Life, Earth and Environmental Sciences (LESC)

ACTIVITY
Workshops on Marine Research Drilling
(MAGELLAN WORKSHOP SERIES)

Workshop

Scientific ocean drilling behind the assessment of geo-hazards from submarine slides

Barcelona, 25-27 October 2006

FINAL REPORT

Co-sponsored by

1. Summary

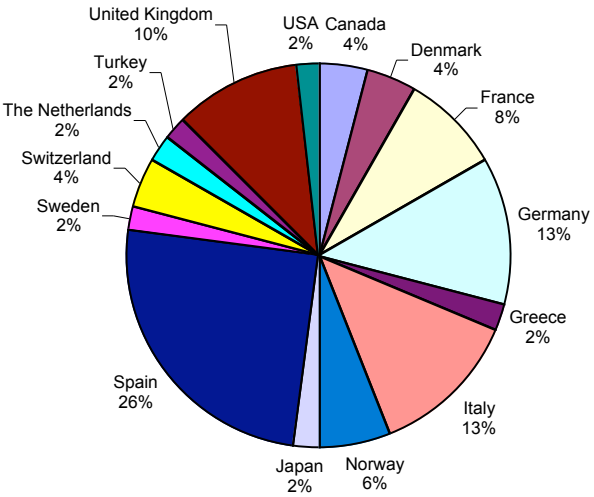
Fifty scientists and representatives of private companies, mainly from the European area, representing a wide spectrum of disciplines such as geophysics, stratigraphy, sedimentology, paleoceanography, marine geotechnology, geotechnical engineering, tsunami modelling, attended the workshop (see the graphics below).

During the workshop, it was agreed that submarine slides represent a geohazard for their destructive potential on seabed structures, for their tsunamigenic potential, and for their capability of methane gas release into the seawater and atmosphere. Scientific drilling offers a possibility to answer a number of scientific questions and test at least two existing hypotheses on basic mechanisms of submarine slides generation and of massive releases of gas.

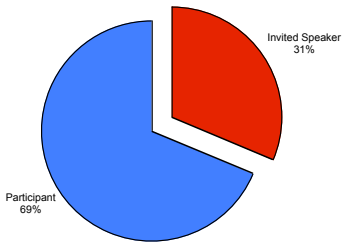
Both mega slides and smaller size slides should be addressed by drilling where slope instability is recognized as a recurrent phenomenon in the stratigraphic succession. Not only sediments that have failed should be studied, but also sediments that are presently undergoing deformation and un-failed slopes should be addressed. The drilling strategies should include classical stratigraphic drilling, dedicated geotechnical drilling, and installation of borehole observatories as well as seafloor observatories.

The outcomes of the workshops are close contacts with other ongoing international initiatives on submarine geo-hazards, and in particular with the organization of the IODP-IMI Geohazards workshop scheduled in summer 2007. An IODP pre-proposal will be submitted in April 2007 to address a suite of medium size submarine slides in different geological environments.

PARTICIPATION BY COUNTRIES



ROLE IN THE WORKSHOP



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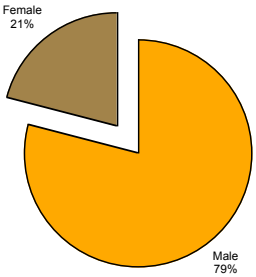

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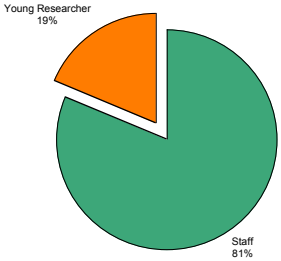

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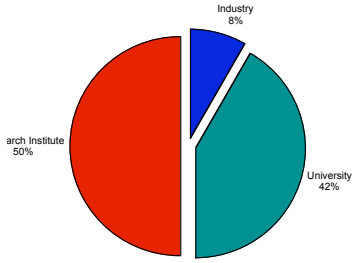

2. Description of the scientific content and of the discussion at the event (max 4 pages)

The workshop was introduced with a review of the **reasons why it is important to study submarine slope instability**. The following list of reasons was agreed:

- It affects offshore infra-structures (platforms, pipelines, cables, sub-sea installations);
- It may affect directly the stability of coastal areas;
- It may trigger tsunamis and affect coastal structures and population;
- It can be used as proxy of paleo-seismicity;
- It affects (destructively and constructively) the marine environment;
- It may trigger or it may be triggered by gas hydrates dissociation;
- It has a relevance to the understanding of natural climate changes;
- There is a relationship between volcanic island eruptions and stability of volcanic island flanks;
- It helps understanding sedimentary basin evolution;
- It helps in reservoir characterization.

With the exception of the last two reasons, and including climate change as a hazard to humanity and to the natural environment, all reasons relate submarine slope instability to hazards.

The **invited presentations** (see section 4) had the purpose to inform the attendees on:

a) The IODP structure and related drilling opportunities (including ICDP).

The concept of MISSION and the analysis of the draft document on MISSION proposals (IODP Missions: Designation and Implementation (Revised Draft: 8 September 2006) by K. Becker, S. Humphris, M. Talwani, Y. Tatsumi, M. Underwood) triggered considerable interest. It was agreed that submarine geohazards are a potential objective for a MISSION proposal. The most interesting point of the concept was considered the intention to follow up Mission projects, once approved in order to guarantee the timing of drilling expeditions and the monitoring of the progress of projects. In this respect Missions will be more attractive than the outcomes of the ODP Detailed Planning Groups, which were very useful to cluster in a coordinated way research proposals focussing to specific objectives, and that lacked of coherent and timely scheduling of drilling Legs.

b) Past and present drilling proposals and drilling expeditions addressing directly or indirectly submarine slope stability.

It was agreed that the following IODP proposals:

557-Full2 Storegga Slide Gas Hydrate Drilling, by *K. Andreassen, J. Mienert et alii;*

633-Full2 Mud extrusion and seamount subduction along the Middle America continental slope – deciphering deep fluid processes at an erosive convergent margin, *by C. Hensen, W. Brueckmann, et alii;*

637-Full2 A Shallow Drilling Campaign to Assess the Pleistocene Hydrogeology, Geomicrobiology, Nutrient Fluxes, and Fresh Water Resources of the Atlantic Continental Shelf, New England, *by M. Person, B. Dugan et alii;*

685-Pre Installation of Borehole Observatories on the Ligurian Margin, *by P. Henry, R. Person et alii*

specifically address either the causes of slope instability (557-Full2) or the mechanisms of fluid migration or the development of pore water overpressures that are important to the occurrence of slope instability (633-Full2 and 637-Full2) or foresee the installation of long-term borehole observatories that should be used also in slope stability post drilling (685-Pre).

IODP Exp. 308 (Gulf of Mexico Hydrogeology) was considered an extremely important experience for future planning of drilling through unstable seafloor because it demonstrated that it is possible to perform controlled riserless drilling in overpressured formations. In addition, it provided important information on the *in-situ* pore pressure measurement capability of the *JOIDES Resolution*, on the important role of Logging While Drilling in unstable holes, and on the drilling strategy of performing logging and in situ measurements before drilling for geotechnical sampling. Because in many instances submarine slides occur in hazardous to drill environments it was considered that the riser capabilities of the Chikyu might offer the chances to investigate submarine slope instability in certain regions.

c) State of the art techniques in drilling and site survey.

The review of state of the art site survey techniques outlined the importance of **high-resolution seafloor mapping** (possibly deep tow, or ROV acquisition). It also showed how important is to integrate bathymetric and backscatter information in order to obtain the best morphologic and acoustic characterization of recent slides to guide suitable site location. Availability of **3D seismic** data was also considered to provide valuable information for appropriate site location in and around a target landslide (unfailed sediments, scar and detachment, evacuation, accumulation). It was shown that for site-survey characterization, where necessary, an efficient, not-so-expensive tool to obtain 3D seismic data is the single channel 3D seismic acquisition system P-Cable developed by the NOC, the University of Tromsø, and a consortium of private enterprises. For appropriate post-cruise geotechnical analyses, it will be essential that the drilling vessel is able to obtain **high-quality undisturbed geotechnical sampling**. It was considered that current drilling techniques on board the JOIDES Resolution do not fulfil this requirement. To overcome this two possible solutions were considered: a) to develop a new generation of thin-walled corers or b) explore the possibilities for chartering a geotechnical drill-ship through Mission-Specific-Platforms (MSP). The use of pressurized core barrels that would avoid or minimize the problem of sample elastic recovery was considered potentially useful in some instances.

Long term monitoring of key parameters in boreholes (pore pressure, hole inclination, ambient acoustic noise etcetera) can utilize the well-established **CORK technology**. For off-site monitoring, a link with **ESO-Net** and other seafloor observatories initiatives was recognized as very important.

After the invited presentations, **discussion** focussed on the following topics:

d) Identify key open questions related to submarine slope instability whose answers can only be found through scientific drilling.

<u>What is the frequency of submarine slides?</u>

Assessment of natural hazards and related risk, no matter which type, requires information of the recurrence interval between events. It is only with drilling and appropriate high resolution stratigraphic and geo-chronologic tools that such frequency can be established for submarine slope failures. To date only a few mega events such as the Storegga Slide off Norway have been dated with sufficient accuracy. Many medium and small size recent submarine slides are known to occur with a qualitative high spatial and temporal occurrence. An open question remained as to which is the size of slides to have into account. It was recognized that some settings (e.g. Canyon heads, seismically active margins) have numerous but relatively small slides, while open slopes of passive margins have relatively infrequent but very large slides.

Which was the tsunamigenic potential of past submarine slides and which is the tsunamigenic potential of un-failed submarine slopes?

The tsunamigenic potential of submarine slides is defined by a number of parameters: Geometrical parameters (slide volume, area, water depth) can be derived without drilling; kinematic parameters (slide acceleration and velocity) can be derived only from the rheology of the sediments involved in the failure, and therefrore sampling and in situ measurments are needed. Evidence suggests that shearing of the landslide mass is significantly different at its base compared to its top and this translates into a distinct profile of physical properties. It is thus clear that insights into the rheology of submarine slides can be obtained through sampling of the failed sediments. Such analysis can also be performed to predict the failure dynamics of an unfailed slope.

Do precursory phenomena of slope failure exist?

In order to improve our prediction capability we need to determine which transient signs might indicate imminent slope instability. For this, it is clearly necessary to long-term monitor a slope that has the necessary ingredients and where slope failure might occur in a relatively short term. Transients in physical parameters that were deemed important were mainly pore pressure, temperature (see for example the Vaiont water reservoir slide, Italy) and hole inclination, but geochemistry of pore fluids should also be investigated, as clay minerals such as smectite may release mineral water during shear (and thus interstitial water may become fresher??). IODP Proposal 685-Pre is indeed a first step towards monitoring the stability of submarine slopes.

Can we monitor seafloor gravitational movements such as creep?

Monitoring is also essential to quantitatively describe how slow deformation of slopes occurs. Seismic reflection profiling has supplied contradictory evidence of distorted slope strata that has been interpreted to result, in some instances, from slow sediment deformation. Through drilling and monitoring of these slopes we think we can provide the clues that allow identifying these features as sediment deformation or not, and in the first case whether they are still active and at which rate are they deforming. Most relevant parameters to monitor in this case are hole tilt and pore pressure.

What makes up weak layers in mid latitude continental margins? When and under which circumstances do weak layers form?

In many occasions submarine landslides are identified, both from multibeam bathymetry and seismic reflection profiles, to be rooted at one or several stratigraphic levels. This/ese level/s most probably represent a "weak layer" that had a fundamental role in landslide initiation, as well as in determining the volume and geometry of the failed mass. In glaciated margins, where contrasting geologic materials exist, weak layers have been identified in contouritic deposits formed during interglacial periods. However it is not clear what determines the occurrence of weak layers in non-glaciated margins or which processes during the sedimentation, burial or early diagenesis tends to form them.

e) Identify hypotheses and models to be tested through drilling.

It was agreed that there are at least two hypotheses and models that could be tested through drilling.

Focussing of fluids and lateral transfer of stresses

Two dimensional modelling of the New Jersey margin suggests that lateral fluid flow in permeable beds under differential overburden stresses produces fluid pressures that approach the lithostatic stress where overburden is thin. This transfer of pressure may cause slope failure initiation at the base of the continental slope (Dugan and Flemings, 2000). IODP expedition 308 was the first attempt to test an hydrogeologic model by which pore fluids are advected laterally under certain loading and stratigraphic conditions, so that pore pressure is transferred to zones of lower overburden over high permeability sediments, thus with an important effect on slope stability there. Similar models of pore fluid advection might occur due to glacial loading of permeable sediments

(e.g. Storegga Slide or Antarctic Peninsula margins), and thus it seems more and more important that we need to **identify the architectures and stratigraphy under which lateral advection of pore fluids might occur**.

Methane emissions during rapid climatic changes and submarines slides

The Clathrate Gun Hypothesis (Kenneth et al., 2000) states that methane emissions from gas hydrates dissociation induced by bottom water warming occur primarily via the emplacement of submarine slides. The un-roofing of buried hydrate-bearing sediments by submarine slides enhances methane emissions from the seafloor by decreasing instantaneously the confining pressure. **The carbon isotope chemistry and the assemblages of benthic calcareous foraminifera living close to paleo-slide heads should be used as a local proxy of massive paleo-methane seeps**. Other biological and microbiological indicators can be used for this purpose.

f) Identify the geological environments that are most prone to slope instability phenomena and which distinctive characteristics are present in each of these environments.

Four geological environments were identified as representative of different processes that lead to submarine slope instability:

NON TECTONIC (PASSIVE) MARGINS – Low latitude passive margins are characterized by isostatic subsidence, rapid burial, *in-situ* methane generation. Conditions of excess pore pressure and consequent underconsolidation are likely to exist. These margins host the largest submarine slides known (Mega slides). Oceanographic conditions favour the deposition of sediment layers that may become 'weak layers' regionally (biogenic oozes, contourite beds).

TECTONICALLY ACTIVE MARGINS – This geological environment includes tectonic accretion and erosion, and strike slip tectonics. Factors influencing submarine slope stability are seismicity, heat flow, vertical fault displacement and slope generation, fluid flow, gas hydrates,mud volcanism, plate morphology (e.g. seamount subduction), and complex stress regimes. Near surface sediments tend to be overconsolidated with the exception of where focused fluid flow occurs. Submarine slides known from theses environments do not reach the exceptional size of those occurring in non-tectonic margins.

GLACIAL MARGINS – Slope stability in these margins is controlled by two primary factors: the along-slope deposition of high-sedimentation rate high-porosity sediments (plumites and contourites) and the rapid load induced by down-slope deposition of glacially derived debris flows. The spatial distribution of ice streams, which determine meltwater plumes and high accumulation rates in trough-mouth fans on the continental shelf, is crucial for the generation of areas of potentially unstable sediments. Steep continental slopes that characterize Antarctic polar margins are not necessarily unstable.

VOLCANIC ISLAND MARGINS – The stability of the submarine slopes of volcanic island depends primarily on the stability conditions of the volcanic slope onshore. Slides are mainly produced on rocks instead of sediments and therefore the approach to study them is also different from the other margins being considered. Volcanic island margin collapses are considered as events with the highest tsunamigenic potential.

Fjords were also considered as distinctive environments, but they were tackled within the glacial margins.

References:

Dugan, B. and Flemings, P.B., 2000. Overpressure and Fluid Flow in the New Jersey Continental Slope: Implications for Slope Failure and Cold Seeps. *Science*, **289**, 288-291.

Kennett, J.P., Cannariato, K.G. Hendy, I.L., and R.J. Behl, 2000. Carbon Isotopic Evidence for Methane Hydrate Instability During Quaternary Interstadials. *Science*, **288**, 128-133.

3. Assessment of the results and impact of the event on the future direction of the field (max 2 pages)

It is to be recognized that until now the geohazards have been only tackled by scientific drilling as a complementary goal. It was admitted during the workshop that **the IODP Initial Science Plan does not address openly geohazards among the program scientific objectives**. Hazards are referred to mainly in relation to earthquakes and initiatives towards the understanding of seismogenesis. Additionally, hazards are mentioned briefly in association with earthquakes-generated tsunamis and sediment destabilization by gas hydrate dissociation. **The workshop participants feel the need of an explicit reference to Geohazard in the next revised version of the IODP ISP, and they offer ECORD their help to formulate suggestions for text to be included in the document.**

The fact that the workshop was co-sponsored and had a formal link with UNESCO's **IGCP-511 project Submarine Mass Movements and their Consequences** will no doubt create a certain awareness on this global community of the possibilities that scientific drilling and IODP have to offer for the study of geohazards from submarine slides. The workshop needs also to be understood in the broader sense of geohazards and coordination was established with the other **ESF Magellan Workshop "Drilling through an active caldera, offshore Campi Flegrei, Eastern Tyrrhenian margin",** 13-15 November 2006 - Naples, Italy, were a M.J: Jurado (attending the Barcelona workshop) reported on the activities that were carried out on the Barcelona workshop with an emphasis on submarine landslides in volcanic ocean islands, which obviously have a direct link with volcanic hazards.

Since the first phases of the workshop organization a formal link was established, with the Steering Committee of the **IODP-IMI workshop on Geohazards** scheduled for the year 2007. Angelo Camerlenghi has been nominated member of that committee in order to ensure the full integration of the ESF workshop results into the programming of the IODP-IMI workshop.

The workshop participants feel that **Geohazards (and submarine slides among them) should be regarded as a potential target for a Mission Proposal to IODP**. However before any action can be taken, it is important that the IODP Science Plan is revised and a broader scientific community has gone through the brainstorming of a focussed workshop such as the IODP-IMI one.

A number of **target areas where submarine slope stability could effectively be addressed by scientific drilling** have been identified (See table below). The space limitation of this report prevents the discussion of the reasons for these choices. Areas have been selected based on a combination of scientific appropriateness and availability of site survey data.

	Margins already considered by existing drilling proposals	**Margins that are candidate targets for future scientific drilling**
NON TECTONIC (PASSIVE) MARGINS	Ligurian, New Jersey	Northwest Africa, New Foundland (Grand Banks), Balearic, Ebro, South Sicily, Nile slope, Israeli, Black Sea
TECTONICALLY ACTIVE MARGINS	Costa Rica/Nicaragua	Nankai, Central Chile, Sumatra, Andaman Sea, Sunda Arc, Gulf of Cadiz, Alboran Sea, Calabrian Arc, Gulf of Corinth Marmara Sea, ESONET Sites in the Mediterranean
GLACIAL MARGINS	Storegga Slide of the Norwegian Margin	North Sea Fan, Bear Island Fan, Svalbard, Antarctica (Wilkes Land?), Greenland, Patagonia, New Zealand
VOLCANIC ISLAND MARGIN	Tyrrhenian Margins (Campi Flegrei Caldera)	Canary Islands, Hawaii, Eolian Islands, Santorini, Etna.

Some general points were agreed on the **strategy to be followed in designing drilling proposals addressing submarine slope instability**.

Drilling proposals should address scientific questions outlined above in any of the geological environments considered. The teams of proponents should include experts on tsunami and deep sea observatories, as well as geotechnical engineering. Paleoceanographers will also have an important role. Addressing submarine slides by scientific drilling is envisioned as a highly multidisciplinary effort.

Proposal should address **mega Slides** as well as **small to medium sized slides**. Mega slides are less frequent but trigger catastrophic consequences both in terms of hazards and of sedimentary basin evolution. The understanding of the mechanics of a Mega Slide might require a **multi-leg effort** and requires a large amount of site survey data. Smaller slides occur with a frequency that might be close to the frequency of natural hazard considered in the determination of the risk (500 years). Although the hazards derived from these slides might not be catastrophic, damage to seabed installations and small tsunami waves may assume catastrophic proportions in densely populated regions. More than one Small to Medium size submarine slide can be addressed effectively in one single drilling expedition. A **multi-platform approach** could be required by the necessity to perform **stratigraphic drilling, geotechnical drilling, and installation borehole and seafloor observatories**.

Drilling should focus on seabed that has already failed, seafloor presently under failure, and un-failed seafloor. Sites where submarine slides occur in the stratigraphic succession will enable understanding of the relations between slope failure and basin evolution.

Future Actions

Besides reporting to ESF and to ECORD, the future actions agreed are the following:

- Interface with the organization of the IODP-IMI Geohazards Workshop in summer 2007.
- Interface with the organization of the 3rd International Conference of Submarine Mass Movements and their Consequences (IGCP 511, Santorini, October 1-3 2007)
- Interface with the organizers of the ESF Magellan Workshop on IODP-ICDP drilling the Campi Flegrei Caldera to coordinate future actions towards Site survey and Proposal writing.
- Write an article to be submitted for publication either to EOS or to the Journal Scientific Drilling.
- Submit to IODP a pre-proposal for drilling of submarine slides in various geological environments of the Mediterranean region.

4. Final Program of the Meeting (attach workshop program)

See following pages.

Barcelona, 20/11/2006

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Scientific ocean drilling behind the assessment of geo-hazards from submarine slides

Barcelona, 25-27 October 2006

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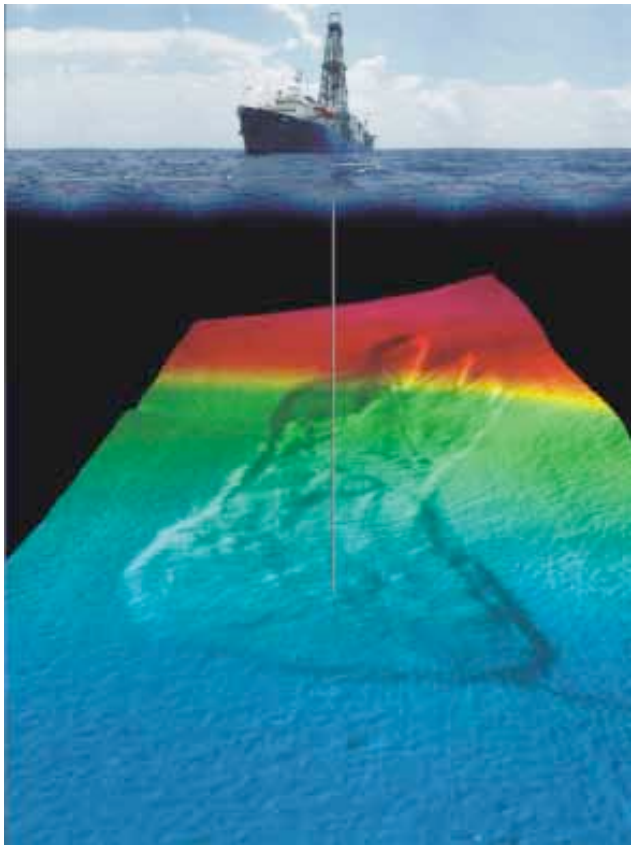

Presentation

None of the DSDP, ODP and IODP drilling legs has addressed openly slope stability. The IODP Science Plan makes explicit reference to geo-hazards as goals of the program in the next decade. Slope instability is included among the hazards derived from natural or anthropogenic gas hydrates destabilization on continental slopes. There is a complex cause-effect relationship between submarine slides and geological processes typically considered as geohazards. Little is known about the geochemical and biological equilibria as well as how fluid flow are re-established after failure occurs. An additional need is to identify areas of ongoing seafloor deformation so as to monitor changes in fluid flow and sediment physical properties in response to imposed stress. Besides the strict relation to submarine geohazards, submarine slides are widespread phenomena that accompany the evolution of continental margins in different geological environments at high and low latitudes. Building on the firm ground of two decades of European cooperative projects on continental margins, the unified European participation to the Integrated Ocean Drilling Program (IODP) through the European Consortium for Ocean Research Drilling (ECORD) offers European marine geo-scientists unprecedented opportunities to plan future research focussed on the assessment of the hazards derived from submarine mass movements.

Objectives of the workshop

The workshop is intended to gather experts in the study of slope instability and young scientists with various levels of expertise, from the strictly engineering aspects, to the regional analyses and the geophysical surveys, from the academic environment as well as from the industry. These experts will review the present knowledge on world wide submarine slides, assess the needs for future investigations through drilling, and develop a concerted strategy and an action plan including initiatives for identifying the necessary funding, for the submission of one or more IODP drilling proposals.

Scientific Committee

Karin Andreassen	University of Tromsø, Norway
Flavio Anselmetti	ETH, Zurich, Switzerland
Warner Brückmann	IFM-GEOMAR, Kiel, Germany
Angelo Camerlenghi	ICREA, University of Barcelona, Spain
Miquel Canals	University of Barcelona, Spain
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Nabil Sultan	IFREMER, Plouzané, France
Pedro Terrinha	INETI, Lisboa, Portugal
Roger Urgeles	University of Barcelona, Spain
Phil Weaver	National Oceanographic Centre, Southampton, UK

Organizing Committee:

Angelo Camerlenghi	ICREA, University of Barcelona, Spain
Roger Urgeles	University of Barcelona, Spain
Gemma Ercilla	ISM-CSIC, Barcelona, Spain

Workshop Programme:

WEDNESDAY October 25 2006

09:00 OPENING. WELCOME FROM THE ORGANIZERS AND HOSTS

09:15 REVIEW OF WORKSHOP GOALS
Angelo Camerlenghi, ICREA-University of Barcelona, Spain

09:30 DRILLING OPPORTUNITIES IN IODP
Dan Evans, BGS/ESO, Edinburgh, UK

10:00 REVIEW OF SOURCES OF SUBMARINE GEOHAZARDS
Anders Solheim, International Centre for Geo-Hazards and Norwegian Gotechnical Institute, Oslo, Norway

10:30 THE ODP AND IODP PROPOSALS TO ADDRESS SLOPE FAILURE ON THE NEW JERSEY MARGIN
Brandon Dugan, Rice University, Houston, USA

11:00 - 11:30 Coffee

11:30 THE STATE OF IODP DRILLING PROPOSAL ON STOREGGA SLIDE ON THE NORWEGIAN CONTINENTAL MARGIN
Speaker to be named

12:00 EC-PROMESS DRILLING IN THE MEDITERRANEAN SEA
Serge Berne, IFREMER, Brest, France and *Fabio Trincardi*, CNR-ISMAR, Bologna, Italy

12:30 SUBMARINE SLIDES AS TRIGGERS OF TSUNAMIS
Stefano Tinti, University of Bologna, Italy

13:15 Questions, discussion, organization of afternoon working groups

13:30 - 14:30 Lunch

14:30 – 16:30 WORKING GROUPS. Preliminary assessment of target areas and open problems

16:30 - 17:00 Coffee

17:00 PLENARY SESSION. Reports of Working Groups leaders. Open discussion.

18:30 End of day 1

Dinner to be arranged

THURSDAY October 26 2006

09:00 STATE OF THE ART IN SEAFLOOR MAPPING
Doug Masson, National Oceanographic Centre, Southampton, UK

09:30 STATE OF THE ART IN SUB-SEAFLOOR MAPPING
Christian Berndt, National Oceanographic Centre, Southampton, UK

10:00 UNDERSTANDING CONTINENTAL MARGIN STABILITY AT A EUROPEAN SCALE
*Miquel Canals***,** University of Barcelona, Spain

11:30 SUBMARINE SLIDES IN THE FOSSIL RECORD
Andrea Pini, University of Bologna, Italy

11:00 - 11:30 Coffee

11:30 IODP TECHNICAL FACILITIES, DOWNHOLE, AND SHIPBOARD
Jan Behrman IFM-GEOMAR, Kiel, Germany

12:00 IMPORTANT GEOTECHNICAL PARAMETERS FOR THE UNDERSTANDING OF TRIGGERS AND FAILURE MECHANISMS
Jacques Locat, Laval University, Quebec, Canada

12:30 BOREHOLE INSTRUMENTATION AND IN SITU MEASUREMENTS
Achim Kopf, University of Bremen, Germany

13:00 Questions, discussion, organization of afternoon working groups

13:30 - 14:30 Lunch

14:30 – 16:30 WORKING GROUPS Identification of key-parameters and site survey needs

16:30 - 17:00 Coffee

17:00 PLENARY SESSION. Reports of Working Groups leaders.
Open discussion on key-factors in drilling:
- Proxies of events (debris flows, turbidites, ash layers, seismites, tsunamites, marker beds, biologic communities)
- Recurrence time of events, chrono-stratigraphiy and time resolution
- Environmental context of events (relation to climatic stages).
- Fault activity. Criteria, indicators.
- Essential *in situ* parameters.
- From 1D to 3D. How to extrapolate in space and time information from drill sites.
- Need for monitoring and identification of key areas for monitoring.

18:30 End of day 2

21:00 Social dinner

FRIDAY October 27 2006

Morning PLENARY SESSION

09:00. PRACTICALITIES IN PROPOSAL WRITING AND EVALUATION
Angelo Camerlenghi, ICREA-University of Barcelona, Spain

09:30 Discussion (breaking up in groups if necessary):
- Open problems and priorities
- Scientific objectives (solutions to problems) for scientific drilling.
- Key-parameters to be extracted
- Site survey needs.
- Ranking of most promising target areas.
- Planning of actions.
  Report writing and distribution
  Clustering of researchers and institutions
  Submission of IODP pre-proposals
  Second Workshop

10:30 - 11:30 Coffee

12:30 CONCLUSIONS and closure (organizers)

13:30 - 14:30 Lunch only for those who reserve the day before (instructions will be given)

NEW!! Important information: During the workshop there will be facilities for displaying posters. If you want to bring any material that you consider relevant to the topic of the workshop (your drilling related science, maps, logs, seismic profiles, ...) there will be vertical A0 panels for displaying such material.

Participants list

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Venue and travel information:

The workshop will take place in the:
"Centre Mediterrani d'Investigacions Marines i Ambientals" (CMIMA)
Passeig Mar'tim de la Barceloneta, 37-49
Barcelona
Tel. (+34) 93 230 95 00
Fax. (+34) 93 230 95 55

The CMIMA is located in between the "Hospital del Mar" and two big buildings recognizable from distance the "Olympic Towers". The CMIMA is well communicated by the public transportation system:

- **Bus**: Lines 10, 45, 57, 59, 71, 92 and 157 have their terminus within a few meters of CMIMA.
- **Metro**: "Ciutadella-Vila Olímpica" station on line L4 (yellow line) is 300 meters NW of CMIMA.

Coming from outside Barcelona:

- **Private car**: Use the "Litoral" ring road (ronda). Take exit 21 direction "Bes˜s" (SW) or 22 direction "Llobregat" (NE).
- **Train**:

_ RENFE: Get off the train at either of the following stations "Sants estació", "Passeig de Grácia", "Estació de França" or "El Clot-Aragó" and then use the metro network.

_ Ferrocarrils de la Generalitat de Catalunya (FGCC): Get off at "Plaza de Catalunya" station, and from ther pick the metro or bus 59.

Coming from the airport, detailed instructions:

- A **Taxi** ride to the Residencia Campus del Mar may take 20 minutes. It could cost around 20 Euros.
- The **bus** is a practical and more economical. The buses are named "Flybus" and depart every 8 minutes or even less from each terminal (just in front of the exit). The tickets are 3.75 Euros. You can buy tickets either form the driver or from machines at the bust stop. In about 20-30 minutes, depending on traffic conditions you will be in "Plaza de Catalunya". From there, the advice is to take a TAXI to the Residencia Campus del Mar (it is about 10 minutes) or otherwise use the Metro. From "Plaza de Catalunya" you need to walk to Metro Line L4 in Plaza Urquinaona and take direction La Pau. Get off two stops later at Barceloneta. Then walk to the Residencia (5 minutes).
- There is a also **train** service to downtown Barcelona, RENFE's trains (Line 10) connect the airport with the stations of "Sants estació" and "Estació de França".

Some useful links:

Barcelona's public transportation system
Official Barcelona website

Accomodation:
Rooms have been reserved for all attendees at the:
"Residencia Universitaria Campus del Mar"
Passeig Salvat Papasseit, 4
08003 Barcelona

All rooms include a fitted kitchen, complete bathroom, heating, telephone and Internet connection. The residence has a 24h desk reception service . The bedrooms are equipped with a bed measuring 200x90 cm, armoire, writing desk, chairs, desk lamp, bookcase unit and mirror.

Find out **how to go from the workshop venue to the residence** using Google Maps:

SEE THE MAP!!!

(note: itineraries on Google Maps are based on driving directions, you may find a shorter/more pleasant itinerary by walking)

Thursday's **social dinner** will take place at (click on link for directions from residence on Google Maps):

La Fonda del Port Olimpic
Moll del Gregal 7-8-9
08005 Barcelona

Doubts? Problems?

For additional information you may contact:

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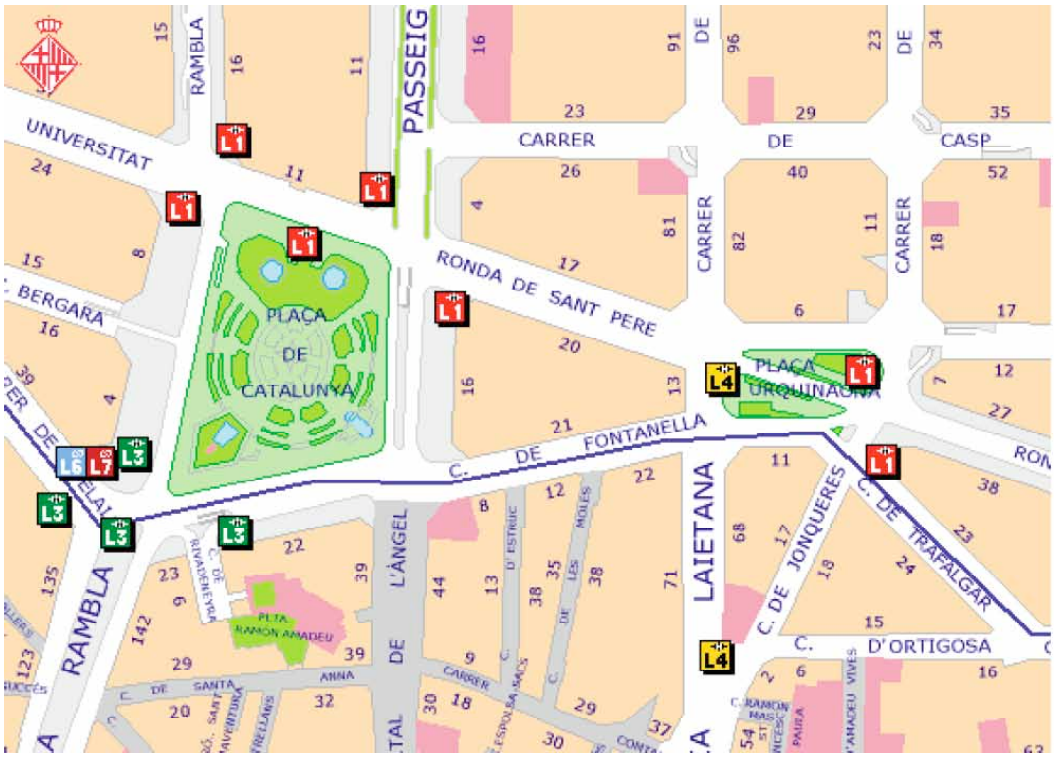
Roger Urgeles	urgeles@ub.edu
Gemma Ercilla	gemma@icm.csic.es

One cellualr phone number to be used in case of REAL problems: Angelo Camerlenghi: 0034-606-969907.

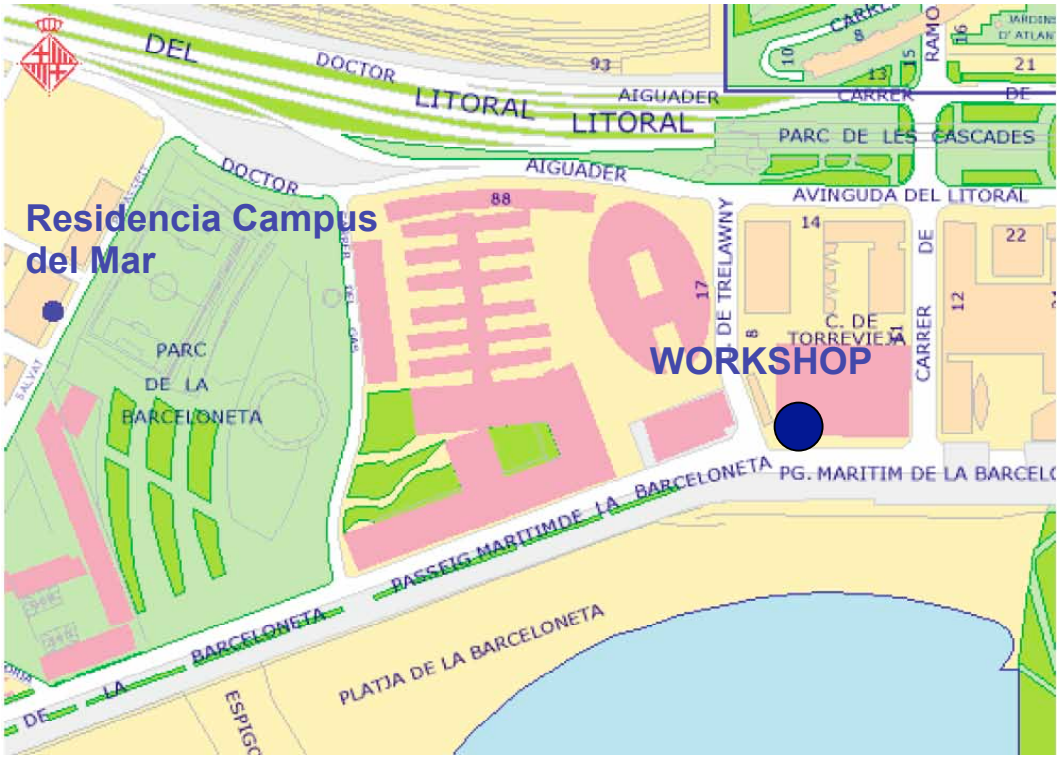
Other maps:

Overview



from Plaza Catalunya to Plaza Urquinaona

from Metro Line L4 stop (Barceloneta) to Residencia Campus del Mar



from Residencia Campus del Mar to Workshop location

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