minerals.
The system under investigation has been modellized through a 1D simplified cartesian geometry. Fine grid specifications have been set to obtain accurate results, and maximum simulation times have been fixed to 100 years to reduce the computational effort.
Liquid conditions (Sl=1.0) have been assumed in the caprock, whereas two phase conditions have been set in the reservoir (Sg=0.3). Reaction paths occur under isothermal and isobaric conditions, with T and P values equal to 45°C and 105 bar, respectively.
Interaction between CO2-rich fluids and sealed caprock occurs by molecular diffusion, whereas mass transfer mainly occurs by advection in the case of reservoir-fractured caprock interaction.
In the first case, numerical simulations predict rapid occlusion of caprock, due to precipitation of calcite. This process is driven by upward Ca and C diffusion from reservoir, where high PCO2 values induce acidification and calcite dissolution.
In the second case, the combined effect of rapid flow and higher initial porosity in the fractured zone of the caprock, inhibits the sealing process and allows fluids from reservoir to circulate through the fracture.

48-12 Poster Minelli, Giorgio

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CO2 INJECTION VS. RE-ACTIVATION IN FRACTURED RESERVOIRS

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Key terms: carbon dioxide; reservoir; reactivation; injection

Geological storage of CO_2 in underground reservoir is a possible short term way to assist the reduction of greenhouse gas emissions. Suitable sites for the storage of CO_2 volumes are represented by structural traps where the presence of a seal is able to avoid fluid escape.
A multidisciplinary approach that requires the knowledge of in situ stresses from drilling data, fault distribution from depth-converted 3D seismic surveys and rock strength from rock deformation experiments, is fundamental in order to discriminate the key areas sustainable for CO_2 injection. In particular, the effects of CO_2 injection on the evolution of effective stresses need to be estimated to prevent the damage of the sealing horizon by fluid-enhanced fault reactivation.
Fault reactivation is governed by Amonton's law:

$$\tau = \mu_s \sigma'_n = \mu_s(\sigma_n - P_f)$$

where τ and σ'_n are respectively the shear stress and the effective normal stress acting on the plane and μ_s is the Byerlee's friction coefficient, that is in the range 0.60-0.85. Reactivation on a pre-existing fault occurs when:

$$T_s = \tau/\sigma'_n > 0.6\text{-}0.85$$

where T_s is defined as the slip tendency.
Simple slip tendency plots - i.e. stereoplots of the T_s value for all the planes in the 3D space - are a useful tool to predict stress evolution during CO_2 storage. By using slip tendency stereoplots the T_s evolution during CO_2 sequestration and associated fluid pressure increase can be estimated. The upper limit for CO_2 injection is represented by the value of the pore fluid pressure that allows $T_s > 0.6$ for the fault planes of the reservoir.
Therefore, once the fault geometry and the applied stress field are known, the code could be an easy to use, quick and powerful tool to estimate sustainable fluid pressures for CO_2 injection before fault reactivation and associated reservoir seals damage occur.

SESSIONE 49

T13 - Depositi sedimentari marini controllati dalle correnti di fondo - Bottom-current-controlled marine sedimentary deposits
Venerdì 23 Settembre 2005 - ore: 14:00
Aula: 8

Convener e Chairperson: Rebesco Michele, Trincardi Fabio

49-1 Invitato Viana, Adriano

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SANDY CONTOURITES OF APTO-ALBIAN SERIES OF THE VOCONTIAN BASIN(SE FRANCE): A COMPARISON WITH MODERN UPPER SLOPE CONTOURITES OF CAMPOS BASIN, BRAZIL

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Key terms: Contourites; France; Brazil; Albian; Sand

Modern shelf edge and upper slope deposits from Campos Basin (SE Brazil) provide an excellent basis to evaluate the control of the hydrodynamic forcing mechanisms on sedimentation and the resultant depositional geometry and facies organisation of sandy contourites. Outcrop analysis of the Aptian-Albian series of Vocontian Basin, SE France, provided the identification of a series of depositional elements that strongly suggest a comparable evolution and similar dynamics aspects for their construction to the Campos Basin contourites where the ultimate control on the sedimentary accumulation is the longitudinal drift of sediments carried by a surface slope boundary current. The main elements observed in this system are a sand-rich outer shelf with strong shelf currents inducing sand waves migration towards the slope with their offshelf transfer by gravity flows; and a narrow upper slope erosional terrace, swept by a western boundary surface current, flowing in a opposite sense in respect to the shelf currents. The contourites are developed upon the terrace, and are mostly constituted by medium- to fine-grained, siliciclastic to mixed, cross- to planar-stratified sands, presenting an extent sand dunes field migrating longitudinally above the terrace. The terrace is interrupted by a canyon head which is lateral infilled by the migrating sand dunes. Economic implication of these deposits is very large since they correspond to a new exploratory play for hydrocarbon reservoirs.

49-2 Invitato Mulder, Thierry

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SEDIMENTARY PROCESSES IN THE GULF OF CADIZ

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Key terms: Sedimentary processes; contourites; Mediterranean Outflow Water; Cadiz; Deep sea

The Gulf of Cadiz represents the pathway of a strong, warm (13°C) and saline (> 37 g/l) current called the Mediterranean Outflow Water (MOW) which comes out of the Mediterranean and spreads in the mid-depth North Atlantic at water depths of 800-1200 m. Its velocity is > 3 m/s when it flows out of the Strait of Gibraltar and drops quickly westward but still reaches 0.2 m/s at Cape St. Vincent (southwest Portugal).
Out of Gibraltar, the MOW divides in two branches. A geostrophic branch following the isobaths of the Spanish margin (contour current). An ageostrophic branch flowing straight forward towards west.
From east to west, the sediments under the action of the geostrophic MOW branch records the impact of the decreasing energy of this current.
The area located just out of the Gibraltar straight shows high energy sedimentary features: giant scours and furrows, sand patches and ribbons suggesting erosion and/or high competency of the MOW.
Eastward, the MOW carries finer particles and builds giant elongate mounded separated drifts and channel-related elongated drifts that prograde westward. These drifts are made of thoroughly bioturbated silt forming stacked sedimentary sequences called contourites. These drifts grew at the top of flat relict plateaus called planaltos and above a regional discontinuity called Neogene erosional surface. This surface marks the fist activity of the MOW due to the opening of the Straight of Gibraltar at the end of Miocene or at the beginning of Pliocene. Westward, sedimentary bodies are only sheeted drifts resulting from the aggradation of contourite sequences. Inactive (relict) drifts are also present.
In the most distal part of the Gulf, the low energetic MOW that moves alongslope interacts with gravity processes that flow downslope through canyons and valleys with erosive flanks. Interaction of the MOW and gravity currents is suggested by the lateral shifting and filling of incisions located on the drifts below the present seafloor, and unusual phenomenon of capture of submarine valleys.
The ageostrophic part of the MOW is either channelled or spills over a sedimentary levee. Channels can form by retrogression following an initial failure. At their mouth, sediment accumulates in the form of small sandy contourite lobes. These observations suggest that the Gulf of Cadiz system shares many similarities with channel-levee complexes formed by turbidity current activity.
Slumps are localized on steep slope areas. They are due to oversteepening and overloading. In addition, frequent earthquakes (such as the 1755 Lisbon earthquake) and the constant current shearing generate widespread sediment deformation and instability of contourite deposits.
Deep marine currents such as MOW are strongly influenced by climatic changes that are recorded by contourites. In the Gulf of Cadiz, the MOW intensifies during cold periods. The change in MOW intensity and pathway impacts the deep-water circulation in the Atlantic Ocean.

49-3 Orale Rebesco, Michele

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CONTOURITES: STATE-OF-THE-ART AND OPEN QUESTIONS

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Key terms: Contourites; Geometry; Facies; Mediterranean Sea; Alps

Contourites are sediments deposited or substantially reworked by the powerful action of bottom currents. Their study is widely accepted to be important in 3 main respects: 1) paleoclimatology/paleoceanography, 2) hydrocarbon exploration, and 3) slope stability. Nevertheless the detailed significance of bottom currents in such three respects has not been completely decoded yet. A wide international multidisciplinary effort is hence still needed to improve our knowledge and to help tackle such questions.
A further, crucial open question is represented by the diagnostic criteria to recognize and differentiate the record of bottom currents, especially with respect to that of turbidity currents. Although in some instances sediment drifts may be clearly recognized on the basis of seismic profiles according to widely agreed criteria, a rigorous identification generally requires complementary supporting data. Different sets of sedimentologic criteria and diagnostic sedimentary structures have been proposed, but a broad consensus has not been reached yet. Terminology of contourites drifts is also not totally defined yet. Most contourite workers currently agree on very broad definitions and on the use of most terms. However, the present state of contourite terminology usage is possibly still too loose to consent a clear description of the sediments and consequently a clear understanding of the depositional processes. Moreover, there is a large variety of contourite types , ranging from those that occur closely interbedded with other deep-water facies to those that build up individually distinct bodies (sediment drifts). Repeated attempts have been made to categorize the essentially continuous spectrum of contourite accumulations within several type members, which in fact are not totally distinct so that some drifts may fall in more than one type. Finally, contourites are constituted most typically by structureless, highly bioturbated fine-grained