Geophysical Research Abstracts, Vol. 7, 03448, 2005
SRef-ID: 1607-7962/gra/EGU05-A-03448

Stratigraphic modelling of organic matter distribution and preservation in marine environment, from shelf to deep-sea basin.

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The understanding of the organic matter accumulation and preservation in marine environment is the subject of various discussions in literature. It is usually thought that water anoxia is the main controlling factor for organic matter accumulation. Indeed, high organic matter content would only be in sediments of confined basins with shallow and stratified water. A new theory gives the main role to oceanic biological productivity. The study of old and modern series allowed to show high organic matter contents (until 20%) in sediments of extensive margin and of deep-sea basin.

This present study fits into this context. Its objective is the stratigraphic modelling of organic matter accumulation, distribution and preservation in marine environment, from shelf to deep-sea basin. Areas of high biological productivity are mainly located in coastal upwelling zones. Thus we chose to base this study on the Benguela Upwelling System (Namibia, Southweast Africa). From this system, main physical, biogeochemical and sedimentary processes have been selected in order to be developed in a modelling of organic matter distribution. The difficulty of this work is the various time (one day to one Ma) and space (one cm to one thousand km) scales of processes and then, the necessity to constrain model.

The methodology, established during these two first years of thesis, uses three modelling softwares. We make use of a 3D stratigraphic model, DIONISOS, which allows to build margin thanks to sediment input and transport and thanks to basin deformation (eustasy, subsidence, etc.). Biogenic sediments are introduced in DIONISOS after their production modelling by two coupled models, ROMS/NPZD.

ROMS is a physical model which allows to simulate upwelling dynamics thanks to wind strength exerted on ocean surface and to margin morphology. Development of high productivity areas is tightly linked to water emergence and then to location and intensity of upwelling cells. That's why biogeochemical model, NPZD is coupled with ROMS.

NPZD models relationships (photosynthesis, grazing, excretion, mortality, remineralization, etc.) between trophic system elements. Nutrients availability (model inputs) and flux intensity between nutrients, phytoplankton, zooplankton and detritus are controlled by upwelling dynamics, i-e ROMS.

These two coupled models allow to obtain biogenic sediment fluxes at the water/sediment interface and the repartition on the margin of the detritus part which is deposited and not remineralized in water column. In order to dissociate the repartition of the various components of biogenic matter, we define two functions for carbonates and opal in NPZD. The parameters which control carbonate and opal behaviour are Si/N and CaCO3/N ratios, dissolution rates and speed sinking. Thus, indirectly, water mass compound, competition relationships between species (diatoms, coccolithophorids, planktonic foraminifers) and their evolution in water column are expressed through these new parameters.

After being introduced in DIONISOS, biogenic sediments (Corg, CaCO3, Opal) are subjected to gravity transport processes mainly long-range but also catastrophic ones. Their intensity depends on physical characteristics of particle and can be influenced by energy waves, littoral drift and margin morphology. Burring in sediment, biogenic matter is under control of diagenetic laws.

Processes controlling organic matter production, distribution and preservation have a variability linked to glacial-interglacial cycles. This variability can be observed with Corg, CaCO3 and opal contents in sedimentary cores from the Namibian margin (MD962086, MD962087, NAUSICAA-IMAGES II, 1996). After testing sensibility of the various parameters of the three models, we study their capacity for simulate climatic cycle effect on organic matter distribution on the Namibian margin.