that the ferrogabbroic assemblages are formed by simple differentiation of Fe-rich basaltic melts. Remarkable is that plagioclase and clinopyroxene are normally absent in natural paragenesis while these phases are stable in phase equilibria experiments. On the other hand, amphibole and orthopyroxene are typical for natural late-stage gabbros and completely absent in our experimental products. However, amphibole + orthopyroxene + An-rich plagioclase are main phases formed in partial melting experiments on gabbros [1]. These observations indicate again that the late-stage high-temperature evolution of the gabbroic suites in the lower oceanic crust can not be simply related to the differentiation of basaltic liquids but requires additional mechanisms operating in the still-hot gabbroic rocks. Potential processes responsible for the formation of mineral assemblages in ferrogabbros could be: impregnation of gabbroic protholith with accumulated phases crystallized in a late-stage melt, partial melting of gabbroic cumulates due to reaction with water-rich fluids and/or precipitation from an immiscible iron-rich silicate liquid.

In situ LA-MC-ICPMS analyses of Sr isotopes in late-stage parageneses in natural rocks were applied to discriminate between hydrous primary magmatic, and seawater-induced late-stage processes. First *in situ* Sr isotope analyses on An-enriched plagioclases, which are regarded to be formed during late-stage hydrous partial melting process, show seawater signatures. However, the Sr isotope analysis in such phases is a challenge due to the very low Sr contents of the plagioclases (less than 100 ppm Sr). Therefore, additional efforts are required to improve the reliability of this method.

References

[1] Koepke J. *et al.* 2004. Contrib. Min. Petrol. 146, 414-432.

Methane and organic matter as sources for excess carbon dioxide in intertidal surface sands: Biogeochemical and stable isotope evidence

M.E. BÖTTCHER^{1,2}, A.M. AL-RAEI², Y. HILKER³,
V. HEUER⁴, K.U. HINRICHS⁴ AND M. SEGL⁴

¹Leibniz Institute for Baltic Sea Research, D-18119

Wanemünde (michael.boettcher@io-warnemuende.de)

²MPI for Marine Microbiology, D-28359 Bremen

³ICBM, University of Oldenburg, D-26111 Oldenburg

⁴Department of Geosciences, University, D-28359 Bremen

Reduced carbon is mineralized in marine sediments by microbial activity using predominantly oxygen, sulfate, and metal oxides as electron acceptors. Besides DOC compounds, methane can be oxidized to carbon dioxide. Both, CO₂ and CH₄ are strong green-house gases that may be liberated from the sediments into the bottom waters or the atmosphere. The partitioning of stable carbon isotopes is a useful tracer for the biogeochemical transformations of different C sources and is used here to identify the key reactions in the C-S cycles of intertidal surface sediments. Sediments and pore waters (top 20 cm) from intertidal sands of the back-barrier tidal areas of Spiekeroog and Sylt islands (southern and eastern North Sea) have been investigated on a seasonal base, and are analyzed for a number of (bio)geochemical parameters as, for instance, TOC, TIC, DIC, TA, methane, SRR, salinity, pH, sulfate, sulfide, and the carbon isotopic compositions of substrates and products.

Results indicate that DIC is dominated by products derived from organic compounds besides exchange via the sediment-water interface, with bioturbation having important effects. Below reduced sulfidic sediment surfaces, the isotopic composition of DIC down to -40 per mil indicates CH₄ (-60 per mil) derived from the oxidation of methane as an important source. These sites promote an energy transfer from the sediments to the bottom waters.

Acknowledgements

The research is supported by the DFG (Research group 'BioGeoChemistry of the Wadden Sea'; JO307/4-1,-2; BO1584/4-3), MPG, and Leibniz IO Warnemünde. N. Volkenborn is thanked for his support at the Königshaven Site.