Work Package III

Fluxes and Processes in Nepheloid Layers and Surface Sediments

Tjeerd C.E. van Weering

Netherlands Institute for Sea Research - The Netherlands

Summary
Considerable and significant progress has been made by the partners of WP III. Sample collection and analysis is well underway and the initial results are being integrated to compare and define the depositional conditions and processes on the entire north Portuguese shelf and upper slope with those established for the Northwest Iberian margin off Vigo. Initial results indicate significant spatial variability. Final integration of results in year 3 of OMEX II-II will be achieved through some small-scale WP III meetings.

Coordination, workshops and meetings
During year 2 of OMEX II-II, all steering committee meetings and the OMEX II-II Annual Workshop were attended by the coordinator. The second, successful WP III workshop was organised on 24 April 1999, preceding the OMEX II-II Meeting in Plymouth (25-27 April 1999). This meeting was attended by almost all WP III partners Oral presentations and poster sessions were given in both the WP III workshop meeting and during the parallel sessions of the OMEX II-II Annual Workshop. Exchange of data and integration of results is in good progress (see also 24 M Rep), and exchange and participation of partners in various sea-going programmes in 1998 and 1999 was realised. WP III partners contributed to the tasks set out by performing activities outlined below.

Task III.1. Particle transport, settling, accumulation, mixing and burial fluxes
Temporal and spatial variability
Partners involved: 2, 5a, 5c, 5d, 7, 8a, 8b, 14b, 15a, 24b, 25, 26, 27.

III.1.1 *Amount, character, distribution and composition of suspended particles in nepheloid and clear water layers.*
The sampling results of cruises held in the second part of 1998 and first six months of 1999 are starting to yield an overall picture of particle distribution and presence in relationship to water mass properties and residence time of particles over the NW Iberian Margin and on the northern Portuguese shelf and upper slope. A comparison of results obtained in the latter area in two winter periods showed significant interannual and spatial variability of SPM distribution and content of organic matter in relationship to hydrographic conditions of water masses on the Portuguese shelf. In addition to observations in the above areas, measurements in the Nazaré canyon show that the upper canyon which is incised in the shelf, acts as a catchment area for fine grained particles in suspension that are transported over the shelf. These then are actively transported down the canyon to the abyssal plain. The interpretations of particle distribution and transport mechanisms are supported and confirmed by the results of measurements of short-lived isotopes in both the water column and in the surface sediments.
Deliverables month 24: met by all partners

III.1.2 *Spatial and temporal variability of the benthic boundary layer dynamics.*
The STABLE lander (POL) was deployed (1-29 August 1998) at the shelf edge and short term current measurements near the bed were made, showing occurrence of irregular bursts. Lander BOBO II (05a) was deployed for a one week deployment in June 1998 and subsequently for long term current and near bed dynamics at a water depth of 2152 m near IfM sediment trap IM 3. It was retrieved in May 1999 and data are being studied. First data of the year 1 deployment indicate maximum tidal current velocities ranging from 15-25 cm s^{-1}, and seabed photographs suggest strong inter-annual changes, with local development of small ripples. Sediment chlorophyll concentrations measured in the BBL indicate

considerable higher values for CPE concentrations at 10 cm ab in the Nazaré canyon than on the NW Iberian margin.
Deliverables month 24: met by all partners

III.1.3 *Particle fluxes to the seabed, accumulation and mixing rates.*
Sediment samples were collected along transects perpendicular to the margin and in the Nazaré canyon during cruises by RV *Charles Darwin*, RV *Pelagia*, RV *Meteor* and by IH at the northern Portuguese shelf and upper slope using RV *Almeida Carvalho*. Fluxes to the seabed show strong spatial variability. Parts of the northern Portuguese shelf are characterised by sedimentation rates ranging from 0.03-0.18 cm yr^{-1}. At the NW Iberian and Portuguese shelf and shelf edge sandy sediments prevail, locally showing strong reworking. Sedimentation is strongly different from E-W over the slope and also from N-S there is significant spatial variability. Studies of accumulation rates and mixing by using short-lived isotopes are presently carried out by all partners involved.
Deliverables month 24: met by all partners

III.1.4 *Sediment distribution, properties and composition along selected transects.*
Samples collected by partners are being analysed and studied. The results so far show that the northern Portuguese shelf and upper slope are similar to sediments of the NW Iberian margin off Vigo. Quartz, mica, plagioclase and potassium feldspar are dominant (in decreasing order) in the surface sediments, and illite is the dominant clay mineral, followed by kaolinite and smectite. Maps of regional composition of seabed sediments and of grain-size of surface sediments have been prepared. There appears no relationship between hydrolisable amino-acids and clay mineralogy. Carbonate and organic carbon in surface sediments of the study area show also strong differences and spatial variability.
Deliverables month 24: met by all partners

III.1.5 *Dominant sediment transport processes at contrasting margins*
Deliverable month 36: na

III.1.6 *Benthic model.*
Integration of results and parameterisation underway. 2-D slice model currently is being tested. See also WP II and IV.
Deliverable month 18: met

III.1.7 *Long term change.*
Kasten and piston cores have been studied, an age model is in progress. Initial results show that sufficient samples of good quality allow an assessment of long-term change, including spatial variability. Initial results of down-core Ba/Al and biogenic Ba distribution indicate a climatic optimum in the middle Holocene, characterised by increased productivity
Deliverables month 24: na

Task III.2. Sediment /water exchange processes and early diagenesis
Partners involved: 5a, 5c, 15a, 28

III.2.1 *Sediment-water exchange processes.*
Phosphate, iron and manganese concentrations were measured in pore waters of samples from the inner Portuguese shelf, in addition to iron oxides and volatile sulfide in the solid phase. Results showed absence of chemical zonation and indicated bioeffects below the surface mixed layer.
Deliverables month 24: met, relation SPM/trace metal contents yet to be done (partner 28)

III.2.2 *Organic matter diagenesis and burial.*
Organic carbon in the surface mm layer ranged form 0.4-1.5%, with lowest values on the shelf (except two stations enriched in refractory carbon). No down-core gradient in organic carbon content is observed on the shelf, an exponential decay is observed in greater water depth. C/N ratios vary between 6-8 for all stations except the deviant shelf stations. Shipboard oxygen microprofiles indicate high rates of oxygen consumption at the shallow shelf stations, which decrease with increasing water depth. This is also shown

by the downward flux of pore water nitrate, the second most important oxidant for organic carbon mineralisation. Oxygen and nitrate pore water profiles were quantitatively examined by diffusion reaction models and benthic carbon mineralisation along transects established (partner 05c) Carbon burial is strongly related to water depth.
Deliverables month 24: met

III.2.3 *Dominant carbon mineralisation mechanisms and factors at contrasting margins.*
Deliverables month 36: na

III.2.4 *Modelling benthic fluxes.*
Deliverable month 36: in progress

Task III.3. Role and importance of the benthic community
Partners involved: 5d, 15a, 15b, 24b

III.3.1 *Role and importance of bioentrainment and biodeposition.*
Experimental studies in flumes have been continued and support an important role for the benthic foraminifer *Marsipella* spec at the Iberian margin in scavenging of aggregates and biodeposition of POC, which is estimated at 1-4% of the total carbon deposited needed to feed the mid slope benthic communities. POC deposition *via* aggregates was low when compared to biodeposition rates measured at Goban Spur. A mean of 0.005% of the horizontal carbon flux is ascribed to biodeposition.
Deliverables month 24: na

III.3.2 *Microbial activity.*
Bacteria associated with large particles appear more active than communities attached to smaller, more easily erodable fractions.
Deliverables month 24: na

III.3.3 *Benthic food supply, respiration, and carbon mineralisation.*
High phytopigment concentrations of fresh material are found in the near slope abyssal stations in the north, off La Coruña. These high chlorophyll *a* concentrations point to a rapid sinking rate and invoke a similar mechanism as found on the Goban Spur, where food supply to the slope and near slope abyssal stations seem decoupled. SCOC values from shipboard incubations and *in situ* measurements approach the global averaged values for specific depths, with the exception of Galicia bank where values are much lower. The deep abyssal station off La Coruña has the highest input of fresh detritus and large benthic activity and mineralisation.
Deliverables month 24: na

III.3.4 *Benthic community structure.*
Meio- and macrofaunal densities and community structures have been established for the NW Iberian Margin, as well as of the megabenthos. Results show that macrofaunal densities and abundance decrease with increasing water depth and that interannual variability between stations 1997 and 1998 was negligible. There are small variations in biomass. Meiofauna densities were highest on the shelf off La Coruña, but also were higher along the entire transect. In general, as shown by a transect off Vigo, the meiofaunal densities decrease with increasing distance from the shore.
Deliverables month 24: met

III.3.5 *Variability of benthic community structure and functioning at contrasting margins.*
Deliverable month 36: na

III.3.6 *Ecological modelling.*
Deliverable month 36: na