IAS POSTGRADUATE GRANT SCHEME

Scientific Report by Francesca Casaglia

The grant was used to undertake research at the Geology Department of Royal Holloway University of London, Egham Surrey-UK, and was carried out from October 24th to December 23rd 2003.
The research involved using SedTec2000, a 2D forward stratigraphic modelling program developed by Dr. David Waltham at Royal Holloway University of London. I carried out quantitative numerical modelling of the stratigraphic unit I have been studying during the three first years of my PhD in Perugia, Italy: the Calcare Massiccio unit. This unit is a Lower Jurassic isolated carbonate platform outcropping in the Umbria-Marche domain of the Northern Apennines. Along the western Tethyan margin, the early Liassic tectonic activity played an important role in the platform growing, break-up and drowning (Colacicchi, 1999). The structural pattern that controlled the drowning is due to a half-graben in a sinistral transtensive regime; the result is a fragmentary physiography of the sea bottom (Santantonio, 1993), which controlled the subsequent sedimentation on tilted faulted blocks (Colacicchi, 1999). We tried to examine the possible driving mechanisms for the development of the stratigraphy on this Lower Jurassic carbonate platform. We investigated potential mechanisms of peritidal parasequence formation, and used SedTec2000 to investigate how numerical forward modelling can be used to explore the complex relationships between sediment supply, accommodation space, relative sea-level change and tectonic activity on platform development. Simulation of the stratigraphy was undertaken to quantify and constrain the parameters behind the stratigraphy and the rates at which some of the processes that controlled the development of the stratigraphy operated. The principal aims of the modelling aspect of this research is to test the origin of the Early Liassic greenhouse cyclicity in the western margin of the Tethyan ocean basin and the possible causes of platform drowning
During the visit I was working under the supervision of Daniel Bosence, Professor in Carbonate Sedimentology, who also discussed in detail the results of my fieldwork and sedimentological logging. I followed a short course about the use of SedTec2000 held by Dr.Dave Waltham and the discussions with both of them have contributed significantly to the development and the advance of this project. I worked in contact with specialists in sedimentology and stratigraphy from Royal Holloway University and from University College of London, that give their fundamental help for providing useful comments and suggestions to this topic.

The sedimentary modelling used can be roughly described as follows (Boylan *et al.*, 2002):
1- Plotting successive stratigraphic surfaces at fixed time increments to display stratigraphic geometries.
2- Displaying the stratigraphy in the form of water depth in which it was deposited by the program. The facies were then interpreted by the modeller with respect to the location on the platform and depth of deposition.
3- Plotting the dominant process of deposition acting at point. The model predicts the sedimentation produced by a number of processes such as carbonate platform accumulation, deep-water pelagic production, etc. and the output the model run in terms of process producing the most sediment at any point.
4- Plotting different carbonate facies that reflect variations of rock textures and grain composition, that arises from the combination of biological, chemical and sedimentological processes that control formation of carbonate sediments.

The unique quality of this program is its ability to separately simulate platform interior, margin and slope sedimentary processes, siliciclastic input, tectonic uplift, subsidence and compaction and the facies are defined and displayed in terms of dominant processes of deposition. SedTec2000 can simulate seven different types of sedimentary processes and products in a 2D cross section, in

response to sea-level changes, carbonate and clastic sediment supply, subsidence, differential compaction: *platform interior carbonates - platform margin carbonates - coarse reworked margin carbonates - fine reworked margin carbonates - pelagic carbonates - coarse clastics - fine clastics*. It is important to notice that the rate and/or amount of sedimentary processes as sediment supply, erosion/dissolution, transport restrictions as well as wave base depth and light stress may be directly defined and entered by the user. It's also possible to define starting sea-level position, rise or fall rate, fluctuations and changes in time (Boylan *et al.* 2002).

The main results achieved during the visit were the successful simulation of:
(1) Sedimentary processes behind the peritidal cyclicity in Calcare Massiccio platform (asymmetric shallowing upward cycles);
(2) Differential platform growth on rotated, extensional fault-blocks;
(3) Platform segmentation and basin development and platform drowning;
(4) Simulation of six different sedimentary facies equivalent to those documented in the field.

This grant was been using during the period abroad to cover the expenses of my temporary stay in Egham/London and to sustain the computer-laboratory costs according to the University host's requirements.

Ref.:

Boylan A.L., Waltham D.A., Bosence D.W., Badenas B. and Aurell B. (2002) –Digital rocks: linking forward modelling to carbonate facies. *Basin Research*, 14, 401-415.

Colacicchi R. (1999) – Facies of Calcare Massiccio platform, its chronological development, the drawing and the subsequent palaeogeography. Section II - Discussion and conclusion. *Paleopelagos, Special Publication*, 3. Bio event and integrated stratigraphy: 149-151.

Santantonio M. (1993) – Facies associations and evolution of pelagic carbonate platform/basin system: examples from the Italian Jurassic. *Sedimentology*, 40, 1039-1067.