

LATERAL PARTICLE TRANSPORT AT HIGH-PRODUCTIVE CONTINENTAL MARGINS – AN IMPORTANT PROCESS INFLUENCING SOURCE ROCK DISTRIBUTION AND QUALITY?

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High-productive continental margin systems are of major importance for today's marine carbon cycle, but are also considered modern analogues of Mesozoic marine black shales that are beyond the most important source rocks worldwide (Calvert & Pedersen, 1992). At several modern continental margins, winnowing of organic matter rich particles from high-productive shelf areas and offshore directed lateral export towards slope-depth depocenters has been observed (e.g., Arthur et al., 1998; Biscaye & Anderson, 1994).

Our investigations from the Benguela upwelling system (BUS) off SW Africa, the most productive coastal upwelling system of the modern ocean, provided detailed information on the influence of this particle redistribution process on organic matter distribution and quality (Fig.1; Inthorn et al., 2006). Like on a conveyor belt, organic matter is transported in suspension-loaded water layers, so called intermediate and bottom nepheloid layers (INL and BNL), from the high productive shelf sea towards a depocenter on the upper continental slope (400-1500 m water depth), where surface sediments have total organic carbon (TOC) contents up to 8%. In this process, a high share of rather labile organic matter components is preserved in the depocenter sediments. This comes as a surprise because radiocarbon and ²³⁴Thorium isotope data indicate that organic particles have undergone a long journey lasting more than a thousand years prior to final burial in the slope sediments. A mean hydrogen index of 343 lies well in the range of published data from other high-productive continental margin, relating these key areas of marine organic matter production and organic carbon burial to each other and indicating that lateral transport at continental margins is a globally important mechanism.

Based on the now available extensive data set for the BUS we applied the process-based source-rock modeling tool OF-Mod (Mann & Zweigel, in press) to model organic carbon distribution and source rock potential of the youngest sediment layer in the northern BUS. The modelling results for TOC and HI matched the calibration data on the high-productive coastal area and the deeper slope generally quite well. But the model couldn't match the high TOC and HI in the slope depocenter as OF-Mod only considers vertical particle flux, reconfirming that in this area the sediment properties can not be explained by vertical particle

input alone. At the depocenter, only about 3 to 10 gCm⁻² y⁻¹ of freshly produced organic carbon actually reach the seafloor (modelling results and sediment trap data), while 4-10 times stronger, additional lateral input is necessary to support the high TOC content and accumulation rates.

We conclude that lateral particle transport needs to be considered in models predicting the regional distribution and quality of organic matter in comparable settings. This quantitative and qualitative important redistribution may represent an often neglected secondary process in petroleum source-rock deposition.

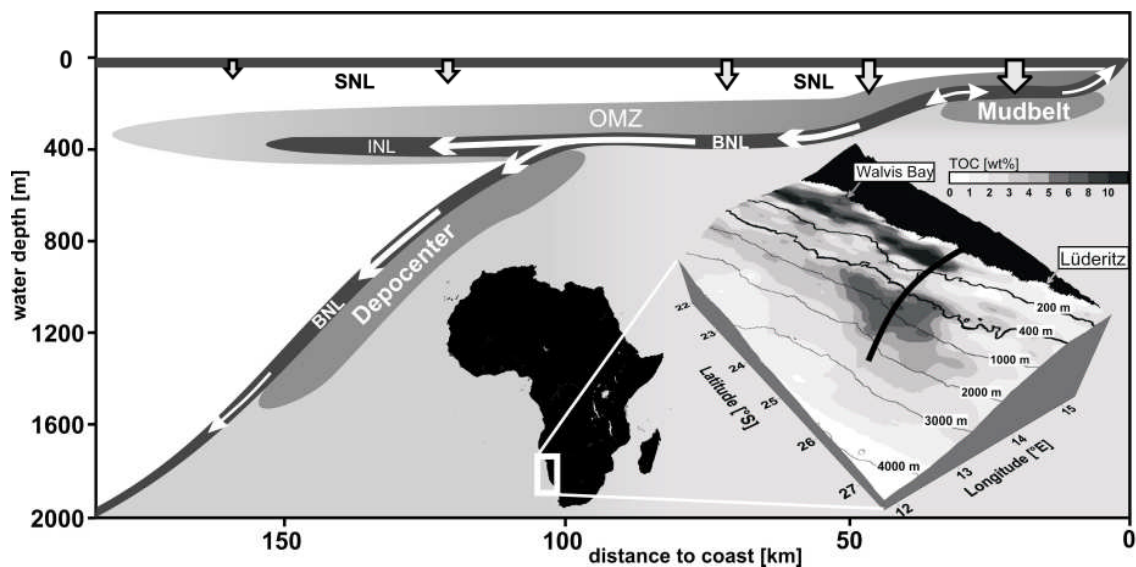


Figure 1. Illustration of particulate organic matter transport and distribution (inlay) across the SW African continental margin. Surface, bottom and intermediate nepheloid layers (SNL, BNL, and INL, resp., dark gray), organic matter enrichments in the surface sediments (mudbelt, depocenters), oxygen minimum zone (OMZ), bottom current directions (white arrows), and primary production (grey arrows) are displayed.

REFERENCES

- Arthur, M.A., Dean, W.E., Laarkamp, K., (1998) Organic carbon accumulation and preservation in surface sediments on the Peru margin. *Chemical Geology*, 152(3-4), 273-286.
- Biscaye, P.E., Anderson, R.F., (1994) Fluxes of particulate matter on the slope of the southern Middle Atlantic Bight: SEEP-II. *Deep-Sea Research II*, 41(2/3), 459-509.
- Calvert, S.E., Pedersen, T.F., (1992) Organic carbon accumulation and preservation in marine sediments: how important is anoxia? In: J.K. Whelan, J.W. Farrington (Eds.), *Organic Matter: Productivity, Accumulation, and Preservation in Recent and Ancient Sediments*, pp. 231-263. Columbia University Press, New York.
- Inthorn, M., Wagner, T., Scheeder, G., Zabel, M., (2006) Lateral transport controls distribution, quality and burial of organic matter along continental slopes in high-productivity areas. *Geology*, 34(3), 205-208.
- Mann, U., Zweigel, J., (in press) Modelling source rock distribution and quality variations: The OF-Mod approach. In: P. de Boer (Ed.), *Special Publication of the International Association of Sedimentologists*. Blackwell Science.