

HIGH-RESOLUTION OCEANOGRAPHIC AND ATMOSPHERIC CHANGES AT THE PLIO-PLEISTOCENE BOUNDARY IN THE EQUATORIAL PACIFIC OCEAN

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INTRODUCTION

The aim of this project is to reconstruct rapid changes in the transport of terrigenous components towards the Equatorial Pacific in relation to the oceanography of the area. This approach will be mainly based in the analyses of sediments from Site 1240 (Figure 1) recently drilled in the ODP Leg 202 (Mix et al., 2001). This site, at present day, is located just below the equatorial upwelling driven by southeasterly trade winds, thus recording high rates of primary productivity (Hovan, 1995). Terrigenous components at this site are the result of the eolian transport of dust originating from the Atacama Desert (Molina-Cruz, 1977). Preliminary onboard results documented the occurrence of severe changes in the mode of operation of the upwelling cell over the late Pliocene-early Pleistocene. In view of the relatively high sedimentation rates for that interval (~15 cm/kyr), this sediment sequence represents an excellent opportunity to explore the reorganisation of the marine-atmospheric system at millennial-centennial time scales.

We present here high resolution geochemical records (every 2 and 1 cm) estimated by means of the XRF-Scanner (University of Bremen, Figure 2) along 100 meters of marine sediments covering the time interval ~1.4-2.2 Ma. These geochemical measurements include semi-quantitative records of K, Ca, Ti, Mn, Fe, Cu and Sr. Additionally, in order to calibrate the intensity data provided by the Scanner and also to obtain a broader set of elements, 31 samples were analysed by the ICP-OES (Figure 3). Results are presented in Figure 4 combined with other physical properties.

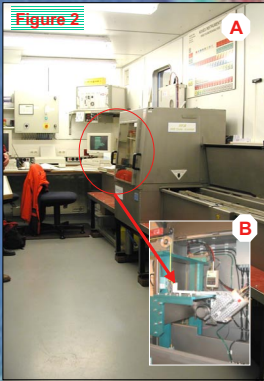


Figure 2. A) XRF core scanner from the University of Bremen installed in a container. B) The zone inside the red circle is enlarged in this picture to observe the Mo X-ray source and the X-ray detector. The plastic prism is lowered on the core surface during analysis. The acquired XRF spectrum for each measurement is processed (background subtraction, sum-peak, deconvolution and peak integration) to finally obtain the intensity of K, Ca, Ti, Mn, Fe, Cu and Sr in counts per second (cps).

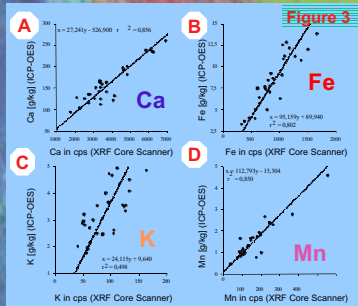


Figure 3. Comparison of ICP-OES and XRF core scanner measurements for some selected elements. Correlation line, equation and r-squared are shown in the graphs. A) Calcium, B) Iron, C) Potassium and D) Manganese. Correlated values of Ca and Fe are taken for Figure 4B and C.

Figure 1.

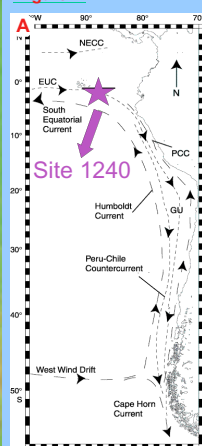
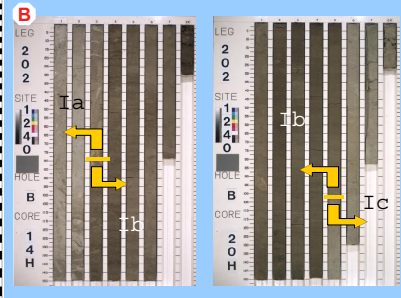


Figure 1. A) Location of Site 1240 (0°..1.31 N; 86°..27.75 W) in the Panama Basin. Main ocean surface currents are indicated by black dashed arrows. B) Photographs of two selected cores from Site 1240 showing the boundaries between the lithological subunits Ia-b (core 14H, hole B), in the left, and Ib-c (core 20H, hole B), in the right. Note the characteristic colour banding that occurs throughout subunit Ib, the general darker colour and the sandier character.



RESULTS AND DISCUSSION

The lithostratigraphic studies carried out on board for the sediments in Site 1240 and the downcore profiles of physical properties, allowed to define three different subunits whose boundaries are included in our selected time interval (Figure 1):

- **Subunit Ia** (0-1.6 Ma aprox.): nanofossil ooze highly bioturbated.
- **Subunit Ib** (1.6-2.2 Ma aprox.): sediment enriched in diatoms and siliciclastic components. Colour banding is frequent, more clear at the boundaries with subunits Ia and c. High values of TOC and chlorines are observed. Magnetic susceptibility (MS), GRA bulk density and Lightness (L) are low whereas Natural gamma radiation (NGM) and the red colour (a*) are high.
- **Subunit Ic** (2.2-2.6 Ma aprox.): nanofossil ooze highly bioturbated.

Characteristics of **Subunit Ib** pointed to the simultaneous increase in primary productivity and effective eolian transport between 1.6 and 2.2 Ma, perhaps related to an intensification of atmospheric and oceanic circulation. To go deeply into this question we present here high-resolution geochemical records (Figures 3 and 4) that will provide new clues to reconstruct rapid atmospheric and oceanographic changes in the Equatorial Pacific Ocean.

These new results show that lightness variability is controlled by changes in carbonate concentration of the sediments (Figure 4A). This variability may be the result of different predominance of microfossil of siliceous or calcareous test that are supposed to reflect changes in the operation way of the Equatorial upwelling cell. The high parallelism between magnetic susceptibility and iron records (Figure 4B) points

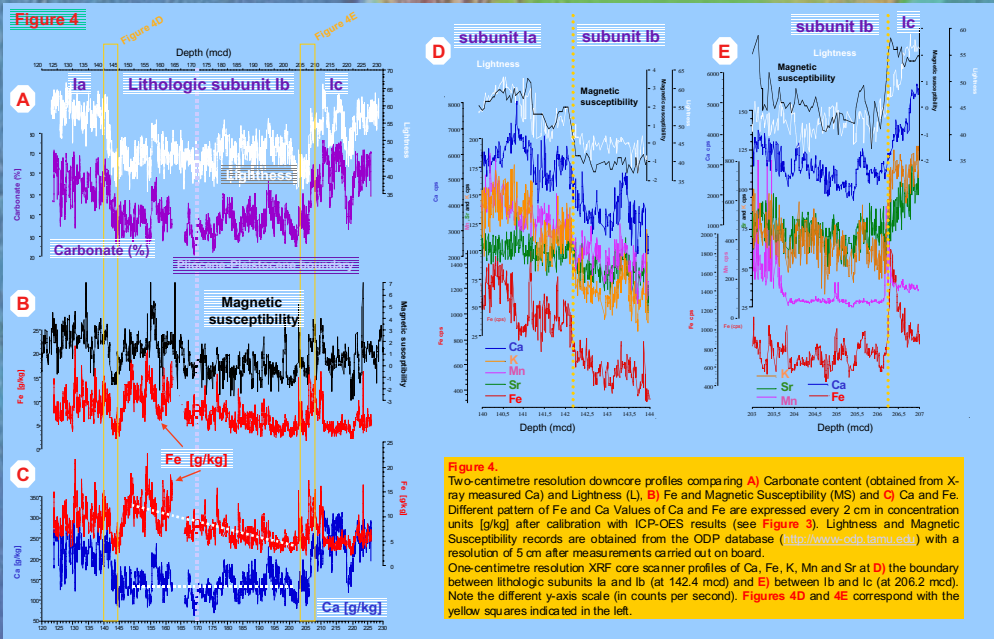


Figure 4. Two-centimetre resolution downcore profiles comparing A) Carbonate content (obtained from X-ray measured Ca) and Lightness (L), B) Fe and Magnetic Susceptibility (MS) and C) Ca and Fe. Different pattern of Fe and Ca. Values of Ca and Fe are expressed every 2 cm in concentration units [µg/g] after calibration with ICP-OES results (see Figure 3). Lightness and Magnetic Susceptibility records are obtained from the ODP database (<http://www.odp.lam.edu/>) with a resolution of 5 cm after measurements carried out on board. One-centimetre resolution XRF core scanner profiles of Ca, Fe, K, Mn and Sr at D) (the boundary between lithological subunits Ia and Ib at 142.4 mcd) and E) between Ib and Ic (at 206.2 mcd). Note the different y-axis scale in (counts per second), Figures 4D and 4E correspond with the yellow squares indicated in the left.

to a common origin of both signals, potentially due to dust transport by winds. These two systems seem to be closely linked, reaching higher carbonate production when eolian transport would be more efficient (Figure 4C). But the close comparison of the records show a more complex relationship with the occurrence of different trends that need to be better explored. Particularly interesting is the increasing trend in the iron content across the studied time interval suggesting an enhancement of the eolian transport towards the early Pleistocene (indicated by a dashed white line in Figure 4C).

The sharp contact between the three lithological subunits defined on board has been studied at high resolution (1 cm) and results are shown in Figures 4D and 4E. These records illustrate the occurrence of a prominent and persistent change at the boundary areas for all the studied elements. We also observe that during these intervals the two groups of proxies (productivity versus eolian transport) evolve with a greater parallelism. All these oscillations and also their cyclic evolution need to be better analysed after an accurate stratigraphy, which is not yet available. Overall, the studied proxies constitute an exceptional high-resolution record of the Pliocene-Pleistocene boundary which will provide a solid base for a further research on the analyses of rapid climatic variability in the Eastern Equatorial Pacific Ocean.

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