The Core Catcher and the Multibeam Echosounder

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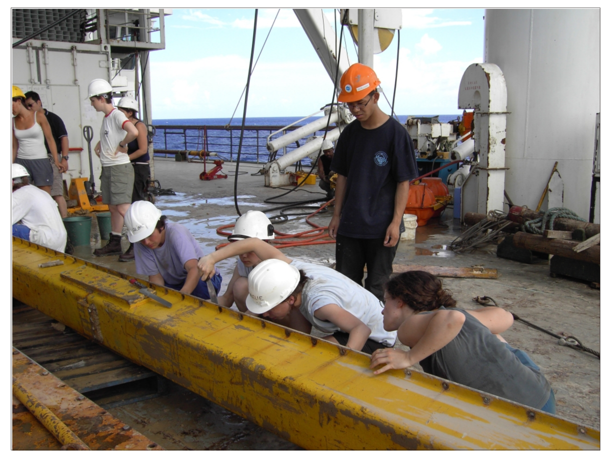
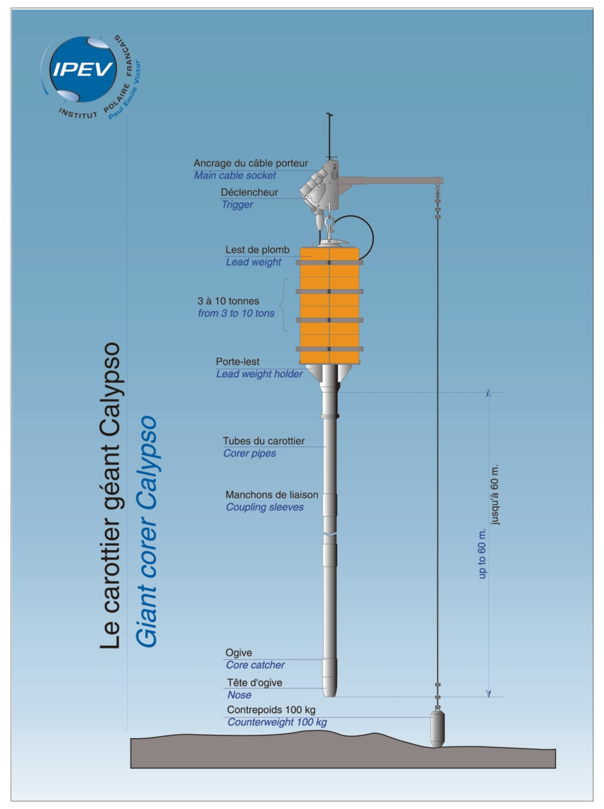


Long duration, high stratigraphic and temporal resolution palaeoceanographic records require the undisturbed recovery of long sections of stratigraphically coherent sedimentary sequences.

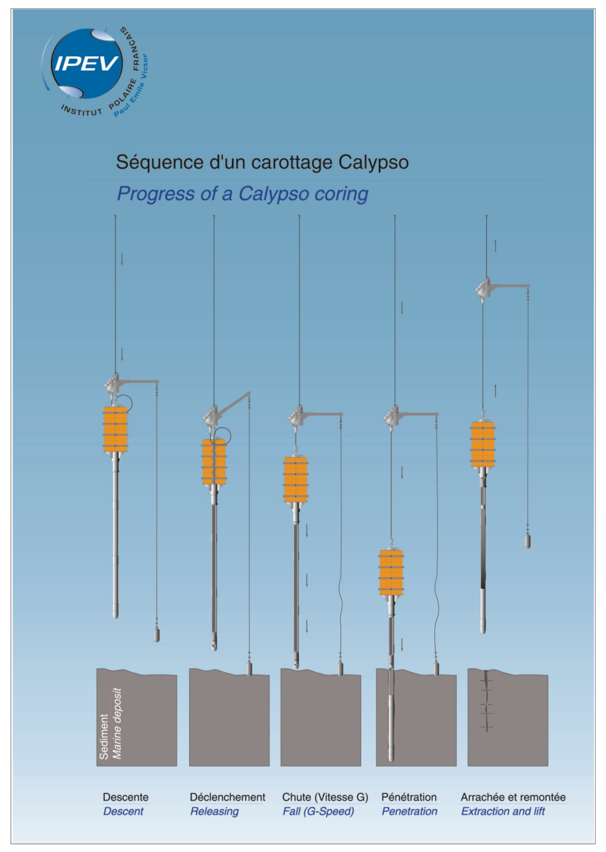
CASQ Coring

The **CASQ** corer is commonly used to obtain sedimentary sequences kept almost intact. The wide core diameter of **CASQ** corer allows recovery of large volume of core material for multi-proxy analysis. The controlled descent speed (1.2m/s) helps to reduce the effects of core sediment friction upon penetration, though deformation is sometimes inevitable. A recovery scale of only 12 meters may have limited the use of it.



CALYPSO Coring

The **CALYPSO** system of the *R/V Marion Dufresne* is a simple Kullenberg type piston corer developed by *Yvon Balut*. It is considered as one of the most practical coring devices for obtaining deep sea sediment cores. The **CALYPSO** allows recovery of very long cores up to 40-60 meters depending on the sediments type. The use of a piston intends to maintain the lithostratigraphic stress conditions at the core nose throughout the penetration of the corer which minimizes deformation and distortion of the sediment.



The core cable

One highlight of the core catcher system on *R/V Marion Dufresne* is the cable used. The usually used cable is made from metal, the weight of the cable become very heavy in deep water, which may cause overload of the lifting system and an abrupt break of the cable because of the stress. The new material used on *R/V Marion Dufresne* is called Aramide, which is one kind of fibre with a weight equal to zero in water but strong enough to hold tons of load.
With the centre of the cable made of Aramide, intermediate compacting plait in polyamide, and an extruded jacket very resistant to abrasion, the cable is used extensively in deep ocean coring. Furthermore, one of the many advantages of this cable is that it is neutral and never contaminates samples.

Introduction of the Multibeam Echosounder

To retrieve information about the sea floor, the *R/V Marion Dufresne* uses a multibeam echosounder to send sound waves and receive their reflected energy. Mechanical vibrations forced at one of two frequencies by an underwater speaker emit sound waves into the water column. These vibrations easily pass through the water, but are reflected by solid objects, such as the ocean floor.

Some of the sound waves that bounce off the seafloor return to the ship and are received by an antenna six meters in length, which hosts 92 sensors and can travel between 60 degrees to port and 60 degrees to starboard. Each sensor detects the incoming waves by vibrations in a membrane. A chronometer is used to record the elapsed time between transmission and reception of the signal. Using the elapsed time and the speed of sound in water (a function of water density, which may be measured *in situ* or retrieved from a database of historical measurements), the distance to the sea floor can be determined.

A technique known as interferometry is used to sort the information by geographic point. Each senser relays a complicated wave function, which can be broken down to display several different waveforms, each corresponding to a different physical feature. Adjacent sensors will record the same waveform out of phase, due to their physical separation. Interferometry groups the waveforms (thus sorting by geographic location) and sums them in phase, to provide the most accurate description of the seafloor. A ship's transect provides the third dimension necessary for extensive bathymetric records.

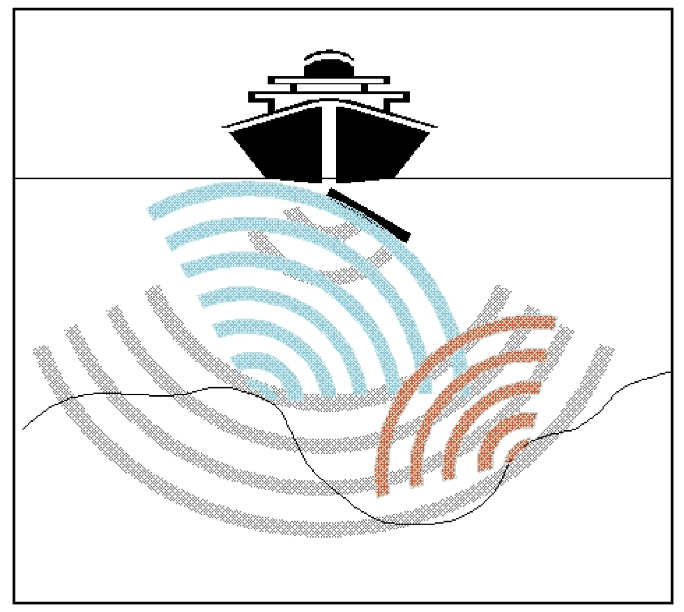


Figure 1 : Sound waves emitted from the ship are reflected off the bottom and received by the antenna.

Multibeam Bathymetry

The Multibeam Echosounder used on board the *R/V Marion Dufresne* is a prototype (**THALES** TSM 5265B) and transmit multibeam frequencies of 12 kHz (acoustics waves) to mesure depths up to 11000 meters.
Five spatially separated swaths are transmitted. The backscattered energy from the initial signal is related both to the water depth and to the speed of propagation through the water column. The latter can be determined by profiling the changes in temperature, salinity and hence conductivity through the water column. When accurate site surveys are required this is done by deploying an expendable **CTD** probe (***C****onductivity* ***T****emperature* ***D****epth*) with *SIPICAN* sonde. Otherwise measurements from an archive (*LEVITUS*) are used.

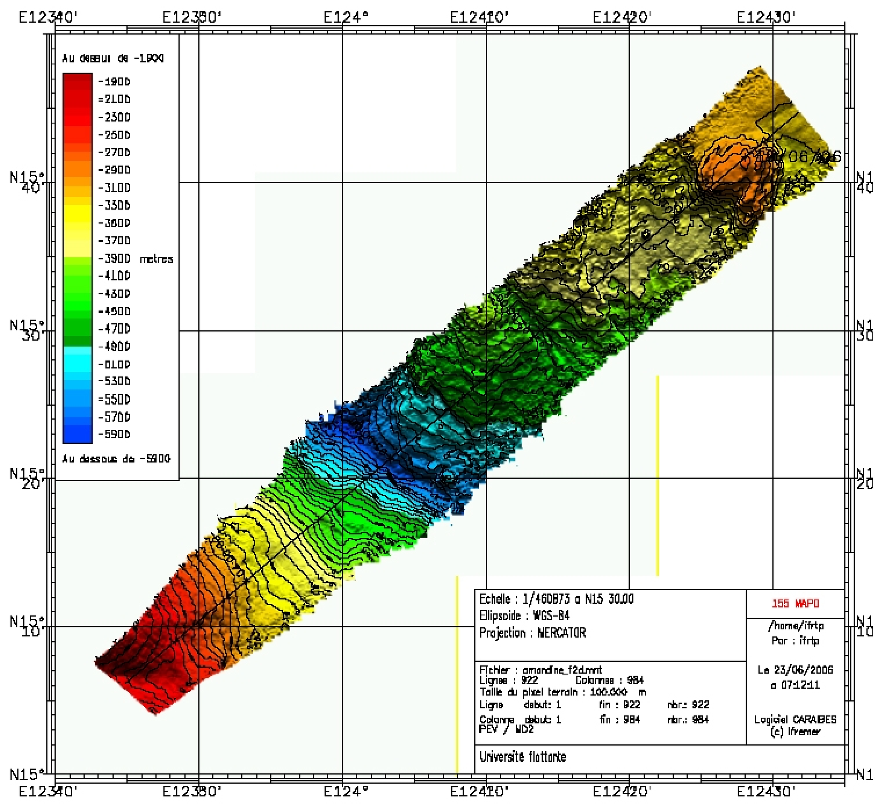


Figure 2 : Bathymetrical map of Philippines Trench.

Reflectivity Imaging

The degree of reflectivity deduced from the multibeam signal gives information about the topography and the sedimentological nature of the sea bed surface. Roughly, darker is the reflectivity imagery, coarser is the sediment. The frequency used to profile the sea bed is **12 kHz**. Here some examples :

- Combining understanding of bottom currents with reflectivity imagery, it is possible to identify areas of contourite drift, where changes in the sedimentology can be used to reconstruct palaeocurrents.
- Areas of steady, long term hemipelagic sedimentation are ideal for studying changes in the ambient flux of material. The tops of low mounds situated away from continental margins are optimal sites for this kind of sedimentation.
- Reflectivity imaging also allows the identification of geomorphological features such as seamounts, coral reefs or areas of active erosion, in which coring should be avoided.

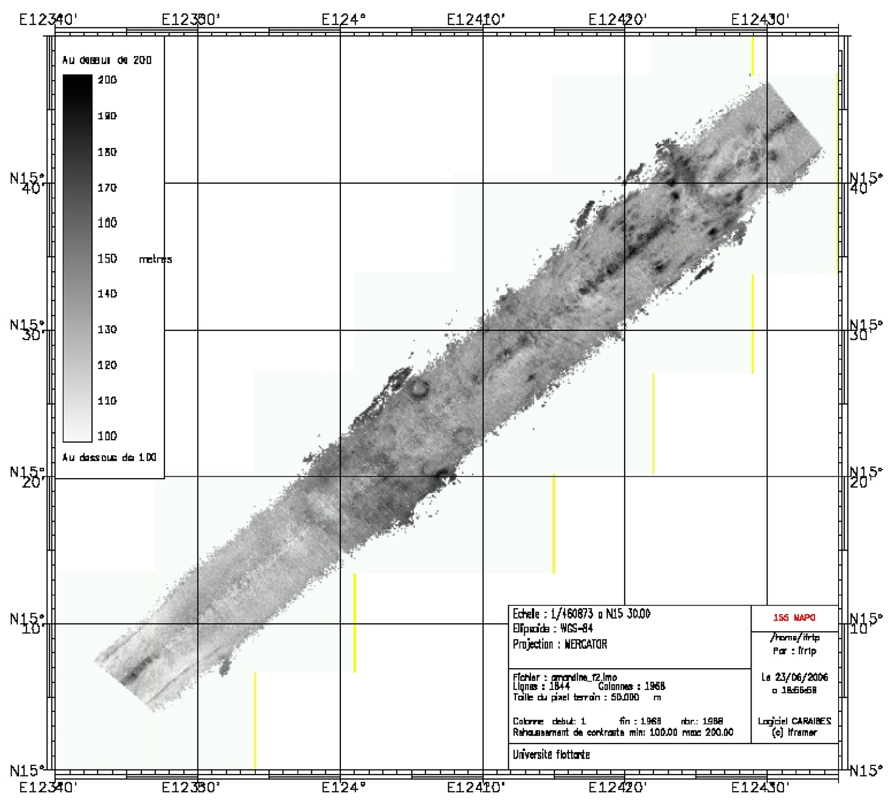


Figure 3: Reflectivity map of Philippines Trench.

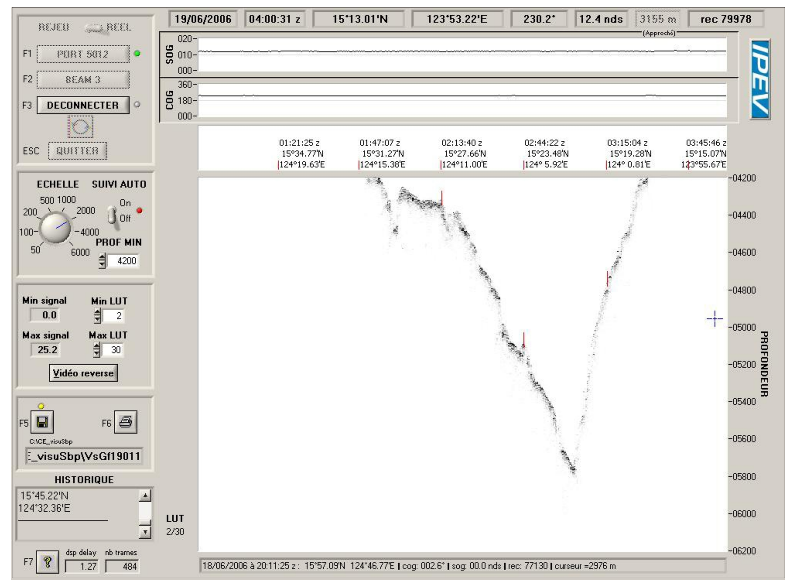


Figure 4: Seismic profile of Philippines Trench.

Sub-bottom Profiling

Sub-bottom profiling creates an image from the reflectivity of the sub-bottom sediment layers. The alternation of dark layers and light layers shows the organisation and the seismic nature of the sediment.
The beam transmits a large bandwidth signal (**3,5 kHz**) from a narrow beam antenna allowing a very good along-track resolution. For example, at 4000 meters depth, a penetration depth of 100 meters is typically achieved.
These are combined with the ships attitude in order to determine the exact position of the sounding.

Caraïbes Software

The **Caraïbes software** (developed by Ifremer) processes multibeam echosounder data and is used on the *R/V Marion Dufresne* to produce accurate images of the seabed bathymetry, which can be combined with the sub-bottom profile. This provides a comprehensive map of the seabed that can be used to assess possible coring sites and determine an appropriate penetration depth.
The topographic contour map, showing a section of the ship's track and one of the coring sites, was created by smoothing and filtering the raw multibeam data as shown below.

Conclusion

This physical tools correlate the different information :

- **Water depth with multibeam bathymetry.**
- **Sea bottom superficial sediment properties with reflectivity imagery.**
- **Sediment thickness and internal bedding with sub-bottom profiling.**

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