Cretaceous oceanic red bed deposition, a tool for paleoenvironmental changes—Workshop of IGCP 463 & 494

Bucharest, Romania, August 15–18, 2004

Members of IGCP 463, Cretaceous Oceanic Red Beds (CORBs), held the third workshop in Romania. In addition to scientific sessions, discussions of results and future plans, the participants examined exposures of Upper Cretaceous Red Beds of the Romanian Carpathians characterized both by pelagic/hemipelagic and turbiditic facies.

Mihaela Carmen Melinte with the National Institute of Marine Geology and Geoecology (GEOECOMAR Bucharest) organized the Workshop of IGCP 463 & 494, which was chaired by project leaders Chengshan Wang (China) and Robert Scott (USA), and Xiumian Hu (China), respectively. The workshop was co-sponsored by UNESCO/IUGS Programme, as well as by the National Institute of Marine Geology and Geoecology (GEOECOMAR Bucharest) and by the Romanian Ministry of Education and Research. Twenty-three participants from ten countries: Austria, Bulgaria, China, Czech Republic, Germany, Poland, Romania, Spain, Turkey and USA attended the meeting and the following field trip.

The objective of this workshop was to review the progress and new data on studies of Cretaceous Oceanic Red Beds, as well as their significance for paleoclimatical, paleoenvironmental and paleoceanographical changes.

Meeting brief

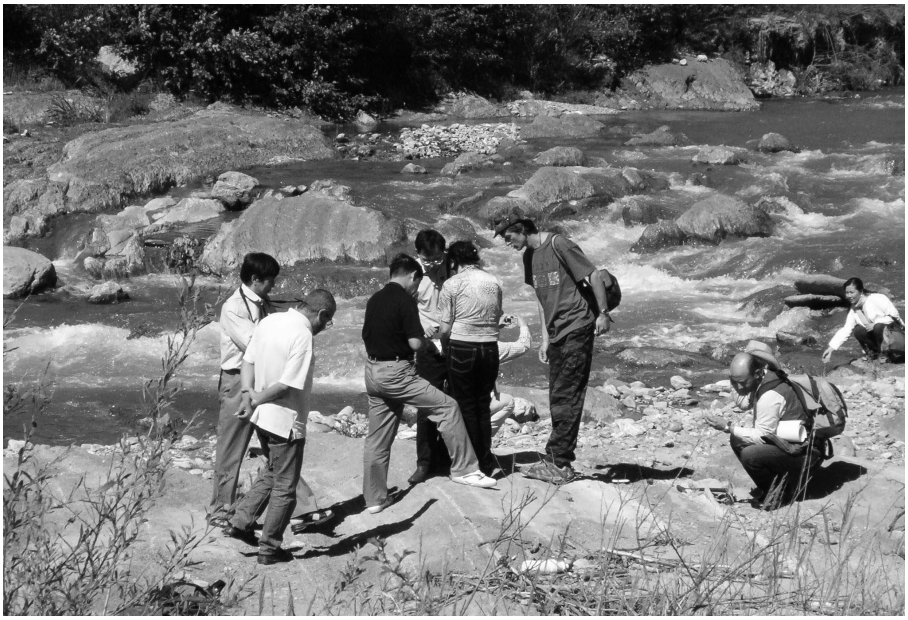
On the first day of the workshop, twenty-three participants presented results of their current research on CORBs at the meeting held in Bucharest, in the Museum of Geology.

At the beginning of the workship, Nicolae Panin, Director of the GEOECOMAR, welcomed the participants. Theodor Neagu also saluted everyone, on behalf of the Romanian Academy. Robert Scott (USA) presented an integrated chronostratigraphic chart of CORBs, indicating that this type of sediments were deposited during each of the Late Cretaceous epochs, when oxygenated conditions developed in deep marine basins. However, it is not known whether the timing of this process was synchronous globally, or whether it was a local phenomenon. CORB examples were biostratigraphically dated in sections in the Apennines, the Austrian Alps, the Polish, Czech, and Romanian Carpathians, in the Caucasus, and in Tibet. Nannofossils, planktic foraminifers, and dinoflagellates in these sections define zones in the Cenomanian, Turonian, Coniacian, Santonian, Campanian, and Maastrichtian stages. In Austria, at Tiefenbach, CORBs were deposited during a brief interval in the Early Santonian. However, in the North Pieniny Belt of the Carpathians, CORBs apparently were sedimented in the late Cenomanian and the process continued until the late Campanian, except during the OAE2. In the Czech Republic and in the Caucasus, pelagic marine red beds were deposited during brief intervals. In Tibet, deposition of the classic pelagic red beds of the Chuangde Formation persisted during much of the Campanian. To determine the significance of these very preliminary results, numerous sections having integrated biostratigraphy are required both within the basins and in additional basins. Detailed bed-by-bed sections of CORB intervals need to be sampled.

In Spain, the so-called "Formación Capas Rojas" (= Red Bed Formation) widely crops out in the Subbetic (External Zones of the Betic Ranges). Jaume Gallemi (Spain) and Mihaela Carmen Melinte (Romania) presented the echinoids and calcareous nannofloras identified in the "Formación Capas Rojas" (Red Bed Formation), coming from several localities: Las Vallongas and Pantà d'Elx (Alicante province), Cieza and Caravaca (Murcia province), Topares (Almería province), Mancha Real and Cas-tillo de Locubín (Jaén). Other Upper Cretaceous red beds, belonging to the so-called "Formación Qipar-Jorquera" (in the Intermediate Units), were also investigated. The echinoid assemblages of the red beds occurring within the two above-mentioned formations are quite different. The association of echinoids of Capas Rojas Formation contains common *Rispolia subtrigonata, Homoeaster auberti, Ovulaster gauthieri, O. zignoanus, O. obtusus, Stenonaster tuberculata* and *Infulaster* sp. The calcareous nannofosils identified in samples collected together with these faunas range from the upper Lower Coniacian-lower Upper Coniacian interval (UC10 Nannofossil Zone) at Las Vallongas up to the upper-most Coniacian/lowermost Santonian (UC11c Nannofossil Zone) at Topares.

The localities of the Quípar-Jorquera Fm. where echinoids have been identified include: Castell de Guadalest and the close village of Benimantell, El Sacarest (between Sella and Finestrat), Orxeta, El Cabrafic Alt (between Aigües de Busot and Busot), Estret de Busot and the area of La Torre de les Maçanes. The echinoid associations usually include *Stegaster novoi, S. bouillei* and *Homoeaster evaristei*. In horizons below those providing *H. evaristei* but not red in colour, *Coraster vilanovae* is present. The nannofosil zones recognised in samples collected aside of these faunas range from UC18 (Lower Maastrichtian) at Estret de Busot to UC20 (Lower/Upper Maastrichtian boundary) at El Cabrafic Alt.

Xiumian Hu (China) and Lilian Švábanická (Czech Republic) presented the stratigraphy of the Rio Fardes section (NE Granada, Spain), located in the deep basinal Middle Subbetic domain. Members II and III of the exposed Fardes Formation contain (hemi)pelagic sediments, which appear together with turbidites and olistostromes. Two brands of red beds were found, one in Member II, and the other in Member III. The red beds sequence consists of thick reddish clays alternating with gray, variegated,



First day of the field trip — Upper Maastrichtian red beds in the Prahova Valley.

Participants sample the CORB in the Covasna Valley during the second day of the field trip.

sometimes black, clays and calcareous clays. Based on calcareous nannofossil investigation, the red beds of Member II were dated as Lower Turonian (the uppermost part) (UC7 Nannofossil Zone). The red beds of Member III are, according to their nannofossil content, Middle Coniacian (UC10 Nannofossil Zone) to Middle-Upper Coniacian boundary (UC10/?UC11 Nannofossil Zones) in age.

Ines Wendler (Germany) presented a modern view of the CORBs topic, taking into account the influence of bottom oxygen content on the preservation of organic matter and calcium carbonate at the seafloor. The content of oxygen in bottom waters of the ocean is not only controlling the oxidation state of iron and other elements, but is also crucial to oxidation of the organic matter in the sediments. The study of recent surface sediments in the highly productive northeastern Arabian Sea revealed a significant relationship between oxygen exposure and the preservation of carbonate particles in the sediments.

Stephanie Neuhuber and Michael Wagreich (Austria) presented the Upper Santonian section of the Rehkogelgraben profile in the Northern Calcareous Alps, consisting of red and white to light grey marls, which alternate regularly. The authors concluded that the red layers represent time periods with higher terrigenous input where a sufficient oxygen supply resulted in a complete oxidation of organic matter within the water column. More nutrients and nutrient-like trace metals (P, Ba, Cu, Zn) reached the ocean floor. The white layers represent suboxic conditions with less terrigenous input but higher organic matter respiration within the lower water column or postdepositional in the carbonaceous ooze.

Camilo Ponton (USA) and Florentin Maurrasse (USA) indicated that overall variation, showing increasing occurrence of oceanic red-to-brown sediments from subordinate in the Mid-Cretaceous to dominant in the late Late Cretaceous and Paleocene, questions the exact controlling mechanisms of these facies. While this sedimentological change may indicate influences associated with paleoclimatic forcing mechanisms on the oxygen level of the water column, the occurrence of red sediments related to oxic conditions may also indicate arid climatic conditions that increased the input of terrigenous material into the oceans. In the opinion of the above-mentioned authors, the variety of these coeval facies implies that local physiography of the basin and related conditions of adjacent landmasses led to factors that could overprint the effects of global oceanic conditions.

Several presentations focussed on CORBs occurring in the Carpathian area. Ewa Malata presented agglutinated foraminifera of the CORB of the Polish Outer Carpathians and their biostratigraphic significance. The oldest index species characteristic of the CORB sediments in this area is *Bulbobaculites problematicus*, ranging within the Cenomanian–Early Coniacian interval. The presence of this agglutinated foraminiferal taxon indicates the earliest appearance of CORB deposits in the Subsilesian basin, which was situated on the submarine elevations. In the Magura, Fore-Magura, Silesian and Skole units, the Turonian part of the *Uvigerinammina jankoi* Zone marks the development of the red beds. At that time, red clays were accumulated beneath the CCD in all sub-basins, and the maximum paleodepth of the Carpathian basins was reached during that time. Exclusively agglutinated foraminifera are characteristic of the younger part of the red beds in the Magura and Silesian units, while in the Subsilesian and Fore-Magura the amount of calcareous taxa increased. Miroslav Bubik (Czech Republic) gave a presentation on the biostratigraphy and paleoecology across the CORB in the Silesian Unit (Moravia, Czech Republic). The quantitative structure of benthic foraminifer communities and foraminifer abundance were plotted to estimate the paleoenvironmental trends during the red bed deposition. The results indicate a change to a more oligotrophic condition higher in the CORB. The deposition of black bands, accompanied by abundant ichnofossils may indicate eutrophic events and possibly hypoxic conditions. Lack of carbonates and calcareous fossils indicates clearly deposition below the CCD. Mihaela Carmen Melinte (Romania) reported the time deposition of the CORBs in the Romanian Carpathians. The base of the oldest known CORB is situated within the uppermost Albian (just below the base of the Stoliczkaia dispar Ammonite Zone). Described as "Variegated Shales", the red beds, occurring in all the nappes of the Outer Flysch Zone of the

All the participants of the Romanian Workshop of IGCP Projects 463 & 494, at the end of the field trip in the Romanian Carpathians.

East Carpathians, overlie the Black Shale Formation (Valanginian?–Albian in age).

İsmail Ömer Yilmaz (Turkey) gave an interpretation of anoxoic-oxic changes, related to the cyclic record of Barremian-Aptian pelagic carbonate successions from NW Turkey. Two detailed stratigraphic sections, dominated by pelagic carbonates consisting of an alternation of pelagic limestones with marl/black shale lithologies and forming couplets throughout the succession, were measured, and almost 200 samples were recovered. The couplets are interpreted as obliquity cycles of Milankovitch band. The duration per cycle in the sections ranges between 34 ka and 57 ka. Change in the nannoconid/coccolith ratio between the marl/black shale and the limestone was prominently observed. Abundance of nannoconids in marl/black shale facies with respect to the limestone facies and the enrichment of coccoliths within limestones reflect nutrient and paleoproductivity variations during deposition. These nutrient and paleoproductivity fluctuations could be in relation with sea level change, affected by change in orbital parameters and reflected in facies changes.

Kağan Tekin and Okan Tüysüz (Turkey) presented the late Cretaceous syntectonic oceanic red beds deposited on an active continental margin. Main branch of the Neo-Tethys, the İzmir-Ankara-Erzincan Ocean, was consumed by northward subduction of its floor below the Pontide continental fragment during the Cenomanian-Maastrichtian interval. In response to this subduction, an ensialic arc on the Pontides and an active continental margin along the south facing border of the Pontides have been established. The age identified based on radiolarian assemblages indicates that the imbrication of the active margin was produced during the middle Albian–late Cenomanian.

Polina Pavlishina (Bulgaria) gave a presentation about the Santonian-Campanian red beds exposed in the central part of Srednogorie area (Bulgaria). The study provides field revisions and palynological data aiming at age determination of the Upper Cretaceous sediments, in general, and of red beds, in particular. The sedimentary rocks of the Mirkovo Formation (reddish limestones and marls), and the overlain turbiditic deposits of the Chugovo Formation were investigated. Samples originating from the Chugovo Formation and above the reddish limestones of the Mirkovo Formation yielded palynoflora comprising dinoflagellate cysts and Normapolles species in equal quantities. The identified taxa suggest a Late Campanian–Early Maastrichtian age for the samples, and thus a preliminary Santonian–Early Campanian age of the red bed deposited below.

Field trip in Romanian Carpathians

For three days following the meeting in Bucharest, participants examined several localities of red beds cropping out in the nappes of the Romanian Carpathians. M.C. Melinte, T. Brustur, D. Jipa and S. Szobotka prepared a detailed field guidebook, including the geology of the Romanian Carpathians, focussed on the East Carpathian Flysch Zone and on the description of red beds cropping out in this area.

On the first day, the participants left Bucharest, travelling along the Prahova Valley. On the way, at the Nistoresti locality, Upper Campanian–Maastrichtian red pelagic/hemipelagic sediments were examined and sampled for geochemical investiations. The field trip continued in the Lalomita Valley, where Campanian–Lower Paleocene red cherry marls of the Gura Beliei Formation were examined. This type of red sediments occurred only in the southern end of the Eastern Carpathians, representing the post-tectonic cover of nappes involved in Cretaceous and Miocene tectonic movements. Gura Beliei Marls contain diversified calcareous nannofossil and planktonic foraminiferal assemblages, as well as scarce macrofaunas, mainly represented by the Belemnitella genus.

At the end of the first day we saw green and red jaspers, and radiolarian green and red rocks of the Azuga Facies, interbedded within the calcareous turbidites of the Tithonian-Barremian Sinaia Formation.

The aim of the second day of the field trip was to present the oldest Cretaceous red beds of the East Carpathians, representing the sedimentary of the inner napes of the Flysch Zone. In the Cernatu-Dalnic and Covasna areas, the red beds (the so-called Variegated Shale Formation) conformably overlay the Lower Cretaceous Black Shales. The above-mentioned red beds are mainly composed of red and green shales, with radiolarian chert intercalations. Based on the presence of the ammonites *Stoliczkaia dispar* and *S. notha*, the base on the variegated shales was dated as uppermost Albian. The benthic foraminifera, the dinoflagellates and the radiolarian assemblages indicated that the deposition of the CORB in the region was continuous during the Cenomanian–Coniacian interval.

During the third (and last) day of the field trip, the participants travelled from the Braşov town to the Buzău river basin, to see the red beds of the sedimentary cover of Outer Dacidian and Inner Moldavidian Nappes of the Eastern Carpathians. The pelagic red beds of the Dumbrăvioara Formation were examined in the Poiana Florilor-Teliu area. All the three members of this lithostratigraphical unit: the uppermost Albian–lowermost Cenomanian Lower Member of Red Shales (containing *Neohibolites ultimus* and microfaunal assemblages with *Rotalipora appenninica*), the Lower Cenomanian–Lower Turonian Middle Member made up from black and grey shales (containing macrofaunal assemblages with *Puzosia planulata, Romaniceras spp., Hamites spp., Acanthoceras rhotomagense, Inoceramus* aff. *hercynicus* and *I. crippsi*) as well as the Lower Turonian Upper Member of Red Shales (with the base situated within the UC6a Nannofossil Zone and the top within the UC9b Nannofossil Zone) were investigated. The last outcrop seen during the last day was the CORB belonging to the sedimentary cover of the Audia Nappe. The red beds crop out as narrow strips, overlying the Black Shale Formation, specifically the Upper Member of it (the Glauconitic Sandstone, lithsotratigraphic unit similar to the Lgota Beds of the Polish Carpathians). The CORB are uppermost Albian–lower Coniacian in age, according to their calcareous nannofossil content (from UC0 up to UC10 Nannofossil Zones). Locally, the red shales (described also as Bota-Botita Formation) contain, within their lower part, bentonites. In places, breccias with granodiorite elements (proceeding from a cordilliera, which was active only during the Late Cretaceous interval) could be observed.

Future programme

A session of IGCP 463 & 494 dealing with CORB deposition, as well as implications for paleoclimatic and paleoceanographic changes, was proposed by the delegates to be held at the 7th Cretaceous Symposium (Neuchâtel, September 2005). A field trip to Spain is also being considered, with the objective of examinaing pelagic red beds of the Betic/Subbetic Cordillieras.

Details about the next year's programme will be circulated at a later date.

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