

ESF-Institut Carnot Edrome-INSU-Actions Marges Science Meeting in Banyuls: the GOLD project, drilling in the Western Mediterranean Sea.

SCIENTIFIC AND FINANCIAL REPORTS

An ESF Magellan Workshop Series supported by ESF-EDROME-INSU-CNRS-ActionMarges has been held successfully on 19th-22nd October 2010 in l'Observatoire Océanologique de Banyuls-sur-mer, FRANCE. Despite a general Strike in France (on the 19th-20th -21st October) most participants (57 out of the 60 registered scientists) managed to arrive in Banyuls, so the strike did not hamper the meeting.

The "GOLD" IODP Project aims to study Global Climate Changes, Extreme Events, Margins formation, Sea-level changes, Natural Resources and the Deep Biosphere in the Gulf of Lion with dedicated drilling Platform (MSP, Joides and Chikyu). It should be emphasized that no drillings dealing with pre-5million year exist in the Mediterranean Sea.

Scientific Organizer : Marina Rabineau, LDO, IUEM

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Organizing Committee :

Marina Rabineau, (LDO, IUEM), Daniel Aslanian, (IFREMER), Christian Gorini (Istep, UPMC), Karine Alain (LM2E, IUEM), Delphine Rousic (IFREMER), Agnès Agarla (LDO, IUEM), Murielle Dubreule (LDO, IUEM)

LIST of speakers and participants

Altogether 60 scientists were registered to the meeting (convenors, speakers and participants). The list has been provided online.

SCIENTIFIC CONTENT OF AND DISCUSSION AT THE EVENT

The Gulf of Lion has appeared in the last years as a unique natural laboratory to study both evolution and interaction of deep processes (geodynamics, tectonics, subsidence, isostasy) and more surficial processes (rivers behavior, sedimentary fluxes, sea-level changes, climate impact...). Here, we present, in the name of a large group of international researchers, the main objectives for a deep drilling **GOLD-1** project at the toe of the continental slope (2400 m water depth) in the Gulf of Lion and **GOLD-2** project on the shelf (30-120 m water depth).

The position of the GOLD-1 drilling is the only place in the Gulf of Lion where the sedimentary column is fully complete without major erosion and hiatuses. It is located sufficiently far from the shelf and slope to be saved from the Messinian outstanding erosional event, and also free from salt faulting and salt diapirs that deform deposits. At this position we record the full and very high resolution history of the last 23-30 Ma of earth history within 7.7 km of sedimentary archives.

FINAL MEETING PROGRAM

Tuesday 19th October 18h00

Welcome and Ice breaker at St Sébastien Restaurant

Day 1 : Wednesday 20th October

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The GOLD Project and Themes development

8h00-8h10: General Welcoming by **G. Jugie**, for the director of the Observatoire océanologique of Banyuls-sur-mer

8h10-8h30: Aims of the Workshop, Program and overview of GOLD project:
2 drilling sites, 5 themes : **M. Rabineau**

8h30-8h40: International significance of the GOLD project: (**B. Haq**, NSF)

8h40-9h10: Technological challenges for exploring the pre-salt reservoirs (Aptian carbonates) in SE Brazil (**A. Viana**, Petrobras)

9h10-9h30: Salt in South Atlantic océan, comparaison with the Messinian salt (**P. Szatmari**, Petrobras)

9h30-9h50: Petroleum Geological Implications of a Deep IODP well on the Rhone Maritime Permit (**E. Lalande**, Melrose)

9h50: Coffee break

10h00-11h00: Presentation of themes and questions

Theme 1 : Deep Biosphere (**K. Alain**)

Theme 2 : Margin Formation (**D. Aslanian**)

Theme 3 & 4 : Paleoenvironments, Paleoclimate & Messinian Event (**J.-P. Suc**, **C. Gorini**, **F. Sierro**, **F. Lirer**)

Theme 5 : Resources (**F. Roure**)

11h00-11h20: The Chikyu Drilling facilities (**N. Eguchi**, CDEX, JAMSTEC)

11h20-11h50: ECORD and IODP : (**C. Mevel**, IODP-ECORD)

11h50-12h30: Questions & Discussion

Lunch at the Station Océanologique

14h00-16h30: Subgroups meetings for the 4 themes with Group leaders (with notes secretary):

Theme 1 – Deep Biosphere –

Convenors: **K. Alain & O. Rouxel**

Theme 2 (Margins) & Theme 5 (Ressources)

Convenors: **A. Viana & D. Aslanian**, **F. Roure & P. Guennoc**

Theme 3 & Theme 4 (Paleoenvironments, Paleoclimate, Messinian)

Convenors: **F. Lirer & J-P Suc**, **F. Sierro & C. Gorini**

16h30: Coffee break

17h00-19h00: Short presentation (15 mn) from Subgroups leaders and Discussion-Summary

20h00- Diner and Wine testing at St Sebastien Restaurant

Day 2: Thursday 21st October

Pre-drilling geophysical data acquisition & Geological Excursion

8h30-9h00: Pre-drilling 2D and 3D seismic project (**E. Lalande**, **Melrose**)

9h00-9h15: The Chikyu Requirements (**N. Eguchi**, CDEX, DV Chikyu office in JAMSTEC)

9h15-9h30 : Analytical Techniques used in Geochronology; Examples from the Western Mediterranean (**G. Scott**, BGC)

9h45-11h00: Subgroup discussion

GOLD-1: Chikyu (salt and below) (Convenor : **M. Rabineau & A. Droxler**)

GOLD-2: MSP (on the shelf) and Joides (Plioquaternary) (Convenor : **J. Lofi**)

11h00-11h45: Summary of discussion

11h45-20h00: Excursion and Picnic in the nearby outcrop in Roussillon Basin: Impact of the Messinian Salinity Crisis (**G. Clauzon**, **J-L Rubino & J-P Suc**).

21h00- Diner at Les Elmes Restaurant

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Day 3: Friday 22nd October
ICDP-IODP projects in the Mediterranean Sea

8h30-9h00: Synthetic presentation of results from the last 2 days (M. Rabineau)

9h00-9h30: L. Gibert– The Neogene Continental Record from a proposed ICDP project in SE Iberia (LARSEI (Lacustrine record of SE Iberia))

9h30-10h00: Discussion on the links between ICDP-IODP projects

10h00: Coffee break

10h30-12h30: Discussion on the building of a **GOLD consortium (Convenors : B. Goffe, F. Roure, L. Lemoine, X. Bourdon)**

12h30 - Lunch for invited proponents and convenors

14h00-17h00: Ongoing Discussion on the building of a GOLD consortium (Convenors : B. Goffe, F. Roure, L. Lemoine, X. Bourdon)

DELIVERABLES

Organisers did produce two booklets for the meeting and videos of all presentations:

- A general booklet with Workshop Program with logos of ESF and co-sponsors (a pdf file or hard copy can be provided)
- A Field Guide for the geological Excursion with logos of ESF and co-sponsors (a pdf file or hard copy can be provided)
- All (non –confidential) presentations were filmed and have been posted online and are accessible at <http://www.congres.upmc.fr/gold/>

DISCUSSION AT THE EVENT

Discussions were organised in three sessions for the three main topics, a number of questions were raised during the discussion by group leaders and participants and are summarized hereafter.

Topic 1 : Deep Biosphere

A. Scientific questions to be addressed in proposal

GOLD-1 represents a world-class opportunity to study the microbial communities from deep marine sediments of the Mediterranean Sea, the so-called ‘deep biosphere’. The site is particularly appropriate to address the question of life’s tolerance to environmental extremes and habitability since extreme conditions, such as high P, high T°, salt layers and particular organic matter content, characteristics which all prevail at the GOLD-1 site. They will allow us to investigate for the first time the combined effect of increasing temperature, pressure and salinity on the deep subsurface microbial communities, and to look for(hyper)thermohalopiezophiles. The core will also be relevant to issues of dispersal and evolution because the GOLD site was affected by the Messinian salinity crisis and therefore exhibits impermeable layers. At the drilling location, seismic data suggest the presence of evaporates and a thick halite-rich zone and intercalations of carbon-rich horizons where high level of microbial activities might be observed. As the 1 km salt layer was deposited in a relatively short time (600ka), we have a unique opportunity to test the survival of the inoculum over this period, and also to compare the microbial communities above and below the salt. These communities may be different due to differences in the inoculum, evolutionary effect or differences in the physicochemical parameters. The question of a possible connection between ancient and modern hypersaline environments of the

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Mediterranean Sea may also be addressed. The ultra-deep drilling GOLD should reach 7700 mbsf whereas the present-day deepest detection for molecular signatures of microbes is 1626 mbsf. Consequently, it would also represent an opportunity to determine the limits of life in terms of depth. It is also an interesting site to study the deep carbon cycle and the microbial degradation of organic carbon at high temperature, in a habitat potentially rich in hydrocarbons and with an endless source of terminal electron acceptor (sulfate from evaporites). Finally, the deep subsurface communities of the GOLD site might be attractive for biotechnological industries (archive of novel genetic material) and oil companies (problematics: microbial hydrocarbon degradation, paleosterilization, sulphide production/oil souring, etc.).

Proposition for major questions:

- Does the combined effect of increasing temperature (& pressure) and salinity restrict or enhance microbial activities?
- Is there life in salt layers? Is life stimulated at geological/geochemical interfaces?
Hypothesis: Interfaces with shale-rich horizons will possess high levels of microbial activity, higher than in the overlying clay-rich sediments, despite the increased temperature / salinity.
 - Are there differences in communities above and below the salt representing (i) differences in inoculum, (2) evolutionary effect or (3) differences in physicochemical parameters (salinity, temperature)?
 - What are the limits of life in terms of depth and of environmental properties?
 - Microbial degradation of organic carbon at high temperature, limit/overlap between biotic *versus* thermogenic sulfate reduction?

Topic 2 & 5 : Margins Formation and Resources

A. Scientific questions to be addressed in the proposal

GOLD-1 also represents an opportunity to address fundamental questions regarding the processes by which continental lithosphere can thin to form passive margins bordered by 'transition zones' of anomalously thin crust, through access to the crustal substratum and the history of subsidence and heat flow recorded by the overlying sedimentary succession. The presence of a transitional zone of highly thinned crust in the Gulf of Lions is clearly imaged by seismic reflection profiles (ECORS and SARDINIA data) across the margin, which show highly reflective lower crust to disappear seaward across the toe of the slope; this is confirmed by refraction data that indicate a lateral change to a relatively thin (<5 km) crust with high velocities, whose precise nature is unknown. Magnetic maps also indicate a large smooth domain, as observed at the toe of other 'transitional' passive margins around the world. The aim of the drilling is to obtain crucial information on the nature and age of this puzzling crust in order to test competing models for its formation as a consequence of lithospheric thinning (e.g. crustal thinning, lower crust exhumation, mantle unroofing and serpentinitisation). Such models will be further constrained by paleoenvironmental and paleobathymetric analyses of the overlying sedimentary succession to reconstruct the subsidence history of the margin, and complementary analyses of the possible impacts of extreme crustal thinning on heat and fluid fluxes over time. The proposed organization for the proposal needs to emphasize regional questions and setting (chronology, geometry, geodynamics, geomorphology, climate, etc.) which can be successfully analyzed by the GOLD project and exported to a more global approach.

1. Margins Formation

A. Regional questions

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- What is the composition of the crustal substratum in the study area, which is known as an allochthonous zone and is thought to be transitional between continental and oceanic crust? Test of different models. (Biomarkers in the fluids)

- What is the geothermal gradient at that depth in this area? How does it relate to gradients measured at surface, has the presence of salt influenced the flow of heat from the Earth's interior. (Geodynamic model). Connection with Deep Biosphere

- Subsidence history and nature of the syn-TOC sedimentation? Can we quantify the paleobathymetry (using bryozoans, pteropods, ostracods, benthic foraminifera, transfer function) to estimate accommodation/evolution ?

- Can potential volcanic ashes in the sedimentary layers be used as chrono-stratigraphic markers? Absolute ages (K-Ar, Ar-Ar, U-Th)? Where did they come from? What composition?

- How have high-amplitude variations in sea level (and sediment supply), both during the Messinian crisis and during glacial-interglacial cycles of climate, impacted the stratigraphic record?? What was the response of the Lithosphere (in terms of vertical movements)

- How has the flux of fluids, including gas, impacted on the history of diagenesis (argillaceous minerals - gibbsite, kaolinite, illite, smectite - and zéolites, prehnites) or of sedimentation (e.g. impact of gas hydrate destabilization during the Messinian crisis and during glacial-interglacial cycles of climate)

Did evidences of the Pyrenean orogeny still preserved? How many extension phases are preserved?

B. General (global?) questions

- What controls transitions from orogenically thickened lithosphere to rifting and passive margin formation within evolving plate boundary zones (e.g. Africa-Europe, North Atlantic)?

- What is the process by which continental lithosphere can be thinned to generate broad zones of anomalously thin crust (transitional crust)?

- How might the flux of solids, fluids and heat during such a process (of strain delocalization during extreme crustal thinning) impact on the resulting crustal structures and materials (igneous, metamorphic)?

- What is the possible impact of extreme crustal thinning on the syn- to post-rift evolution of subsidence and sedimentation on rifted continental margins?

- Is the post-rift history of rifted margins truly passive (i.e. decaying subsidence), or does it include vertical and horizontal movements that might be explained by dynamic interactions of the lithosphere with the upper mantle?

- What is the relative importance of tectonics, sediment supply (climate) and sea level in controlling the stratigraphic architecture of passive margins?

- How thermal overprint of the crust correlates with deposition rates?

- How thermal changes during thinning affected the mantle and the crust (mineralogy, rheology...)? What is the duration of the thermal events?

2. Resources

Identification and quantification of potential resource and Geohazards: The GOLD-1 drilling will also facilitate an estimate of potential mineral (e.g. lithium), geothermal and hydrocarbon systems associated with saliferous sedimentary successions. The area of the GOLD-1 drillsite presents evidence of localised seabed seepage of hydrocarbons, across depths where gas hydrates are theoretically stable, suggesting an upward flux of fluids from sub- or supra-salt sources through near-seabed hydrate reservoirs (greenhouse gas concentrators). Moreover, glacial-interglacial cyclicity in the Mediterranean Sea is known to have driven high-amplitude variations in gas hydrate stability, with implications for fluid release and slope instabilities. GOLD-1 thus provides an opportunity to assess the linkages of deeper fluid flow systems to seabed seepage of greenhouse gases, and their possible contributions to the ongoing sedimentary dynamics of the Rhone fan.

Topic 3 & 4 : Paleoenvironments, Paleoclimate and Messinian Event

A. Scientific questions to be addressed in the proposal

Climate Changes: the Gulf of Lion receives most of the sediments eroded from the Alps and transported via the Rhône River to form the Rhone Fan, one of the thickest Neogene depocentres of the Mediterranean Sea. We infer that the volumes of sediment will have varied significantly over Plio-Quaternary timescales according to the existence or not of alpine glaciers and ice caps. We will therefore date and characterize the impact of the initiation of alpine glacial activity in relation to changes in glacioeustatic cyclicities and sedimentation recorded in the deep basin during the Pliocene and Quaternary. For the Miocene and older sediments (Oligocene?), the drill core combined with seismic reflection data, will elucidate the nature of the paleoenvironments. Dating of deposits will contribute to refining the Astronomically Tuned Neogene Time Scale for a very poorly known period (Aquitainian, Burdigalian and Langhian). Sampling these deposits will also give key tie points to define the early history of margin formation and subsidence, as above, and to address basic questions regarding the relative roles of climate drivers, sea level change and post-rift tectonism in controlling the stratigraphic architecture of passive continental margins.

Extreme Events: The Messinian extreme event represents a unique sedimentological, hydrological, oceanographic, biological and probably climatological crisis in the Earth's history. GOLD-1 represents a unique opportunity to study and quantify the impact of an outstanding sea-level drop (more than 1500 m, one order of magnitude greater than the Late Quaternary glaciations) on fluvial discharges, deltaic and evaporitic deposition, and biotic crises. Furthermore, the amount of Messinian deposits (detritics, evaporites and salt deposits) is >3000 m corresponding to an extreme depositional rate. Such important erosion and sedimentation will provide crucial information on margin dynamics (isostatic readjustment). Previous DSDP and IODP drillings have only reached the upper part of the evaporites, the beginning and the development of the crisis is still a matter of intense debate and conjectures. Coring all Messinian series is crucial to understand the origins, the timing of closure and opening of Western Mediterranean connections with the Atlantic and/or Eastern Mediterranean. Our observations suggest a thick series of «lower evaporites», under the halite but above major detritic deposits (Bache et al., 2009). Other interpretations suggest evaporites deposition before major detritic phase under variable water-columns (Krijnsman, 1999). Deep drilling with the R/V Chikyu is the only way to drill through the complete series of evaporites in the Provence Basin, sample the initiation and evolution of the crisis, the first deposits related to the lowering of sea-level on one hand and to the salinity crisis on the other. The proposed organization aims to emphasize regional events or specificities generally well-handled (chronology, geometry, geodynamics, geomorphology, climate, etc.) which can be successfully exported for what concern approaches, results, quantifications, modellings that sets up their general high interest.

1. Ante-Messinian Miocene.

C. Regional questions.

- Exact age of the beginning of terrigenous sedimentation in the Gulf of Lions, and first occurrence of the Rhone deep sea fan (microfossil content, sedimentology, geochemistry)?
- Nature of deep post rift sedimentation (syn TOC, syn and post drift transition).
- Establishment of a precise chronology (foraminifers, nannofossils, $d^{18}O$, $^{87}Sr/^{89}Sr$, radiometric age of possible volcanic ashes, paleomagnetism, astronomical tuning) of this time-interval resulting in some idea on sedimentation rate and maybe on sediment compaction.
- When did the Rhône River appear (a detectable event through strong increase in terrigenous material input: sedimentology, organic matter, pollen grains)?

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- Quantification of paleobathymetry (using bryozoans, pteropods, ostracods, benthic foraminifers, transfer function)?
- Regional climatic evolution (stable isotopes, pollen grains, foraminifers, dinoflagellate cysts, ostracods, diatoms? transfer functions), climatostratigraphic relationships with other more coastal incomplete or low-chronologic resolution offshore records and patchy land records. Changes in deep marine ecosystems during the short and long term astronomical perturbation. May the 1.2 Myr obliquity cycles control the faunal turnover? A possible correlation between continental and deep marine turnover? The calcareous plankton assemblages during the Neogene reveal several changes. Are these changes in sea-surface system only controlled by Mediterranean climate (like changes in continental runoff)? Or the global oceanic climate system is the only drive motor? If both signals are present, can we separate these signals?
- Was the influence of brackish-fresh water input from Paratethys felt at this westernmost longitude (geochemistry particularly the Ba/Ca ratio, ostracods, dinoflagellate cysts)?
- Paleoaltitude reconstruction of the Eastern Pyrenees: was uplift coeval or not with the tectonic structuration of the chain (pollen grains)?

D. General (global?) questions.

- Towards an interdisciplinary bio-magneto-chronostratigraphic framework (planktonic and benthic stable isotope stacks, improvement of the planktonic foraminifer and nannofossil biostratigraphy, pollen grain climatostratigraphy, dinoflagellate cysts stratigraphy, ash layers, main tectonic and sedimentary events) along a continuous paleoclimatic record at mid-latitude for the time-interval 23 (older?) – 6 Ma. Contribution to global modeling from a Mediterranean model.
- A contribution to improve knowledge of sea-level changes.
- Study the Atlantic-Mediterranean water exchange from the Early Miocene to the Late Miocene. Was the Atlantic-Mediterranean exchange always antiestuarine, like today? Evidences for periods of restriction in the Mediterranean Atlantic connection before the Messinian. Proxies to study: stable isotopes, benthic assemblages, geochemistry?
- Question of evaporitic basin genesis is a general key question : some answer here

2. Messinian Event.

A. Regional questions.

- Exact timing of the onset of the Messinian Salinity Crisis (foraminifers, nannofossils, $d^{18}O$, $^{87}Sr/^{89}Sr$, radiometric age of possible volcanic ashes, paleomagnetism) in a central Mediterranean basin (closing definitely the debate on the scenario of the Messinian Event). Biota react in the same way to the onset of this stress. Are present discrepancies and why?
- Was this onset of the Messinian sea-level drop sudden or progressive (bryozoans, ostracods, benthic foraminifers, sedimentology, geochemistry)? Was any effect in the deep basin of the first step in sea-level drop causing evaporite deposition in marginal basins? Which evolution in salinity (foraminifers, ostracods, dinoflagellate cysts)? Is it possible to identify high resolution seasonal changes during the evaporite deposition? The cyclic alternation, as in Realmolte cave (Sicily), may be associate to possible *sub-Milankovitch* cycles or to solar cycles.
- Nature of the successive evaporite masses (sedimentology, geochemistry, micropaleontology), homogenous? Heterogenous (with detritic material? with marine incursions)?
- Datation of halite using possible langbeinite mineral and/or possible volcanic ashes ($^{40}Ar/^{39}Ar$).
- Is the Gulf of Lions halite similar to the Sicilian halite (geochemistry)? to the Levantine basin one (geochemistry, micropaleontology)?
- Depth of the basin at the onset of the Messinian desiccation (ostracods, bryozoans)?
- Which impact of the Mediterranean desiccation on the continental regional climate (pollen grains if any)?
- Is there any evidence of desiccation in the Mediterranean deep sea sediments?
- Evidences of sea-level position during the Lago Mare event(s). Changes in terrigenous input? Any evidence of cyclical sedimentation during this period that can be compared with sedimentary cycles on land?

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B. General (global?) questions.

- Complete investigation of a salt giant (sedimentology, geochemistry, chronology, cyclostratigraphy).
- Effects of extreme sea-level drop.
- Consequences on lithospheric vertical movements of high erosion/sedimentations rates (link Margins).
- Which remaining life in such extreme environments (toward extreme micro-organisms)? Are present bacteria in different parts of the evaporite deposits? What is their significance? (link Deep Biosphere)

3. Pliocene and Quaternary.

A. Regional questions.

- Did a first phase of progressive reflooding occurs (micropaleontology and Ba/Ca ratio)? Which timing (foraminifers, nannofossils, $d^{18}O$, $^{87}Sr/^{89}Sr$, radiometric age of possible volcanic ashes, paleomagnetism)?
- Establishment of a precise chronology (foraminifers, nannofossils, $d^{18}O$, $^{87}Sr/^{89}Sr$, radiometric age of possible volcanic ashes, paleomagnetism, cyclostratigraphy) of this time-interval resulting in some idea on sedimentation rate and maybe on sediment compaction.
- Quantification of paleobathymetry during climatic cycles (using bryozoans, ostracods, benthic foraminifers?)
- Regional climatic evolution (stable isotopes, pollen grains, planktonic and benthic foraminifers, nannofossils, dinoflagellate cysts, ostracods, diatoms? transfer functions), climatostratigraphic relationships with other more coastal offshore records disturbed by the Rhône River freshwater input and patchy land records. Changes in deep marine ecosystem during the short and long term astronomical perturbation. May the 1.2 Myr obliquity cycles control the faunal turnover? A possible correlation between continental and deep marine turnover? The calcareous plankton assemblages during the Neogene reveal several changes. Are these changes in sea-surface system only controlled by Mediterranean climate and/or paleoceanographic system?
- Elaboration of a high resolution Mediterranean millennial climate record for the last million years that can be compared with Antarctic and Greenland ice core climate records.
- Changes in carbonate dissolution throughout the Pliocene-Pleistocene in deep sea sediments from the Western Mediterranean and comparison with Atlantic and Pacific records.
- Was the influence of brackish-fresh water input from Paratethys still felt at this westernmost longitude (geochemistry, ostracods, dinoflagellate cysts)? If yes, how longtime?
- Paleoelevation reconstruction of the Eastern Pyrenees: continued uplifting (pollen grains)?
- Increased Rhône transport during cool to cold phases (sedimentology, organic matter, pollen grains)? Impact on sedimentation rate (sedimentology, chronostratigraphy)? Relationship with continental erosion (organic matter, sedimentology, pollen grains, modelling)?
- When submarine canyons appeared (turbiditic sedimentology)?
- Which record of regional Alpine glaciers (sedimentology)?

B. General (global?) questions.

- Which process at the origin of onset of a mediterranean-type climate (double seasonality) originating from a subtropical climate (pollen grains)?
- Effects of repeated glaciations on terrigenous sedimentation (sedimentology, geochemistry, microfossils)?
- Towards a high-resolution multiproxy (stable isotope, foraminifers, nannofossils, pollen grains, dinoflagellate cysts) continuous paleoclimatic record at mid-latitude for the time-interval 5.33 Ma – Present. Contribution to global modelling.
- Changes in deep marine ecosystem during the short and long term astronomical perturbation. May the 1.2 Myr obliquity cycles control the faunal turnover? The occurrence of strong glacial-interglacial cycles really correspond to drastic changes in calcareous plankton and or in the other biota.
- A contribution to improve knowledge of sea-level changes in a less tectonically active area? Which amplitudes with respect to glacial-interglacial cycles?
- Land erosion vs. basin sedimentation according to climate variability (towards modelling).
- Which release for beginning of submarine canyon cutting (respective influence of climate variations, tectonic instability, sedimentary mass accumulation, river influence)?

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- Water depth of living micro-organisms?

Another general question (out of the chronological frame) resulting from the specific evolution of the Gulf of Lions and bordering lands: comparative evolution between a sedimentary basin fed by medium-size rivers coming from moderate reliefs (Gulf of Lions from 23 to ca.7 Ma) and a basin fed by a large river collector (Rhône) since ca. 7 Ma coming from high reliefs, which in addition has been severely impacted by an outstanding event, i.e. the almost complete desiccation of the sea (Messinian Salinity Crisis).

4- GOLD Consortium discussion 22-10-10

On the last day of the meeting, we also had a discussion on the possibility to build a consortium with oil companies. Represents of Six different companies were present (PETROBRAS, TOTAL, MELROSE, SONATRACH and STATOIL). All companies recognise the drilling as an important source of information. The main problem of their involvement is that the drilling site is situated in the Rhône-Permit Block hold by Melrose, so that no companies would invest in such a situation. However, Melrose informed us that they should release part of their block before the end of the year. We look forward for this information.

ASSESSMENT OF THE RESULTS AND IMPACT OF THE EVENT ON THE FUTURE DIRECTION OF THE FIELD

All discussions during the meeting were very lively and fruitful. Topic discussions enabled to identify key questions raised in the proposal. All participants were enthusiastic and mentioned their interest to go ahead with the project. We decided to keep all the scientific themes because the objectives of the GOLD-1 drilling program are diverse and fully relevant to the science targeted in the new drilling program (as summarized in the INVEST report, IODP New Ventures in Exploring Scientific Targets and Science Plan 2013-2023). They concern four main scientific topics:

- 1) Climate Changes and their impacts on sediments and marine and terrestrial ecosystems and their potential feedbacks: records of sea-level changes, installation of glaciations, extreme events, ...
- 2) The Co-evolution of Life and Planet with a direct relevance for the search for the limits of Life in the Deep subseafloor Biosphere as well as the evolution of life in face of Extreme events (Messinian salinity crisis)
- 3) Deep Earth processes such as the formation of margins with implications for our understanding of mantle and crustal dynamics
- 4) Cross-Disciplinary Research Frontiers (Climate-Tectonic and Biosphere linkages)

Some key points were identified to organize the **future of the project**.

- 1) Final Objective: submit an IODP proposal for the New IODP Program 1st October 2011
- 2) Define international leaders for the project
 - a. We came out with a proposition with : Marina Rabineau (France), Junichiro Kuroda (Japan) and Andre Droxler (USA)
- 3) Organize a new workshop in Tokyo to reach the “Asian“ community.
 - a. We therefore have submitted a new proposal to IODP on 1st December 2010 to held a new Workshop in Tokyo
 - b. We also defined a Steering Committee :

France : Daniel Aslanian, (IFREMER), Christian Gorini (UPMC), Karine Alain (LM2E), N. Thouveny (Cerege), O. Rouxel (IUEM), J. Lofi (Montpellier), F. Lucazeau (IPGP), F. Roure (IPFnergiesnouvelles), E. Burov (UPMC), Jean-Pierre Suc (UPMC), B. Dennielou (Ifremer)
Japan : K. Takai (Jamstec), N. Eguchi (CDEX), F. Inagaki (Jamstec), M. Takeuchi (AIST),

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Dr. N. Ohkouchi (Jamstec)

USA : J. Amend (USA), B. Haq (NSF), L. Giosan (WHOI), G. Scott (BGC-USA), Al Deino (BGC-USA), S.-M. Popescu (LSU)

Canada : M. Constantin (Université Laval)

NZ : F. Bache (GNS Science, Wellington)

Germany : K-U. Hinrichs (Marum, Bremen)

U.K. : R. Flecker (Univ. Bristol), Terry Mc Genity (Univ. Essex)

Italy : F. Lirer (IAMC-CNR, Napoli), D. Praeg (OGS, Trieste), M. Sprovieri (IAMC-CNR, Napoli), S. Lugli (Univ. di Morano), V. Manzi (Univ. di Parma)

Spain : F. Sierro (Univ Salamanca), J. Hernandez-Molina (Univ. Vigo)

Switzerland : J. Mc Kenzie (ETH, Zurich)

Portugal : M. Moulin (Univ. Lisboa)

Netherlands : S. Cloetingh (UV, Amsterdam)

Oil industry representatives (already present at Banyuls workshop) :

A Viana (Petrobras), J-L. Rubino (Total), E. Lalande (Melrose), A. Tizley (Statoil), R. Bracene (Sonatrach)

FINANCIAL REPORT

ACTUAL EXPENDITURE on ESF Grant:

Travel: (only part of Europeans participants) : 6393,11 (FRAM Agency)

Accommodation: 8 316.80 € (SOL hotel, CANAL and Les Elmes Hotel)

Meals: 6263.30 € (Ice breaker-4800 + St Seb-1208.8 + 2 meals committee (254.5))

TOTAL ESF Grant = 20 973.21

Travel: (for US and Japanese participants): paid by co-sponsors

Meals: (at Les Elmes): paid by co-sponsors

Local administrative costs: paid by co-sponsors

Videos during Workshop: paid by co-sponsors (1702,00 €)

Bus location: paid by co-sponsors

Pens and Book: paid by co-sponsors

Field guide: paid by co-sponsors