



axis 4

**Sediment transfers from the coast to the
abyss**

LabexMER Research project

2016-2019 axis 4 roadmap

January 2016



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Sediment transfers from the coast to the abyss

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List of participating laboratories:

- LDO – UMR 6538 (Laboratoire Domaines Océaniques), UBO, CNRS
- U.R. GM (Geosciences Marines), Ifremer/REM.

In collaboration with :

- DYNECO (Département dynamiques de l'environnement côtier), Ifremer / LEMAR (Laboratoire des sciences de l'environnement marin) / LM2E (Laboratoire Microbiologie des Environnements Extrêmes)
- New Partner of **Ocean Frontier Institute** (OFI), together with Dalhousie University, GEOMAR, Woods Hole Oceanographic Institution and Lamont-Doherty Earth Observatory

1. SCIENTIFIC CONTEXT, SCIENTIFIC QUESTIONS

Mountains building and their erosion and peneplanation, sediment and nutrient transfers through river into continental plate-form and deep ocean, are deeply connected with the growth cycle of the earth, the birth and the evolution of the ocean, the palaeo-climate and the palaeo-oceanography variations, which are all linked with deep earth processes. Sedimentary processes occurring along continental margins are complex and result from the interaction between these deep processes (tectonics with subsidence/uplift) and surficial processes (climate and sea level changes, hydrodynamics). Such processes, their origins and consequences are only partially known, meaning that global models remain extremely limited and simplistic. Probing the strong correlation between deep and surface processes in order to understand the Earth growing and to model forecasts needs multidisciplinary approach.

Major questions remain unanswered as far as quantifying sedimentary fluxes are concerned as well as modelling 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 body 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 abyss through time.

The main objective of Axis 4 is to understand and quantify, using marine sediment archives, all changes related to natural parameters (climate, sea level, hydrodynamic and paleoceanography, tectonics) and decipher their relative impact and timing on sedimentary fluxes.



Among essential questions:

- Can we quantify the Source of sediment produced through time? 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 millennial) is still undetermined;
- What are the relative importance, through time, of tectonic (topography dynamic) and palaeoclimate on the erosion process? Can decipher their relative role?
- 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?);
- Can we quantify the amount of sediment arriving in the Sink through time?
- Can we estimate the vertical movements on the margins through time using sedimentary records? What information about the deep behaviour can the sedimentary record give, especially during catastrophic events (huge mass transfer)?
- Can we establish real Source to Sink budgets and model the role of the different parameters?
- What is the role of the tectonic inheritance versus the location of the sedimentary depot-centres on the subsidence? What are the impacts of the deep structure, nature, temperature and geometry on the sedimentary record (for instance, salt geometry versus crust nature and temperature)?

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.

2. OBJECTIVES FOR THE NEXT FOUR YEARS AND SPECIFIC ACTIONS

Main recommendations of the International Council are:

- not alter much the directions of the main topics addressed during the early part of the LabexMER ;
- dialogue with colleagues working on the continent (sources) should be continued and even improved ;
- methods using trace elements and different isotopes should be even more developed ;
- an effort should be pursued in sedimentary modelling ;
- members of Axis 4 should developed better interaction with their Axes 3 and 5 colleagues, initially in organizing informal brain storming sessions.



2.1. SCIENTIFIC EVOLUTIONS

Based on findings and challenges that have been overcome during the first phase of the LabexMER and in accordance with the recommendations of the International Council, we suggest to identify the most relevant scientific questions in order to open specific Axis 4 project calls. Based on the past three years, those questions will be focused on isotope geochemistry (including the transfer of dissolved material), modelling of sediment transfer (how to connect models from river plains to the deep sea?), and the connections between deep and surface processes (particularly focusing mainly on working areas funded during the first phase of the LabexMER).

As a partner of Ocean Frontier Institute (OFI), together with Dalhousie University (CANADA), GEOMAR (Germany), Woods Hole Oceanographic Institution (WHOI) (Massachusetts, USA) and Lamont-Doherty Earth Observatory (LDEO, Columbia University, New York, USA), Axis 4 will participate at some actions developed in that world-class programs.

2.2. INTERDISCIPLINARITY AND SYNERGIES BETWEEN TEAMS

Several initiatives have been launched with colleagues from Axis 3 during phase 1, in particular with the funding of two postdoc (T. Caley and C. Skonieczny) and the International Chair in Stable Isotopes (A. Tripathi) whose research topics are frontiers between understanding of sediment transfers and novel isotope geochemistry approaches. We plan to increase this collaboration for phase 2 of the LabexMER with possible common focused project.

Collaboration with Axis 5 is also natural as they focus on the littoral realm, the junction between Source to Sink areas. Concerning modelling, we propose to organize a meeting in 2016 with researchers in Brest (Ifremer and LDO) together with a few key international experts (e.g. U. Delft, U. Colorado) to discuss concepts and new issues in modelling of sediment transfers.

We encourage the contribution of researchers from both IUEM and Ifremer laboratories on research project of Axis 4. Priorities will be given to integrated projects. We also encourage the emergence of a research group in Brest dedicated to modelling of sediment transfers

2.3. INTERNATIONAL VISIBILITY STRATEGY

- International workshop (with short course for master students)
- Postdoc and student training
- Invited scientists
- Develop international collaboration through networking (develop connections with the Dalahousie and Ocean Frontier Institute network)

2.4. LEVERAGING/ BOOSTING EFFECT

In phase 2 of LabexMER, we plan to organize two workshops (a national workshop together with Rennes in 2016 and an international workshop in Brest in 2017), to initiate a strong synergy between three different French and international scientific communities from Sea, Land and Deep Earth to reach a fully integrated vision of Source to Sink transfers through time. This will (i) bridge the gaps between these communities in order to blow out still exiting major



locks and will foster national and international collaborations. In this new bridging context, Axis 4 will (ii) open a « focused projects » call (previously named 'exploratory projects') with the aim to finalize major studies, blow up major locks, and generate highly visible publications. (i) and (ii) will provide a solid base and a thematic incubator background for new interdisciplinary and international projects.

This strong will to bridge the gap between these different teams is a crucial point to build holistic international projects, which will be proposed for external and international co-funding (e.g. Institutional, Region of Brittany, ANR, H2020, ERC...), and to share students and postdocs for long-lived collaborations. These collaborations will benefit from a huge set of tools coming from different teams; that may lead to the creation of international laboratories.

Another leveraging effect of our axis concerns cooperation with Labex from other disciplines (e.g. contacts are taken with the Labex 'Dynamique Territoriales et Spatiales' (groupe de travail 'Changements environnementaux et sociétés dans le passé').

2.5. GOVERNANCE

Coordination of Axis 4 will change for the second phase, and will be represented by:

- Samuel Toucanne (sedimentologist at Ifremer, GM)
- Marina Rabineau (sedimentologist/basin geologist at IUEM, LDO)
- Pascal Le Roy (sedimentologist/marine geologist at IUEM, LDO)
- Daniel Aslanian (geodynamician at Ifremer, GM)

This new governance will help to improve the interaction between deep earth surface processes and sedimentary systems in research projects of Axis 4.

3. ANSWERS TO CSI RECOMMANDATIONS

Following the recommendation of the International Council concerning the dialogues with colleagues working on the continents, we suggest to organize an international workshop “Bridging the gap between the continent and the ocean” at the end of 2016 (gathering 40-50 researchers), which will be focused on presentations and discussions between continental and marine geologists. All aspects such as impact of vertical movements on topography, quantification of denudation rates and modelling of sediment transport in fluvial networks will be discussed at the light of projects dedicated to sediment transfers into the deep-sea environment. Short courses for master students will be planned during this event.

Another workshop “Mud to Mantle” is also scheduled in the autumn 2017. This meeting dedicated to the relationship between deep structures, vertical motions and sedimentation will be organized in association with the groupe TopoEurope.

4. IMPLEMENTATION PLAN AND RESOURCES

- Workshops “Bridging the gap between the continent and the ocean” at the end of 2016 and “Mud to Mantle” in the autumn 2017
- Two PhD projects will be cofunded by Axis 4 starting in 2016/2017
- Co-funding of one Postdoc in 2017/2018
- An annual restitution meeting will be organized with all participants of Axis 4 Budget breakdown.