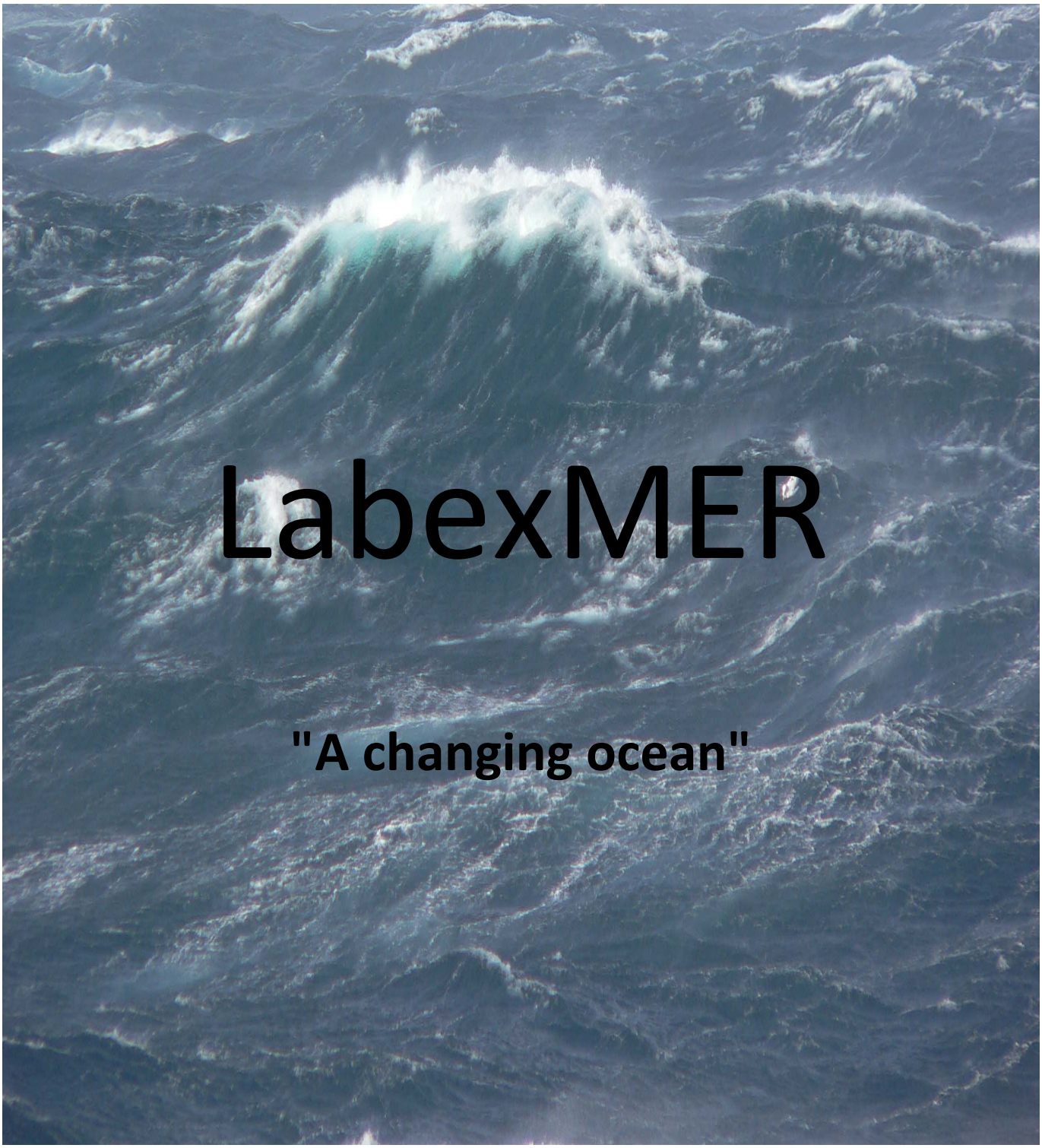

LabexMER

"A changing ocean"

LabexMER - Axe 4	**Research project 2012-2014**	**16/02/2012**

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1. AXIS 4 : SEDIMENT TRANSFER FROM THE COAST TO THE ABYSS

Coordinators: Marina Rabineau & Stéphan Jorry

List of participating laboratories:

- Domaines Océaniques (IUEM)
- Géosciences Marines (Ifremer)
- DYNECO (Ifremer)
- LEMAR (IUEM)
- LMEE (IUEM-Ifremer)

1.1. SCIENTIFIC CONTEXT, SCIENTIFIC QUESTIONS, 10-YEARS VISION

a) Background / State of the Art

Sedimentary processes occurring along continental margins are complex and result from the interaction between deep processes (Tectonics with Subsidence/Uplift) and surficial processes (Climate, Sea level and Hydrodynamic) as shown on figure 1 and summarized in Cloetingh et al., 2005, 2007). Such processes, their origins and consequences are only partially known so that global models remain extremely limited and simplistic (Trincardi and Syvitski, 2005; Allen, 2008; Sømme et al. 2009).

Major questions remain unanswered as far as quantifying sedimentary fluxes are concerned as well as modeling precisely both solid matter transport from source to sink zones and their consequences on building margin architecture. Conditions of erosion, timing and processes of sedimentary bodies deposition and preservation as a function of paleoenvironmental and paleoclimatic conditions are still a challenge in earth science. This axis aims at reconstructing 4D sedimentary fluxes from the coast to the absyss and understanding their consequences on basin evolution and global cycles.

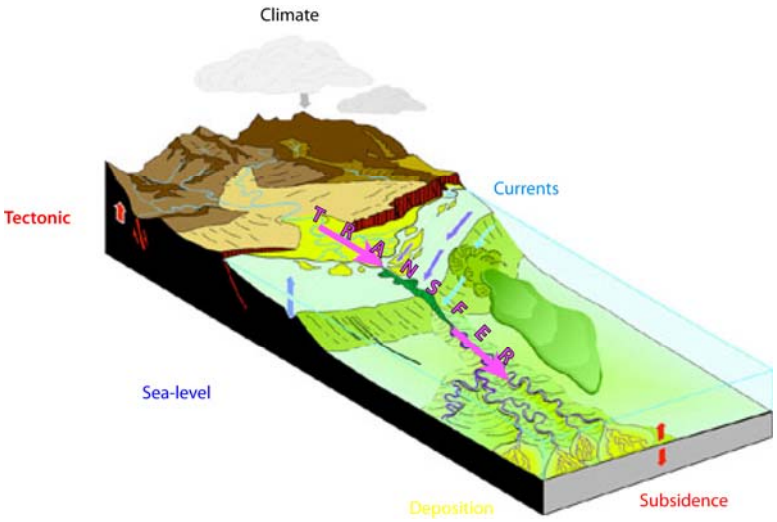

Figure 1 – Factors influencing sediment transfer

b) Scientific objectives

The main objective is to understand and quantify, using marine sediment archives, all changes related to natural parameters (climate, sea level, hydrodynamic and paleoceanographic, tectonics) and decipher their relative impact and timing on sedimentary fluxes. Among essential questions:

1) Fluxes at the terrestrial-coastal interface are still, in fact, very poorly known. The relative role of extreme events (storms, floods, cyclones for example) compared to more continuous record (annual, pluriannual or millenial) is still undetermined. We will therefore concentrate on the reconstruction of these events at present and in the past. Those paleoenvironmental and paleoclimatic reconstruction will be useful to test models used for predictions.

2) Another important question concerns transfer of sediment towards the deep domain during phases of erosion/transport/deposition on the shelf, by gravity processes via submarine canyons but also more generally through open-slope. Scientific questions in this topic concern at the same time the characterization of the processes at the origin of the fluxes (how are canyons fed , What are the sources and triggering factors for gravity flows ?) and their role in the formation and evolution of canyons through time (What are the volumes involved, the timing, and the impacts on ecosystems) but also the biogeochemical composition of these fluxes (C and associated biogenic elements), their evolution through time and impact on global biogeochemical cycles.

Along margins peculiar types of deposits such as Gas Hydrates for example remain badly known. However, their dissociation can have a considerable impact on greenhouse gases release to the atmosphere as well as a key role in sediments stability.

These questions are related to different time scales: from an event-scale (hours, day to weeks with possible direct measurements and instrumentation) to years, thousands years and million years for which internal earth processes (e.g. thinning of the crust) that govern subsidence plays a fundamental role in preservation of sediments and ought to be further understood.

1.2. OBJECTIVES FOR THE NEXT THREE YEARS AND SPECIFIC ACTIONS

a) Objectives

Scientific objectives will contribute to a better knowledge of the dynamics of sedimentary transfers between the coast to the abyss domains, integrated over the entire sedimentary continuum, and their consequences at geological time-scale. This understanding needs a 4D characterization of sedimentary architecture and paleoenvironments from drainage basins and continental shelves towards the foot of the slopes with a land to sea approach using multiples proxies, but also through a modelling approach dealing with the complete system, which has not yet been achieved within the scientific community. The long-term understanding imposes also the study of deeply rooted processes such as crustal thinning of margins that governs subsidence in the basin and preservation of sediments.
Answering these questions will enable to better understand and better anticipate evolutions that have important consequences such as natural hazards (e.g. tsunamis, storms), coastal areas sensibilities (sea-level rise), climate change but also natural resources (gravels, hydrocarbons, economic zones) in many regions of the world. Fundings from LabexMER represents a unique opportunity to develop multidisciplinary studies and to keep up the exploration of new ideas, which are essential to increase the international visibility of our team.

b) New synergies

The originality of the project resides in its multi-temporal scales (from event-scale to million years) and multi-methods (with observations, geophysical measurements, sedimentological sampling, coring to deep drillings (with links to the GOLD-EQUIPEX project to drill in Mediterranean Sea, the Esonet-EMSO observatories initiative) to multi-proxies analyses and numerical modelling, all integrated on the continuum from the Coast to the Abyss. The teams involved are therefore multidisciplinary and

combine approches from geomorphology, satellite-based imagery, sedimentology, sequence stratigraphy, geophysics, stratigraphic modelling, hydrodynamic, biological indicators, biostratigraphy, paleoceanography, geochemistry, geochronology, physical modelling, chemistry and microbiology.

The development axis 4 is a unique opportunity to develop new synergies between Ifremer and IUEM. It will also increase the international visibility of the marine geology community. However our 10 years aim is also to strengthen the relation and collaboration between our marine community and the continental terrestrial community to reach a fully integrated vision of erosion –transport-deposition.

As a starting point, we have divided the objectives of the next three years in three main themes, naturally divided along a source-to-sea transect, from sediment production to abyssal deposition (Figure 2).

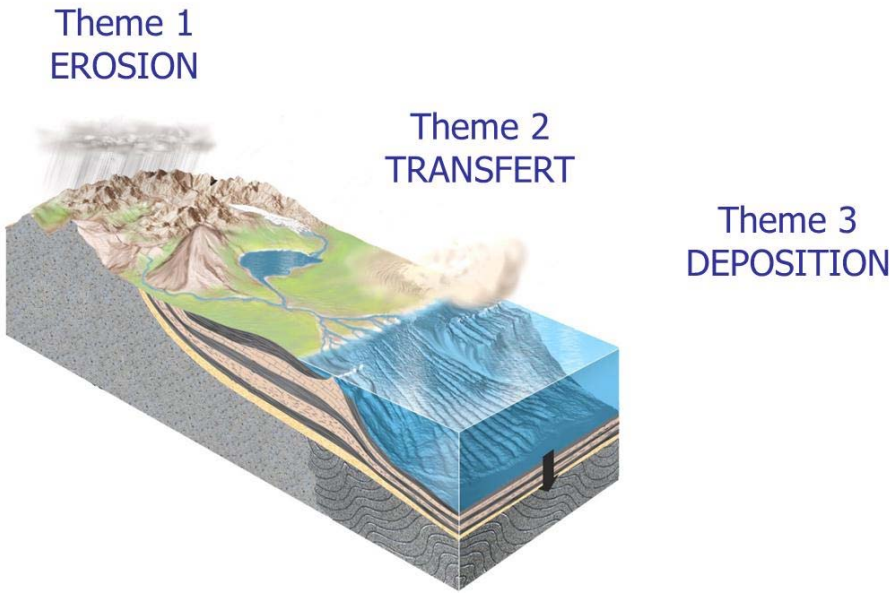

Figure 2 – Our three main themes for the next three years along a source-to-sea transect.

Theme I –Quantifying the erosion products

This theme is dedicated to the evolution of the sediment production and the quantification of erosion products which are driven by controlling factors like subsidence/uplift rates, climate and sea-level fluctuations.

Action for 2012-2013 : ½ grant for a post-doctoral fellowship

This action aims to study the geomorphologic relationships between watershed basins and plio-quaternary marine deposits on Mediterranean margins (Gulf of Lion and East-Corsica margin) using new challenging methods. A first large-scale study concerning the Gulf of Lion and including geomorphological and cosmogenic (10Be) studies will allow to develop a high resolution and long-time scale study, including the differences in denudation rates and modalities of erosion processes according to glacial/interglacial cycles. It will also help to better understand the parameters responsible for these variations. Moreover, this research proposal will propose to develop a unique experience dedicated to the determination of burial ages and paleo-denudation rates using cosmogenic studies methods, but applied on marine sediments which has never been applied so far.

Theme II – Sediment transfers: processes and controlling factors

The aim is to study factors and associated processes involved in the sediment transfer focusing on modern environments, in order to predict those observed in the fossil record. Some recent studies conducted by IUEM and Ifremer on deep-marine sedimentary environments revealed that the sediment record is interdependent of significant climatic variations which have contributed to modified the erosion of drainage basins. The intensification of the erosion of a drainage basin being directly correlated with intensification of river flood, it is generally accepted that increase of river flood can impact the frequency of gravity flows in submarine canyons. Moreover, recent observations at the scale of the last centuries show that submarine canyons are fed by turbidity currents at a higher frequency than expected.

Taking into account that our team in Brest conducted some pioneer studies dedicated to establish high-resolution stratigraphies of deep-marine turbiditic environments (see Theme III), it becomes obvious that the understanding of sedimentary processes in particular past river floods would contribute to quantify past and rapid climatic fluctuations which have affected a drainage basin.

In this context, the study of present-day active canyons (connected to a fluvial network) would allow to decipher the genesis of hyperpycnal currents (triggered by river flash flood), which is poorly documented in the literature.

Action 2012: Exploration projects are encouraged to be submitted in the frame of Theme II to be funded by the LabexMER. Priority would be given to innovative project proposing to acquire some new data on river mouths, shelf or canyons in order to study mechanisms and processes at the origin of hyperpycnal turbidity currents.

Action 2013: we plan to support a PhD thesis on this theme. The PhD thesis will be financially supported by the LabexMER (50%) and another funding source (50%).

Theme III- Tracing sediment sources in deep-marine environments using high-resolution stratigraphy, geochemistry and paleoenvironments

The study of deep turbiditic environments has long been considered as unsuitable for paleoenvironmental, paleoclimatic and chronostratigraphic studies. However, very recently, our teams in Brest have proven that using the very detailed knowledge of sedimentary processes in a turbiditic sequence it was possible to apply conventional chronostratigraphic and paleoclimatic analysis using carefully sampled, specific layers within a turbidite. This novel approach should be further developed in Brest. Our long-term project for this objective would require the development in Brest of stable isotopes measurements necessary for this method. This new equipment would be part of the PSO, and is of interest for several axes within the Labex (Axis 3, 4, 5 and possibly 2 and 6). The installation and the equipment and development of the analysis could be supported by a Chair of Excellence with suitable technical support.

Another aspect concerns the recognition and tracing of sediment sources using geochemical methods (Nd, Sr, Hf, …) that are being developed in Brest since a few years.

Action 2012: Exploration projects are encouraged to be submitted in the frame of Theme III to be funded by the LabexMER. Priority would be given to innovative project proposing to establish some new high-resolution chronostratigraphic dataset helping to better constrain controlling factors (climate, sea level, tectonic) that have impacted the sedimentation in shelf, slope and deep-marine settings during the Late Quaternary.

Action 2013-2015: we plan to support a PhD thesis on this theme. The PhD thesis will be financially supported by the LabexMER (50%) and another funding source (50%).