Turbidite deposits as long-term deep-marine record of extreme events

N. Babonneau[1] and G. Ratzov[1, 2]

[1] Laboratoire Domaines Océaniques, UBO-CNRS, IUEM, Brest, France
[2] IFREMER, Géosciences Marines, Plouzané, France

Most of sediment transfer from land to deep-sea basins generally occurs during extreme climatic or geological events (floods, storms, earthquakes...) as brief and recurrent episodes. Onland and along the coast, apart in limited confined environments (lagoons, lakes, closed bays), the sedimentary processes are dominated by erosion and transport, preventing long-term sedimentary record of extreme events (thousands of years).

In marine environments, turbidity currents are one of the major processes of sediment transfer, that are in most cases directly triggered by extreme events affecting coastal areas. Three major origins are distinguished: 1) the continuity at sea of hyper-concentrated stream flows generating hyperpycnal flows into canyons (flood-induced turbidity currents), 2) mass wasting at various water depths (earthquake, sediment overload...) and 3) re-suspension of sediment deposits under the influence of oceanographic factors (storm waves, currents). Turbidites deposits represent a record of the gravity events, but to date, discriminating the trigger (earthquake, torrential floods...) based on sedimentological characters is hotly debated.

The location of depositional areas is highly controlled by the slope morphology (turbidite systems, channelization…), but also by the source areas of turbidites and the type of extreme event. Indeed, earthquakes can promote multiple and synchronous slope failures (coastal and submarine) over large segments of submarine slope (up to several hundreds of kms), whereas typhoons or torrential floods induce hyperpycnal flows (continental source) focused into submarine canyon networks. The understanding of the morpho-sedimentary setting, combined with turbidite characteristics (thickness, grain-size, composition…), give insights into the processes, the source and the potential triggering factors. This preliminary approach is necessary to target locations of sediment cores, which could collect separately the events generated by different trigger.

By collecting sediment cores where turbidite deposits are thin and fine-grained, it is possible (1) to identify elementary gravity events, (2) to establish a stratigraphic framework from continuous background hemipelagic deposits and thus (3) to obtain chronologies of events recorded in the cores. This approach requires an accurate sedimentological analysis (facies description, X-Ray data analysis, grainsize measurements, XRF data analysis), and the establishment of age models along the hemipelagic sedimentation using radiocarbon dates.

This strategy revealed fruitful in contexts where tectonic forcing prevails. Based on turbidite stratigraphy and correlation with land evidences when possible, the emerging

submarine paleoseismology discipline reconstructed ~10kyr time-series of large earthquakes in convergent zones (Cascadia, New-Zealand, Algeria…), thus allowing to better assess the seismic hazard. In contexts driven by climatic forcing, where hyperpycnal flows are generated, although individual historical events are retrieved, the establisment of time-series is more tricky, because of the higher frequency of the climatic events (floods, cyclones, typhoons), exceeding the time resolution of the sedimentary record.

The Eastern Taiwan margin which is under the influence of both climatic and tectonic events, exhibits among the greatest sedimentary rates worldwide, thus enhancing the temporal resolution, and has a strong historical record of seismicity and major typhoons allowing robust correlations. It therefore represents a great natural laboratory to investigate between the different triggers in the turbidite record, and subsequently assess kyr-long time series of climatic and seismic events.