ESF Scientific Report for Short Visit Grant

Applicant Name: Mr. Daniele Reghellin
Host Institute: Dr. Simone Galeotti, Università degli Studi di Urbino Carlo Bo

Dear Committee members,

Here is a short report of my participation at the Urbino Summer School in Paleoclimatology 2011.

The purpose of my attendance at the USSP 2011 has been the improvement of my scientific knowledge in the field of paleoclimatology and paleoceanography. The USSP 2011 has comprised a series of lectures, focused on the interpretation of the dynamics that control past and present climates.
The main topics discussed were:

- Stratigraphy, especially magneto- and biostratigraphy for the age models;
- Investigation of complex climatic systems;
- Principles of organic geochemistry and biochemistry;
- Carbon cycle, with particular emphasis on the long term carbon cycle and climate changes;
- The theory of cyclostratigraphy and orbital forcing;
- Application of oxygen and carbon stable isotopes in paleoclimate reconstructions;
- Organic and inorganic marine proxies (e.g. nannofossils, benthic and planktonic foraminifera, siliceous microfossils, dinoflagellates) and organic chemistry proxies (e.g. Alkenones, $U^{k}_{37,}$ TEX86);
- Climate modeling (comprising principles, calculation and simulation of the climate modeling at different geological periods).

All these different aspects of paleoclimatology were analyzed in respect of the most important past-climate events, such as the K-T Mass Extinction, the Late Paleocene Thermal Maximum (PETM), the Early Eocene Climatic Optimum, the Eocene-Oligocene boundary, the Greenhouse-Icehouse transition, the climate

dynamics during the Neogene and the Quaternary, and the high frequency climate variability (millennial-scale climate variability).

The lectures were integrated with field work and field data analyses sessions (e.g. cyclostratigraphy of field sections, sediment processing, foraminifera zoning, etc.), besides sessions dedicated to the discussions between students and scientists.

My PhD project, from the topic "Late Miocene and early Pliocene paleoceanography from wind-driven upwelling regions in the Pacific and Indian oceans", is focused on the reconstruction of sea surface water temperatures (SSTs), productivity conditions and carbon cycling in particular areas of the Indo-Pacific ocean characterized by wind-driven upwelling.

This study is part of a bigger project aimed to provide comparable and correlative records for SSTs and biological productivity across several regions over the past 10 Myr mainly using DSDP, ODP and IODP sediment cores.

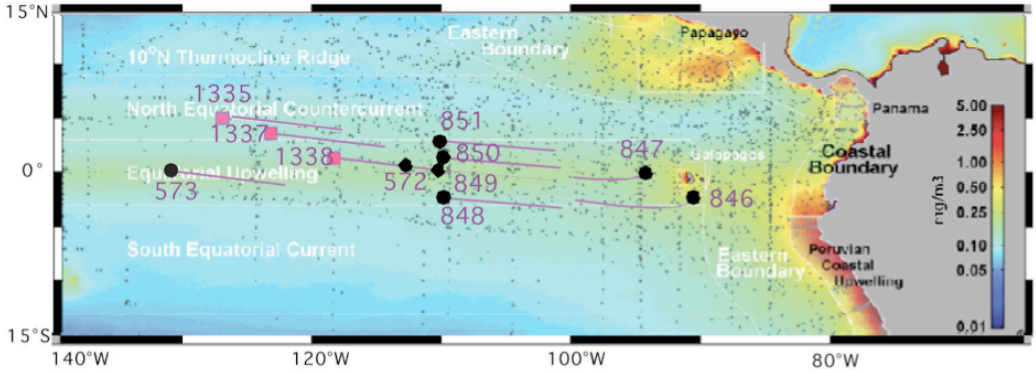
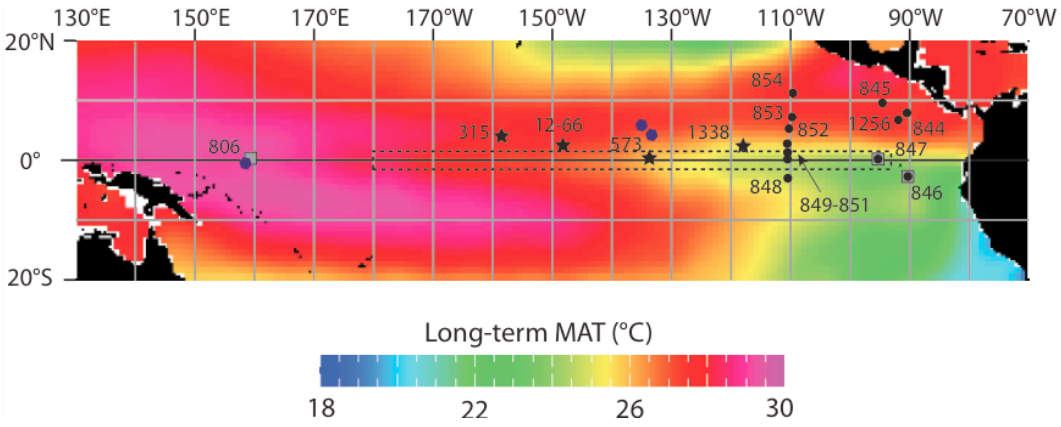


Figure 1 (above). Present day primary productivity in the Eastern Equatorial Pacific (EEP), with the location of key DSDP, ODP and IODP sites (from Pennington *et al.*, 2006).

Figure 2 (below). Present day surface waters Mean Annual Temperature of the EEP. The dashed rectangle delimits a strong equatorial upwelling area.



The main objectives of my PhD research is to improve the overall understanding of biological productivity and water temperature conditions, in wind-driven upwelling regions, during a particular geological time period characterized by prominent changes in the upwelling intensity and in water temperature and biological productivity patterns.

The work chiefly focuses on the study of sediment and micropaleontological material from the Central Equatorial Pacific Ocean (DSDP Site 573; IODP Site 1338) and from the Owen Ridge in the Indian Ocean (ODP Site 722).

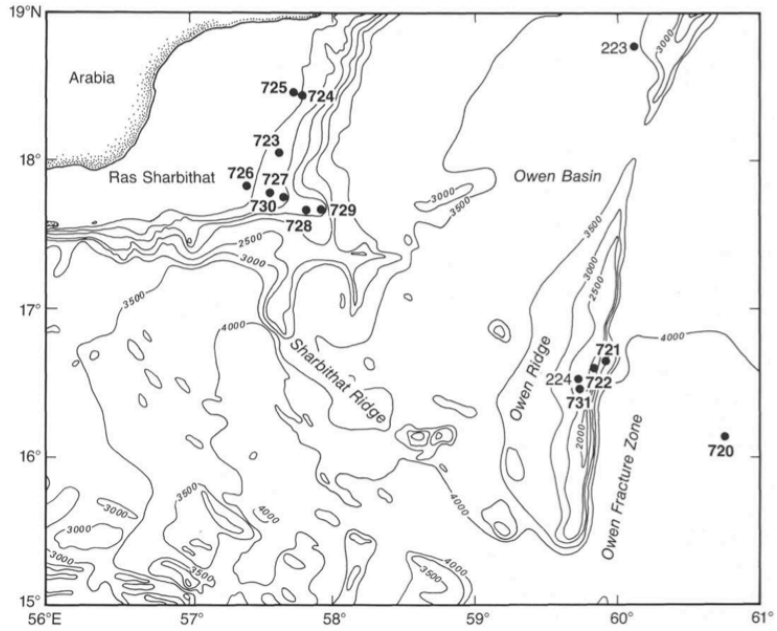


Figure 2. Simplified bathymetric map of Owen Ridge area (Arabian sea, Indian Ocean) with location of Leg 117 ODP drill sites.

The time interval of interest is the late Miocene and the early Pliocene, a geological period characterized by important perturbation in the global geochemical cycling ("The biogenic bloom"), with very high sedimentation rates beneath upwelling zones, and a decreased carbon isotope signal of bulk carbonate and benthic and planktic foraminifera (Farrell et al., 1995; Dickens & Owen, 1999; Grant & Dickens, 2002).

To carry out these tasks, I will generate micropaleontological, carbon and oxygen stable isotopes, trace element and other inorganic geochemical data, chiefly using planktonic foraminifera.

For the reconstruction of SSTs and biological productivity in the past environments, widely known geochemical analyses use calcareous and siliceous

microfossils. Planktonic foraminifera are normally analyzed for their oxygen and carbon isotope composition ($\delta^{18}OM$; $\delta^{13}C$), their Mg/Ca ratio, as these depend on the water temperature and on chemical properties of the water.
Moreover, the preservation and the abundance variability among planktonic foraminiferal assemblages, the presence or the absence of peculiar species and the examination of different foraminifera assemblages, are another straightforward paleoclimate tool since the ratios of various species depends on the water temperature and water chemical conditions (Dekens et al., 2007; Dowsett and Robison, 2009).
Hence the study of planktonic foraminifera assemblages, paleoceanographic proxy methods, carbon and oxygen stable isotopes, and sedimentological analyses is of primary relevance for the aims of my PhD project.
At the USSP 2011 I gained some crucial knowledge about how to use geochemical proxies and biostratigraphic data, and how to combine them to obtain straightforward paleoclimate and paleoenvironmental reconstructions. In particular the summer school helped me to reinforce my understanding of some of the primary topics of my PhD research, such as the long-term carbon cycle and its implication on the climate change, the use of foraminifera species and foraminifera assemblages to reconstruct water column conditions, and how to integrate biostratigraphic data with other geochemical proxies such as biomarkers (e.g. $U^{k}_{37,}$ TEX86, Alkenones) and trace elements (Mg/Ca and Sr/Ca ratios).
Therefore, the attendance of the Urbino Summer School in Paleoclimatology 2011 gave me some essential knowledge about the most important disciplines involved in the field of paleoclimatology and paleoceanography and has represented a unique chance to improve my education in this field.

References

Dickens, G.R., Owen, R.M. (1999). The latest Miocene-early Pliocene biogenic bloom: a revised
Indian Ocean perspective. *Marine Geology*, 161:75-91.

Dekens, P.S. et al. (2007). Warm upwelling regions in the Pliocene warm period. *Paleoceanography*, 22, doi:10.1029/2006PA001394

Dowsett, H.J., Robinson, M.M. (2009). Mid-Pliocene equatorial Pacific sea surface temperature
reconstruction: a multi-proxy perspective. *Phil. Trans. R. Soc. A*, 367:109-125.

Farrell, J.W. et al. (1995). Late Neogene sedimentation patterns in the eastern equatorial Pacific Ocean. *Proceedings ODP, Scientific Results*, 138:717-756.

Grant, K.M., Dickens, G.R. (2002). Coupled productivity and carbon isotope records in the southwest Pacific Ocean during the late Miocene-early Pliocene biogenic bloom. *Palaeo.3,* 187:61-82.