White paper

Drilling below the salt in the Western Mediterranean Sea : the GOLD (Gulf of Lion Drilling) Project.

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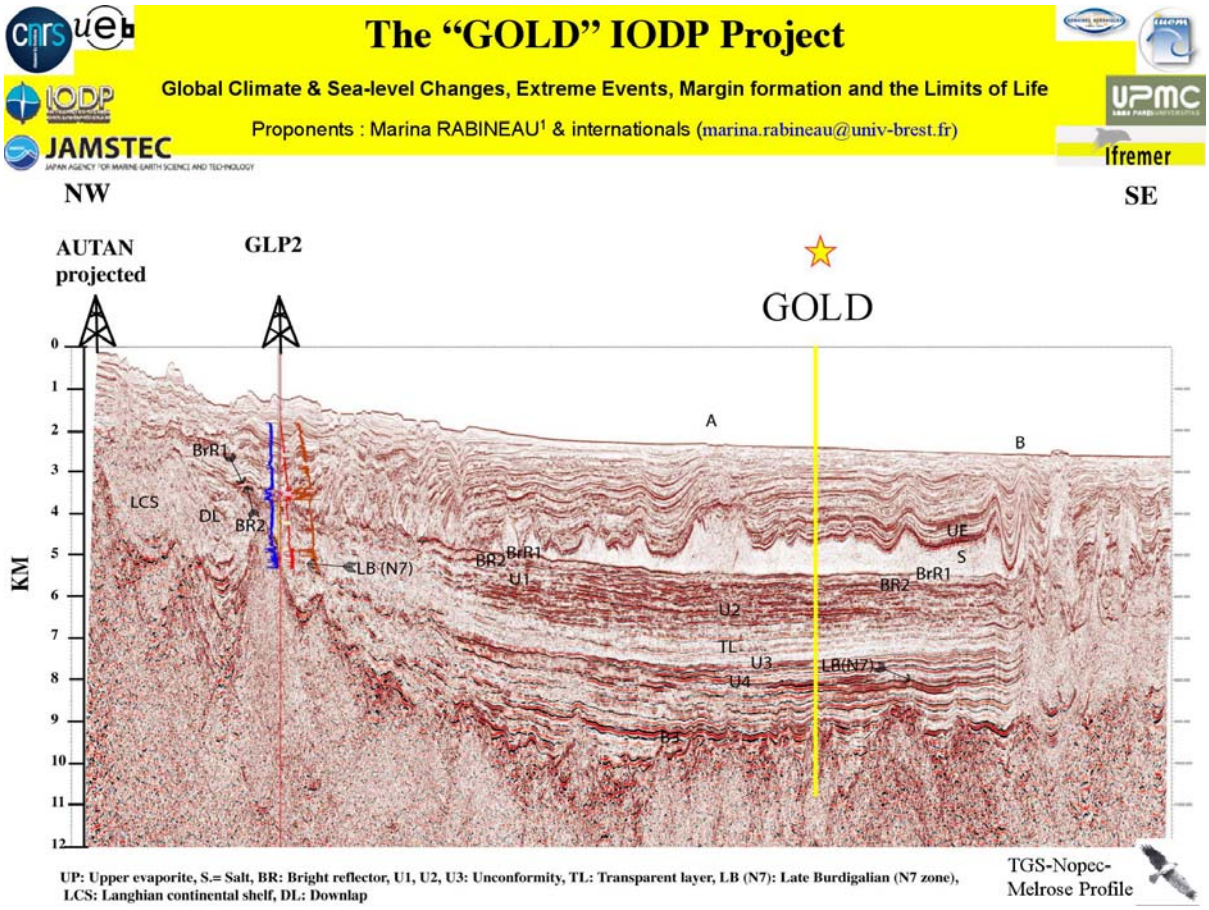
In recent years the Gulf of Lion within the Occidental Mediterranean Sea has become a unique natural laboratory for the study both the evolution and interaction of deep processes (geodynamics, tectonics, subsidence, isostasy) and surficial processes (river behavior, sedimentary fluxes, sea-level changes, climatic impacts). Here, representing a large group of international researchers, we present the main objectives for a deep drilling project at the foot of the continental slope (2400 m water depth) in the Gulf of Lion. This position is the only place in the Gulf of Lion where the sedimentary column is expected to be complete without major erosional hiatuses or time gaps. It is located sufficiently far from the shelf and slope to not have been affected by the extraordinarly erosional event of the Messinian, and at the same time be free from salt-related faulting and diapirism. At this position we have recorded nearly a complete high-resolution history of the last 23 through 30 Ma of Mediterranean history in some 7.7 km of sedimentary archive. From the petroleum exploration perspective the deepest part of the margin reamain underexplored since all existing wells were drilled on the shelf and slope GLP1 & 2 being the deepest one (Fig. 1). New interpretations in the region (especially concerning the Messinian event) have considerably changed earlier views of potential hydrocarbon reservoirs.

New results expected from deep drilling are numerous:

1) For the substratum, seismic reflexion data (ECORS and SARDINIA) quite clearly image the limit between continental crust and transitional substratum at the toe of the slope. Here highly reflective lower crust that is clearly visible below the shelf disappears. Refraction data confirm those observations: the upper continental crust thins to less than 5 km, and changes laterally to a relatively thin crust with high velocities whose precise nature is still undetermined (Gailler et al., 2009). Magnetic maps also indicate a large smooth domain as is sometimes observed at the foot of the margins around the world. The aim of the drilling is to reach this crucial information on the puzzle of the nature of this crust which, in association with precise kinematic and paloebathymetric reconstructions, is essential for the understanding of the evolution of the sedimentary basin (Aslanian et al., 2009).



2) The Gulf of Lion receives most of its sediment eroded from the Alps and transported through the Rhône River. The amount of sediment is expected to vary significantly depending on the existence or the absence of glaciation. The drilling will allow the dating and characterization of the impact of the initiation and changes in glacioeustatic cyclicity in alpine glaciers and ultimately on sedimentation in the deep basin during Plio-Quaternary interval. For the Miocene and older sediments the drilling, combined with seismic reflexion data, will yield information about the nature, paleoenvironments and age of deposits enabling an astronomically-tuned Neogene time scale to be refined for the period of Aquitanian through Langhian interval. Sampling these deposits will also proide key elements to reconstruct the early history of margin formation and subsidence testing recent work that suggested that this margin stayed in a high position during early phase of rifting (Bache, 2008).

3) The Messinian extreme event represents a unique sedimentological, hydrological, oceanographic, biological and probably climatological crisis in Earth history. It is a unique case to study the impact of sea-level drop (more than 1000 m, one order of magnitude greater than Late Quaternary glaciations) on sedimentary river behavior, deltaic and evaporitic deposition and ensuing biotic crisis. Furthermore, the amount of Messinian deposits (detritics, evaporites and salt) have been inferred to have reached more than 3000 m in thickness which corresponds to a massive depositional rate. Such rapid and vast erosional and sedimentation rates must affect continental margin dynamics (isostatic readjustment, behaviour of the upper mantle) in a significant way. So far old DSDP and IODP drilling have reached only the upper part of the evaporites, and thus the beginning of the crisis is still a matter of intense debate and conjectures. Our observations suggest a thick series of "lower evaporates" under the halite resting above a major detritic series (Bache et al., 2009). Other interpretations suggest

less amount of Messinian detritics and pre-Messinian canyons (Lofi & Berné, 2008) or evaporite deposition before major the detritic phase and without a sea-level drop (Krijsmann, 1999). Deep drilling with the R/V Chikyu is the only way to go through the complete series of evaporites in the Provence Basin, sample the initiation and evolution of the crises, the first deposits related to the lowering of sea-level on the one hand and to the salinity crisis on the other.

4) Finally, this drilling will represent the first opportunity to study the composition and functioning (metabolic processes and products, regulation of populations, etc.) of the microbial communities (bacteria, Archaea, viruses, fungi and protists) from the deep biosphere of the Mediterranean Sea. This site is particularly relevant to address the question of life's tolerance to environmental extremes since extreme conditions such as high P, high T°, salt layers (are there organisms in salt inclusions?) and particular organic matter content were prevailing. The ultra-deep drilling should reach 7700 mbsf while the current deepest detection for molecular signatures of microbes is at 1626 mbsf (Roussel et al. 2008). Consequently, it would represent an opportunity to determine the limits of life in terms of depth and physico-chemical constraints. This drilling is also relevant to study of dispersal and evolution (isolation during Messinian salinity crisis) and the interaction biosphere with geosphere.

We invite all interested scientists to join us in planning and promoting this drilling project. We are proposing an IODP Magellan workshop in Banyuls on 3-5 March, 2010 to bring together all interested scientists and stake-holders around this proposal and other drilling projects in the Mediterranean Sea. Please contat us at the earliest opportunity.
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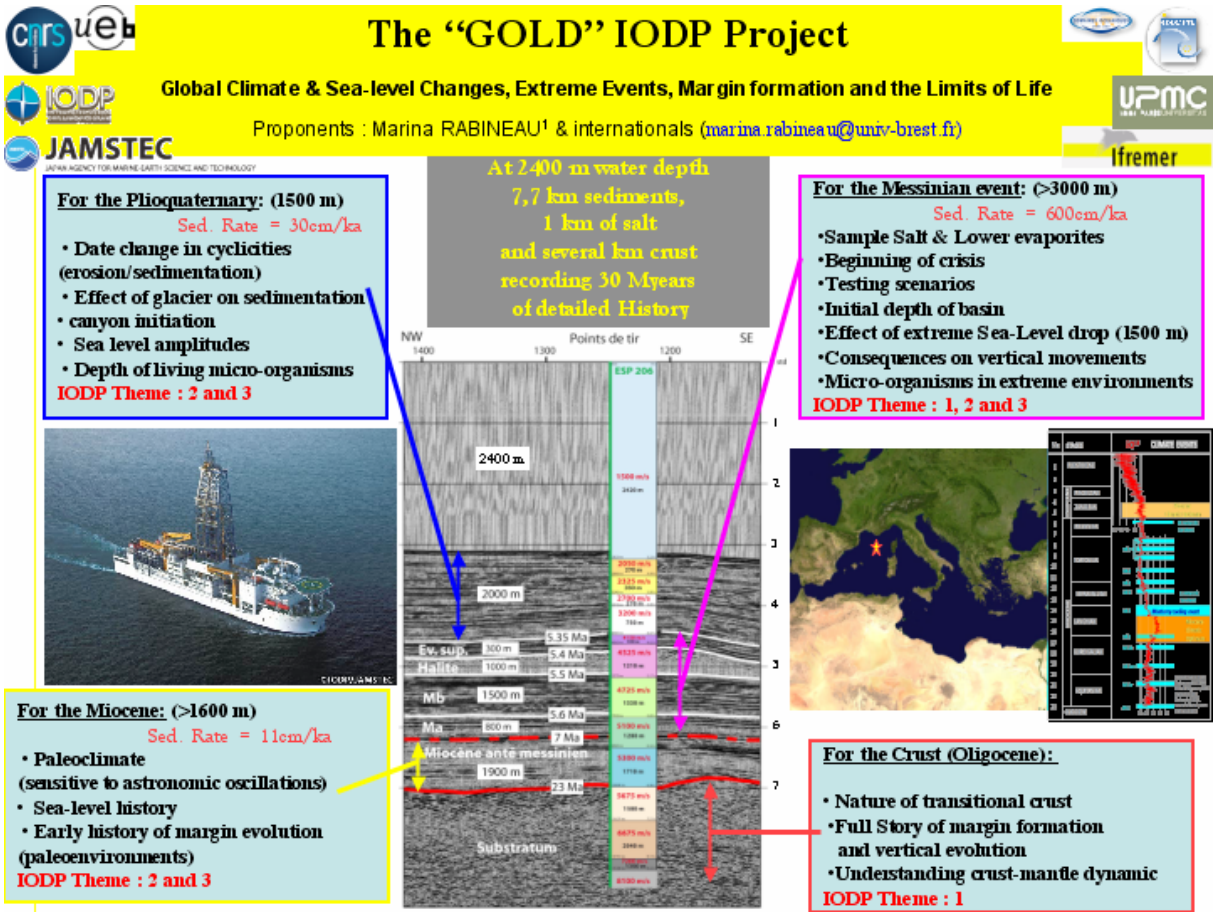

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