Open Ph. D. position at K.U.Leuven (assistant position)

Spatial variation in sedimentpetrographical, geochemical and petrophysical characteristics of coarse crystalline dolomites on a regional scale: the Ranero case study (Cantabrian Mountains, N-Spain). **Promoter:** *Rudy Swennen <http://cwisdb.cc.kuleuven.ac.be/persdb-bin/persdb?oproep=persoon&lang=E&fnaam=u0015513>*

Description: The genesis of dolomites and especially the origin of the magnesium bearing fluids is still a matter of debate in geosciences and is referred as "the dolomite problem". Scientific and economic interest in the nature of especially coarse crystalline dolomite hosted hydrocarbon reservoirs (AAPG volume 90, 2006) or base metal ore deposits (e.g. Pine point) increased over the last years. It is in this context that this project proposal has been formulated.
The main research objective is to unravel the genesis as well as the variation in sedimentpetrological, geochemical and petrophysical characteristics of coarse crystalline and zebra dolomites in the Ranero area. In this area, at the transition between basin to platform Cretaceous limestones, a dolomite body, about 0,7 by 1,5km in size exists along the Ranero fault. This outcrop can be regarded as one of the best surface analogues of this type of fault related reservoir lithologies worldwide. Furthermore, the Ranero fault is uniquely exposed in an old quarry in which the quarry walls have been recently cut, exposing the different dolomite types over a distance 100 by 30m. The rocks allow deducing different pulses of most likely hydrothermal dolomitising fluids, next to other interesting diagenetic phenomena like hydrothermal karstification with calcite cementation. Some of the dolomitisation events testify of very high fluid velocities, as is attested by the meter-sized partially assimilated floating host rock blocks enclosed in the coarse crystalline dolomites.
In the framework of this project the different dolomite lithologies will be mapped and sampled by drilling plugs in a grid pattern (about 400 samples) on a regional scale. A representative set of samples will be petrographically studied by classical petrography (on stained thin-sections) and by cathodoluminescence and fluorescence microscopy. These data will be complemented by SEM examination, and should lead on the one hand to the development of a paragenetic model, and on the other hand to the regional variation in lithotypes and diagenetic phenomena. This dataset will be complemented by stable oxygen and carbon isotope data, Sr-isotope data (analysed by MC-ICP-MS) and major and trace element geochemistry (Ca, Mg, Fe, Mn, Sr, Na, K, Al, Zn, …). In addition microprobe analysis will be carried out on individual diagenetic phases. A microthermometric analysis of fluid inclusions, complemented by micro-raman analysis will be carried out to unravel the fluid composition and minimum formation temperature of dolomitisation. This will be complemented by crush-leach analysis of carefully selected and prepared samples. All samples will be scanned with an "in-vivo-micro-CT", based on which the porenetwork will be quantified in 3 dimensions. A geostatistical, multivariate and multiple point geostatistical analysis will be carried out on the acquired dataset. A better understanding of the factors controlling dolomitisation and its geochemistry and petrophysical characteristics will not only be of use for unravelling the genesis of coarse crystalline dolomites, but should also allow deducing the fluid flow history and its control on petrophysical characteristics such as porosity and permeability.
Key words: Dolomites, lithotypes, diagenesis, geochemisty, petrophysical characteristics, reservoir analogue, computerized tomograp
Start date: 2008-09-01
Application date: 2008-05-25
Publication date: 2008-03-25

Sedimentpetrological and geochemical study of cold-water coral carbonate mound sediments from the northeast Atlantic.

In the framework of the project entitled "CARBONATE: Mid latitude carbonate systems: complete sequences from cold-water coral carbonate mounds in the northeast Atlantic (
http://www.esf-carbonate.org/home.aspx <http://www.esf-carbonate.org/home.aspx>), a (3-3,5 year) Ph.D. position is available.
Along the European Atlantic continental margin, recent to young fossil carbonate mounds and build-ups by cold-water corals (predominantly the framework forming ahermatypic corals *Lophelia pertusa* and *Madrepora oculata*) occur from northern Norway to the Gulf of Cadiz. Despite the major research efforts of the last year, the long-term carbonate budget for carbonate mounds in different environmental settings, including the influences of climate change on this process, and the role of the mounds in the global carbon cycle is still unclear is. By understanding how biogeochemical processes control the development of these carbonate mounds and their response to climate change, in the framework of this international project an important step in quantifying their role as mid-latitude carbonate sinks will be made. In the end, a better understanding of the processes involved in mound formation and development may also result in new views on fossil analogues many of which are less accessible hydrocarbon reservoirs.

Within the frame of this international project, the Ph. D. student will address some of the sedimentological and diagenetic aspects involved in mound formation and development. Also age dating by Sr-isotope stratigraphy is one of the key tasks. The deduction of the physico-chemical conditions as well as the variations of the diagenetic conditions through time, are the main focus of the research.

After deposition, the mound sediments which consist of a complex mixture of (carbonate) mud, bioclasts and ice raft material, etc undergo diagenesis. This leads to the physical, biological and chemical stabilisation of the mound structures. The mechanisms (sedimentary and diagenesis) which govern this mound formation, however, are not well understood, especially since at this stage the scientific community mainly possess core material from the uppermost sediments. However in the framework of this project we will dispose of core material of several tens of meters taken by the MEBO-drilling equipment from the University of Bremen.

Focus of the Ph. D. research will be on the petrography and geochemistry of sediments, allowing to refine the chemical signatures of the sediments which build up the mound structures and to quantify the effect of diagenesis. Fundamental questions which will be addressed relate to the depositional regime and its controlling factors, the diagenetic processes (physical, chemical and biological) that stabilise sediments but that also changes their petrophysical characteristics and the preservation of primary signals in diagenetically overprinted sediments.

More specifically, the following major research topics will be addressed:
1. Dating the sediments by high resolution Sr-isotope analysis of carbonate phases (e.g. benthic foraminifera) by MC-ICP-MS. Contributing high resolution Sr stratigraphy will support the stratigraphic model for the mound successions. Furthermore, the diagenetic study of the carbonates analysed will help in better constraining the stable oxygen isotopic signals which are relevant for age dating of the sediments. This study will also address the sedimentological mound evolution. It will particularly pay attention to firm and hardground intervals.
2. Characterising by geochemical and petrographical means the authigenic mineral phases (e.g. authigenic carbonates, clays, pyrite) formed in the mound sediments. This will highlight the influence of diagenesis on mound initiation and development. Attention will particularly go to the variation in diagenetic processes between

different mounds.
3. Quantifying the controls of diagenesis in the post-depositional mobilization and/or redistribution of CaCO3 in the mound structures and adjacent strata. The latter data are necessary to accurately calculate depositional carbon flux. They also should allow assessment with respect to some of the seismic attributes in the mound structures that can be linked to diagenesis (see also point 1).
4. Inferring the effect of diagenesis in altering the depositional signal. Especially with regard to the resetting of the geochemical signals (e.g. stable oxygen isotopes, Sr-isotopes) information on diagenesis is needed to assess the preservation of primary signals.
5. Quantifying the pore-water composition. Based on this signature insight in water/sediment interactions will be deduced and based on diagenetic modelling conclusions on the equilibrium status of the diagenetic products will be gathered.
6. Inferring the effect of physical (e.g. compaction) and biological/chemical diagenesis in altering the internal mound properties and surrounding sediments. Attention will go to the study of different sedimentation hiatus, development of hardgrounds and the base of the mound structures. The occurrence of hardgrounds is often indicative of environmental controls on mound formation and development with diagenetic effects playing a progressive role in internal mound structure. Diagenesis will affect porosity and permeability and especially shear strength controlling mound stability. Unravelling the depositional signal requires a firm understanding of the role of diagenesis in the preservation process.
7. Inferring the possible stabilisation of sediments by bacteria based on petrographical inspection.
8. Inspection of cement phases to study possible gas bearing fluid inclusions.

In function of the response of potential good Ph. D. candidates this position can be rewritten as a 2,5 year post-doc position.