

Sediment plume monitoring in the Clarion-Clipperton Zone

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Abstract: OD Nature has a vast experience in monitoring and modelling Suspended Particulate Matter concentration in shelf areas. In the framework of the JPI-Oceans cruise with the RV Sonne in the Belgian, French and German concession zones for deep-sea mining in the Clarion-Clipperton Zone, this experience will be used to monitor sediment plumes, caused by deep-sea mining exploration activities.

Key words: Sediment plume monitoring, deep-sea mining, Clarion-Clipperton Zone

INTRODUCTION

In the coming years, deep-sea mining will be an important economic activity that will exploit the deep-sea for precious metals or rare earth minerals. Belgium has foreseen legislation, to allow the International Seabed Authority to grant a 15 year concession of 77,000km² in the Clarion-Clipperton Zone (CCZ) in the North-East Pacific Ocean, for polymetallic nodule mining. The concession agreement stipulates that a program of oceanographic and environmental baseline studies should be executed, involving annual cruises to the area for environmental research and data gathering to make an assessment of the potential environmental impact of exploration and subsequent exploitation possible. The mining of mineral resources will create a near-bottom turbid plume that could lead to redeposition of sediments in the vicinity of the mine site, potentially burying benthic organisms, both in the near and far field. Long-range lateral and vertical dispersion of fine-grained particles is possible. The effects on the deep-sea ecosystem of the sediment plume dispersion are at present not known.

The Royal Belgian Institute for Natural Sciences (RBINS), Operational Directorate Natural Environment (OD Nature) is involved in the monitoring of the sediment plume characteristics. The monitoring will be executed in the framework of the JPI-Oceans RV Sonne cruise to the German, France and Belgian concession zones in the CCZ in 2015. Landers and instrumentation from the RBINS-OD Nature will be made available for the cruise and the data collected will be analysed afterwards.

SEDIMENT PLUMES ON THE CONTINENTAL SHELF

The RBINS-OD Nature has a vast experience in measuring Suspended Particulate Matter (SPM) concentration and in the analysis of complex data sets. Since the beginning of 2004, more than 1800 days of moorings were performed in the southern North Sea, using a benthic lander, equipped with a series of

oceanographic sensors (Figure 1). From autumn 2009, a permanent coastal observatory has been installed, near the entrance of Zeebrugge harbor. Other moorings have been carried out, both at very nearshore areas and at more offshore locations. The collected data increased the understanding of cohesive sediment dynamics in response to tidal and meteorological forcing, during various weather conditions and from short (turbulence) to long (seasonal variations) time scales (Fettweis et al., 2010; Baeye et al., 2011). The observatory significantly contributes to the general and permanent duties of monitoring and evaluation of anthropogenic activities on the marine ecosystem, a legal commitment of Belgium, both nationally and internationally (e.g., EU Marine Strategy Framework Directive, OSPAR).



FIGURE 1. Benthic bottom lander, used in the Belgian nearshore area.

Experience also exists in the design of spatio-temporal monitoring strategies that combine high-resolution acoustic seabed mapping with transect-based quantification of flow and turbidity variation. New technologies are used for mapping (AUV, Wave Glider) and ground-truthing (ROV). This has been applied to the study of sediment plumes derived from extraction activities (Van Lancker et al., 2014).

Furthermore, RBINS-OD Nature operates numerical models for the simulation of sediment transport in the southern Bight of the North Sea. The models have been

used e.g., to setup the fine-grained sediment balance of the Belgian Continental Shelf (Fettweis and Van den Eynde, 2003), to assess the impacts of aggregate extraction on the sediment transport (Van den Eynde et al., 2010) or to model the dispersion of the disposal of fine-grained dredged material (Van den Eynde and Fettweis, 2006). An operational model is being set up that can be used to optimise the dredging and disposal operations (Van den Eynde and Fettweis, 2012).

SEDIMENT PLUMES IN THE DEEP-SEA

The monitoring in the CCZ is intended to collect SPM mass concentration using optical and acoustic backscatter sensors and particle characteristics using holographic cameras. The Optical Back Scatter (OBS) voltage reading can be converted to SPM mass concentration by calibration with water samples with different concentration of sediment, that have been sampled from the seabed (Fettweis, 2008). The particle size characteristics (size, shape) will be measured using a holographic camera (LISST-Holo), in order to estimate the flocculation capability and the settling velocity of the SPM (Fettweis et al., 2006, Lee et al., 2012). Knowledge of settling velocity is a key parameter for modelling the dispersion of fine-grained particles. The current profile will be measured with an Acoustic Doppler Current Profiler (ADCP). Furthermore, the acoustic backscatter from the ADCP will be converted to SPM mass concentration using the SPM concentration from the OBS. Acoustic backscatter is affected by sediment type, size and composition and are site specific.

The monitoring will consist of measurements with three small benthic frames, each equipped with an OBS and a CTD, during experiments where the seabed will be distorted. At the same time, vertical profiles of particle characteristics, SPM concentration and CTD will be carried out from the ship. Furthermore, long-term measurements will be executed by the German colleagues (BGR) involving long-term co-located OBS and ADCP measurements.

The data will deliver information on the natural sediment processes and on the behaviour of human induced turbid plumes in the deep sea. Data will serve as input for numerical models that will be set up by JPI-Ocean partners.

CONCLUSIONS

The RBINS-OD Nature has a vast experience in monitoring of SPM concentration, using different instruments and in analysing the data to get insight in sediment dynamics and in the impacts of anthropogenic activities. Numerical models are applied to assess the impacts of anthropogenic impacts and to perform predictions to improve management of the marine environment.

The RBINS-OD Nature will use this experience in providing equipment for a JPI-Oceans cruise with the

RV Sonne to the CCZ area, to monitor the natural SPM concentration and to assess the impact of deep-sea mining related activities.

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