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Abstract volume

THE CENOMANIAN-TURONIAN ANOXIC EVENT IN NORTHERN ITALY (SOUTHERN ALPS AND CENTRAL APPENINES) CORRELATION WITH THE PENIBETIC ZONE (SOUTH SPAIN)

ADATTE T., STEINMANN P., MORT, H., AFFOLTER S., JACQUAT O., PARATTE G., DUCOMMUN P.
Institut de Géologie, Université de Neuchâtel, 2007 Neuchâtel, Switzerland. thierry.adatte@unine.ch
GERTA KELLER
Department of Geosciences, Princeton University, Princeton NJ 08540, USA
ZSOLT BERNER & DORIS STÜBEN
Institut für Petrographie und Geochemie, Universität Karlsruhe, D-76128 Karlsruhe, Germany.

The aims of the present research are to determine the nature and timing of the faunal change (and associated facies) in deep (bathyal) environments and how these events are correlated with changes in clay-minerals, P, C and CaCO3 fluxes, in order to precise climatic and weathering conditions which prevailed during the Cenomanian-Turonian events.
In Italia, the Bonarelli Level consists of a spectacular lithological record of OAE2, and represents the type locality of the C/T boundary. It was defined in the Umbria-Marche Basin and consists of approximately 1.5 m of black shales and radiolarian-rich layers. Cenomanian-Turonian organic rich sediments including the Bonarelli level have been sampled and are presently studied in 2 diferent paleogeographic settings of the Umbria-Marche Basin. Two representative sections have been therefore selected. The Furlo section located near Piobbico in the Central Appennines and the Monte Veloso section located near the Garda Lake. The Furlo section was sampled in high resolution to investigate a more expanded Bonarelli as well as several black shales, precursors of the main event. This section differs somewhat from its equivalents elsewhere in the Umbria-Marche Basin due to the presence of multiple black cherts and shales (Bonarelli 'precursors') located 10-20m below the Bonarelli level. As already seen in the spanish sections, the Bonarelli horizon consists of 1.2m thick black laminated shales and radiolarian rich levels and is almost devoided in carbonates. Paleodepth ranges probably between 700-1500m. The two studied spanish sections are located in the Penibetic Zone of the southern Iberian margin, which was in bathyal position during the Cenomanian-Turomian transition. The El Chorro section is situated 70km northwest of Ronda, whereas the Manilva section is located along the coast, 50km southeast of Marbella (Andalucia). Altough these sections are separated by more than 100km, they present the same kind of lithological change and can be probably be correlated at beds level.
The spanish and italians sections are biostratigraphically quite similar. In these sections, these black shales are unfortunatly devoided of planctic foraminifera (<2% of carbonates) and consequently not suitable for bulk rock stables isotopes measurments. The black shales are overlain by cherty pelagic limestones. *W. archaeocretacea* has been identified in the first limestone bed. The first occurence of *P. helvetica* is observed 30-50cm above the the last black shale layer. Some of the cherty limestone layers, which exhibit erosive contacts, are very rich in radiolarian and gradded, indicating reworking by winnowing currents. These two areas probably belonged to different Mesozoic continental margins. However, the Cenomanian-Turonian transition exhibits surprising similarities to corresponding paleogeographic settings along the Iberian continental margin. We present herein the preliminary results including planktonic foraminiferal and biostratigraphy, microfacies, organic geochemistry, bulk rock and clay mineralogy and organic carbon stable isotopes.

SEDIMENTOLOGIC AND STRATIGRAPHIC EVIDENCES OF EUSTATIC CONTROL ON SHALLOW-WATER CARBONATES EARLY CRETACEOUS, SOUTHERN ITALY

AMODIO SABRINA[1,2], FERRERI VITTORIA[1] & D'ARGENIO BRUNO[1,2]
[1]Dipartimento di Scienze della Terra, Università "Federico II", Largo San Marcellino 10, 80138 Naples, Italy.
[2]Istituto per l'Ambiente Marino Costiero, (IAMC), "Geomare Sud", National Research Council, Porto di Napoli, Calata Porta di Massa, 80133, Naples, Italy. Fax:+39 081542388; e-mail: ciclisti@gms01.geomare.na.cnr.it

Stratal packages of Cretaceous shallow–water carbonates, laterally consistent at >100 km distance in their horizontal distribution and vertical changes, are widespread in the Mediterranean region. These strata, if analyzed at cm- to dm-scale, show a number of lithofacies suggesting carbonate platform depositional settings oscillating from relatively open lagoon to more restricted (peritidal) conditions. Vertical variation of depositional textures (lithofacies and lithofacies associations) and early diagenetic features (from marine to meteoric) results in a hierarchy of cycles formed of elementary cycles (normally corresponding to single beds), bundles (groups of 2-5 elementary cycles) and superbundles (groups of 2-4 bundles). Composite sea-level fluctuations, modulated by orbital climatic changes (Milankovitch cycles), explain this cyclic organization in the studied successions, as well as the predominance of cycles showing emersion-related features directly superimposed on subtidal deposits. Moreover, the elementary cycles and their groupings appear to be superimposed on Transgressive/Regressive Facies Trends (T/RFTs) whose time duration (800- to 2000 ky) may be related to extended periodicities of the Earth's orbital eccentricity. These carbonate platform sequences have been interpreted in terms of sequence stratigraphy, even if they show predominantly aggradational growth geometries. On the above base orbital chronostratigraphy and high-resolution regional - to global-scale correlations are proposed.
The high-precision correlations carried out in southern Apennines, Sicily and Dinarids suggests that, in the Early Cretaceous of the Mediterranean area, two basic cycle modes alternate over the whole carbonate platform systems where more differentiated facies (restricted-lagoon to tidal/supratidal areas) turn upwards into more uniform patterns (open-lagoon areas). These two modes, largely but not totally each other exclusive, point at non-actualistic green-house facies models.

A LATE HAUTERIVIAN SHORT-LIVED ANOXIC EVENT IN THE MEDITERRANEAN TETHYS: THE 'FARAONI EVENT'

FRANÇOIS BAUDIN
Département de Géologie Sédimentaire et CNRS FR 32 – Université Pierre et Marie Curie case 117, 4 place Jussieu 75252 Paris Cedex 05 France (frbaudin@ccr.jussieu.fr)

A Late Hauterivian interval (~127.5 Ma), characterised by the deposition of deep-marine black shales in the Mediterranean Tethys. is demonstrably of sufficient geological brevity to be qualify as anoxic event. This event lies within the *Pseudothurmannia catulloi* ammonite subzone, coincides with the extinction of the calcareous nannofossil species *Lithraphidites bollii* and records an explosion of *Gorbatchikella* specimens, a globular planktonic foraminifer. High quantities of marine organic matter were preserved in pelagic successions from northern and central Italy, Switzerland, South-East France, southern Spain and probably elsewhere in the Mediterranean Tethys and Atlantic Ocean. Carbon-isotope stratigraphy from Tethyan and Atlantic sections shows a minor positive excursion in the uppermost part of the Hauterivian and lowermost Barremian, suggesting accelerated extraction of organic carbon from the ocean reservoir just after the 'Faraoni Event'. The duration of this short event is about 100 ka according to cyclostratigraphy and coincides with a third order sea-level rise. It is likely that similar forcing mechanisms responsible for global OAE's operated during this short time interval.

STRATIGRAPHIE INTÉGRÉE COMPARATIVE : DU VALANGINIEN À L'APTIEN, EN FRANCE (BASSIN DU SE) ET EN ITALIE (ALPES ET APENNINS).

BERNARD BEAUDOIN
Ecole des Mines de Paris

Le rêve de tout géologue est de pouvoir inscrire ses observations et ses reconstructions, structurales, paléogéographiques … dans un cadre stratigraphique calibré associant les âges et les durées, ainsi que les données magnéto-stratigraphiques, bio-stratigraphiques (ammonites, …), isotopiques ($\delta^{13}C$) …
Nombre de publications récentes proposent de telles chartes intégrées. Leur examen montre qu'en fait elles reposent bien souvent sur des *hypothèses implicites* de continuité et de régularité des coupes-support et de possibilité de corrélation d'un signal spécifique (nannos, isotopes …). Dans la plupart des cas, aucune coupe (unique ou composite) proposée à ce jour ne comporte tous les éléments stratigraphiques néanmoins répertoriés. Des comparaisons apparaissent donc indispensables par domaine, puis entre domaines, pour tester la continuité des enregistrements et la stabilité des divers signaux.

C'est ce que nous entreprenons ici pour l'intervalle Valanginien-Aptien tant en France (SE) qu'en Italie (Alpes et Apennins), où sont localisées nombre de coupes de référence fréquemment citées par les auteurs.

Dans le SE de la France, on dispose en général d'un excellent contrôle biostratigraphique (ammonites, foraminifères) tout au long de la série ; par contre aucun signal magnétique n'est à ce jour utilisable malgré de multiples tentatives. Des mesures isotopiques $\delta^{13}C$, $\delta^{18}O$) ont été réalisées, en partie publiées, souvent peu connues ; des approches des durées par cyclostratigraphie ont été menées, et la continuité des coupes support parfois mise en doute…

En Italie par contre, tant dans les Alpes du Nord que dans les Apennins centraux, les enregistrements paléo-magnétiques sont excellents et nombreux, les données isotopiques sont largement connues, l'approche cyclo-stratigraphique "banale", mais les récoltes d'ammonites rares et discontinues ; les micro- et les nannofossiles ont été souvent utilisés. Là aussi la continuité des coupes est mise en doute.
Ailleurs, … on se réfère le plus souvent aux données précédentes pour calibrer en temps des données isotopiques dont on connaît "en gros" l'âge.

Dans chaque bassin (SE France, Alpes italiennes, Apennins) toutes les *coupes de référence* ont été vues ou revues sur le terrain, complétées par le lever de coupes nouvelles, tandis que les données publiées ont pu être resituées sur les successions lithologiques réellement observées, et enrichies de résultats originaux. Les hiatus déjà connus ou mis en évidence à cette occasion ont été autant que possible pris en compte, par l'intermédiaire de coupes auxiliaires corrélées, de même que les phénomènes de resédimentation (slumpings …).
Une mise en temps des successions a été réalisée, combinant données chronologiques publiées et cyclo-stratigraphie originale. Des événements singuliers (Faraoni, Selli-Goguel, Jacob,…, niveaux de bentonites Van Gogh …) ont été répertoriés et utilisés dans les corrélations.

Deux *successions synthétiques* ont été établies pour l'intervalle [Valanginien - Aptien] et proposées en temps absolu sur une durée d'environ 25 Ma. Elles comportent toutes deux une courbe $\delta^{13}C$ quasi-complète ainsi que l'essentiel des données stratigraphiques disponibles : zones d'ammonites et de foraminifères dans le SE de la France, indications analogues (fragmentaires) plus paléomagnétisme en Italie, événements singuliers dans les deux cas.

L'élaboration de ces composites a souligné, dans chaque domaine, la présence de hiatus sous-estimés voire ignorés (comme à Cismon …). Leur mise en regard montre certes de fortes analogies, établies depuis longtemps, des corrélations précises corroborées par plusieurs outils indépendants, mais aussi des hiatus démontrés ou suspectés.

Comme bien souvent, des comparaisons latérales basées sur une lecture raisonnée des coupes-support et sans (trop d') *a priori* sur l'universalité d'une seule méthode permettent de résoudre, mais aussi de poser, d'intéressantes questions.

GÉOCHIMIE (ISOTOPES STABLES ET ÉLÉMENTS TRACES) DES SYSTÈMES ALTERNANTS MARNO-CALCAIRES. APPLICATION À LA COUPE DE RIO ARGOS (ESPAGNE)

BELTRAN C., MINOLETTI F., HUE G., DE RAFELIS M., RENARD M. & BAUDIN F.
Département de Géologie Sédimentaire, UMPC, Paris

En domaine de bassin, la sédimentation carbonatée présente, au cours de nombreuses périodes, des fluctuations du taux de carbonates qui s'expriment plus ou moins clairement du point de vue lithologique (doublet marne-calcaire). Ces contrastes lithologiques sont accompagnés de différences biologiques marquées : les bancs calcaires sont dominés par un taxon opportuniste alors que les inter-bancs marneux présentent une grande diversité spécifique (Wendler *et al*., 2002 ; Mattioli 1997 ; Busson *et al*., 1997 ; Bellanca *et al*., 1996). Différentes études ont ainsi montré, au moins pour certaines périodes, que les variations des types de producteurs carbonatés pélagiques (nannoconus versus coccolithophoridés par exemple) étaient en relation avec les contrastes lithologiques (Busson *et al*., 1995 ; Noel *et al*., 1995 ; Mattioli *et al*., 2001 ; Mattioli 1997). Différentes études stratonomiques ont mis en évidence des cyclicités de type Milankovitch suggérant un contrôle climatique orbito-dépendant de ces cycles (Einsele & Ricken 1991). Toutefois la démonstration reste à faire car de nombreux auteurs postulent encore en faveur d'un rôle prépondérant de la diagenèse et des transferts d'éléments lors de la mise en bancs. (Arthur *et al*., 1984).=.

Le but de ce travail est donc de dépasser ces contradictions en utilisant une méthode nouvelle de séparation (la *technique Minoletti* (Minoletti *et al*., 2001)) des particules sédimentaires permettant de travailler à la fois sur le *bulk* mais aussi sur des nanno-fractions granulométriquement (et le plus souvent génétiquement) homogènes de façon à disposer de signaux géochimiques comparables pour les marnes et les calcaires.

La coupe de Rio Argos (Cordillère bétique, Espagne) choisie pour cette étude, présente une succession monotone d'alternances marno-calcaires couvrant toute la période du Crétacé inférieur (Hoedemaeker *et al*., 1995 ; Coccioni *et al*., 1994). Une dizaine de doublets prélevés dans la zone à Catulloi (Hauterivien terminal), ont été analysés. L'observation préalable de frottis réalisés pour chaque échantillon a permis de déterminer le spectre de taille des différents éléments constitutifs des sédiments et de choisir trois niveaux de filtration :

- (>12µm) pour isoler de gros débris carbonatés d'origine incertaine
- (>8µm) pour concentrer les nannoconus
- (<8µm) composée de calcite microcristalline et de coccolithes.

Le dosage des éléments trace a ensuite été fait sur chaque fraction et leur signal systématiquement comparé à celui de l'échantillon brut.

OXYGEN ISOTOPE COMPOSITIONS OF LATE JURASSIC VERTEBRATE REMAINS FROM LITHOGRAPHIC LIMESTONES OF WESTERN EUROPE: IMPLICATIONS ON THE ECOLOGY OF FISH, AQUATIC CHELONIANS AND CROCODILIANS

JEAN-PAUL BILLON-BRUYAT[1], CHRISTOPHE LÉCUYER[2], FRANÇOIS MARTINEAU[2], JEAN-MICHEL MAZIN[1]

[1] Laboratoire de Géobiologie, Biochronologie et Paléontologie humaine, CNRS UMR 6046, Université de Poitiers, 40 av. du recteur Pineau, 86022 Poitiers, France.

[2] Laboratoire "Paléoenvironnements & Paléobiosphère", CNRS UMR 5125, Université Claude Bernard Lyon I, 27-43 boulevard du 11 novembre 1918, 69622 Villeurbanne, France.

The lithographic limestones from the Late Jurassic of Western Europe (Northern margin of the Tethys Ocean) are famous for the vertebrates they contain, however, geochemical data are scarce concerning these Lagerstätten.

Here we report biogeochemical records in order to characterize the aquatic living environments of some vertebrates (fish, crocodilians, chelonians), deposited in these subtropical and protected environments of shallow carbonate platforms. Four localities from the Lower Tithonian have been studied: Canjuers (Var), Cerin (Ain), Solnhofen (Bavaria) and Crayssac (Lot), from the Mediterranean Tethys and North-Atlantic domain respectively. A fifth locality has been included, Chassiron (Charente-Maritime, North-Atlantic domain), to compare with an open littoral system.

The analyses consist in the determination of the oxygen isotope composition of vertebrate biogenic phosphates (tooth enamel, scales, osteoderms). The $\delta^{18}O$ values of chelonian phosphates allow the estimation of the $\delta^{18}O$ of ambient water, which can be used with the $\delta^{18}O$ of fish phosphates to calculate the ambient water temperature, improving the use of $\delta^{18}O_{water}$ = -1‰ for an ice-free world.

The $\delta^{18}O$ values from the lithographic limestones (20.5±0.9‰ SMOW) are similar independent of the domain but about 1‰ lower than that of Chassiron. The fish $\delta^{18}O$ values from the lithographic limestones are highly variable (20.6±0.9‰). The Pycnodontiforms have $\delta^{18}O$ values (20.1±0.4‰) slightly lower or equivalent to the Semionotidae *Lepidotes* (20.7±0.8‰). The marine crocodilian *Steneosaurus* and chelonians of the Plesiochelyidae family have $\delta^{18}O$ values close to the Pycnodontiforms and *Lepidotes*. Conversely, chelonians of the "Thalassemydidae" family always have very low $\delta^{18}O$ values, e.g. in Solnhofen with a value at least 1.5‰ lower than the "isotopic faunal group" of "*Lepidotes*, *Steneosaurus* and Plesiochelyidae".

The mean calculated temperatures from the lithographic limestones (~17-20°C) are logically higher (> 4°C) than that from the open littoral of Chassiron. The temperatures range from 9.2 to 22.3°C, the lowest corresponding to beached fish, living in deeper waters of the open ocean. Pycnodontiforms indicate the sea surface temperatures (~18-22°C), equivalent or higher than that from *Lepidotes* which could have lived rather close to the benthos. According to their close $\delta^{18}O$ values, fish (Pycnodontiforms, *Lepidotes*) and reptiles (*Steneosaurus*, Plesiochelyidae) seem to have lived in similar littoral marine waters. The chelonians can be separated in two groups according to their living aquatic environment ($\delta^{18}O_{water}$ inferred from $\delta^{18}O_{phosphate}$): one from littoral marine waters ($-1 < \delta^{18}O_{water} < 0$‰) and one from fresh or brackish waters ($\delta^{18}O_{water} < -2$‰). The use of the $\delta^{18}O_{water}$ from littoral marine chelonians increases calculated temperatures by 1-3°C. The ecological dichotomy surprisingly corresponds to a systematic separation between Plesiochelyidae and "Thalassemydidae", two chelonian families for which the living environment is questioned according to the anatomy.

STRATIGRAPHIC ARCHITECTURE OF THE NORTHERN OMAN CONTINENTAL MARGIN - MESOZOIC HAMRAT DURU GROUP (HAWASINA COMPLEX, SULTANATE OF OMAN)

INGO BLECHSCHMIDT[1], PAULIAN DUMITRICA[2], ALBERT MATTER[1], LEOPOLD KRYSTYN[3] & TJERK PETERS[1]

[1]*University of Bern, Institute of Geological Sciences, Baltzerstrasse 1, CH-3012 Bern, Switzerland,*
[2]*Dennigkofenweg 33, CH-3073 Guemligen, Switzerland,*
[3]*University of Vienna, Institute of Palaeontology, Althanstrasse 14, A-1090 Vienna, Austria*

keywords: Hamrat Duru Group, Oman, Mesozoic stratigraphic architecture, radiolarian biostratigraphy

The Triassic to Late Cretaceous deep marine sediments of the Hamrat Duru Group, Oman Mountains, represent a subunit of the Hawasina nappe-complex which has been deposited in a deep marine basin. During the Late Cretaceous SSW directed obduction of the Semail Ophiolite, the Hawasina complex was emplaced onto the para-autochthonous cover of the Arabian basement, while the original configuration of the basin was destroyed.

New lithostratigraphic data and high resolution radiolarian and conodont biostratigraphy lead to a revised stratigraphic scheme of the Hamrat Duru Group, which conforms with the standard stratigraphical nomenclature. The Hamrat Duru Group is divided into six formations: the Early Triassic (Olenekian) to Late Triassic (Upper Norian) **Zulla Formation** (Limestone & Shale Member, Sandstone & Shale Member, Radiolarian Chert Member and Halobia Limestone Member**)**, the Late Triassic (Upper Norian to Rhaetian) **Al Ayn Formation**, the Early Jurassic (Late Pliensbachian) to Middle Jurassic (Early Callovian**) Guwayza Formation (**Tawi Sadh Member and Oolitic Limestone Member**)**, the Middle Jurassic (Callovian) to Late Cretaceous (Cenomanian?) **Sid'r Formation** (Lower Member, Upper Member), the Late Cretaceous (Cenomanian? to Santonian?) **Nayid Formation** and the Late Jurassic (Early Callovian) to Early (Late?) Cretaceous **Wahrah Formation**. Most of the lithostratigraphic units (formations and members) show isochronous boundaries between the different outcrop areas.

The stratigraphic architecture of the Hamrat Duru Group megasequence is controlled by alternating siliciclastic and carbonate sedimentation possibly related to the second order sea-level variations. The sediments accumulated on the continental rise of the Arabian margin mostly by submarine gravity flows and hemipelagic to pelagic rainout. A close relationship of sedimentary evolution between the Arabian Platform and the adjoining slope and basinal environments is obvious. Variations in carbonate supply, oceanographic parameters and/or variations in silica productivity resulted in two distinct phases of radiolarian sedimentation. The first phase corresponds to the Late Anisian - Early Norian time span, the second started in the Late Pliensbachian and lasted, with some interruptions, to the Coniacian. The litho- and biostratigraphic similarities between the Mesozoic Hamrat Duru Group and the Mesozoic Batain Group are seen as related to Neotethys wide palaeoceanographic changes and suggest a strong interdependence of the two basins with the Arabian Platform evolution.

A 20 MYR RECORD (LATEST JURASSIC - EARLIEST CRETACEOUS) OF CALCAREOUS NANNOFOSSILS FROM THE WESTERN CENTRAL ATLANTIC: IMPLICATIONS FOR PALAEOCEANOGRAPHY AND CARBONATE ACCUMULATION

ANDRÉ BORNEMANN, JÖRG MUTTERLOSE
Institut für Geologie, Mineralogie und Geophysik, Ruhr-Universität Bochum, Universitätsstr. 150, D-44801 Bochum, Germany; email: andre.bornemann@rub.de

The goal of this study was to improve our understanding of long-term variations of the nannofossil carbonate accumulation, its importance for the total carbonate flux, and its relation to environmental changes during the latest Jurassic and earliest Cretaceous. We studied sediments from DSDP sites of the western Central Atlantic (Sites 105, 534A, 603B) with respect to their content of calcareous nannofossils and calculated the amount of nannofossil carbonate by taking into account absolute abundances, size-variations through time and volumetric estimates of the species. Results from nannofossil carbonate estimates have been compared to bulk-rock carbonate data.

The Tithonian to Hauterivian interval is characterized by two major perturbation of the pelagic carbonate record: (1) the onset of pelagic carbonate production in the late Tithonian; and (2) the mid Valanginian 'nannoconid crisis'.

The Tithonian event is triggered by high abundances of strongly calcified nannofossil genera ('nannofossil calcification event'; 'NCE'), which probably have an affinity to more oligotrophic surface water conditions. A widespread deposition of pelagic carbonates took place in the low latitudes. Cooler and drier climate prevailed across the Jurassic/Cretaceous boundary.

A global positive carbon isotope excursion marked the mid Valanginian. This event coincides with a sea level highstand, increased volcanic activity and elevated atmospheric pCO_2 levels. Greenhouse climate and an accelerated hydrological cycle are thought to have intensified the weathering processes. This may have caused an elevated nutrient transfer from the continents into the oceans. Enhanced fertility in the surface water is indicated by an increase in abundance of nannofossil species which are believed to indicate more eutrophic conditions.

In the western Tethys the carbon isotope excursion is predated by a sharp decrease in the abundance of rockforming nannoconids ('nannoconid crisis'). This event is much less pronounced in the western Atlantic due to a general scarcity of these nannoliths, but nevertheless a decline in the nannofossil carbonate accumulation and a dominance of less calcified nannofossil species were observed. We assume that the interval of the so-called 'nannoconid crisis' was characterized by lower rates of carbonate accumulation reflecting a general crisis in the biogenic carbonate production.

Two different factors are feasible to have caused the changes in the pelagic carbonate production: variations within (1) the trophic system and (2) the atmospheric pCO_2. Low nutrient concentrations co-occur with high abundances of strongly calcified nannofossils in the Tithonian, whereas higher nutrient levels may have caused a shift towards a less calcified assemblage in the Valanginian. High pCO_2 may affect the surface water pH, which is thought to reduce the calcification rates of modern coccolithophores.

PALEOCLIMAT ET RICHESSE SPECIFIQUE: UNE SIMULATION

ARNAUD BRAYARD*†, GILLES ESCARGUEL*, HUGO BUCHER†
**UMR 5125 CNRS PaléoEnvironnements et PaléobioSphère, Domaine scientifique de la Doua, 2 rue Dubois, 69622 Villeurbanne Cedex, France <arnaud.brayard@univ-lyon1.fr> <gilles.escarguel@univ-lyon1.fr>.*
†Paläontologisches Institut und Museum der Universität Zürich, Karl-Schmid Strasse 4, 8006 Zürich, Switzerland <hugo.fr.bucher@pim.unizh.ch>.

La crise permo-triasique est une des cinq grandes extinctions majeures du Phanérozoïque, dont le rôle essentiel dans l'évolution du vivant est aujourd'hui acquis. La configuration paléogéographique de la limite Permien-Trias est très simple, les continents étant réunis en un bloc unique : la Pangée. Pendant le temps de recouvrement nécessaire après la crise, aucun bouleversement géologique majeur n'est connu. Cette période offre donc un cadre idéal pour rechercher une signature climatique dans les rythmes, modalités et processus de récupération biotique. Les différents modèles climatiques déjà proposés suggèrent une importante hétérogénéité spatiale des conditions climatiques à la fin du Permien. Les contrastes climatiques devaient être marqués sur la Pangée comme sur l'immense océan qui l'entourait : la Panthalassa. Paradoxalement, les groupes marins à récupération précoce tels que les ammonoïdes présentent au début du Trias une répartition cosmopolite. Cependant, à partir de l'Anisien moyen, la plupart de ces groupes avaient acquis une forte répartition latitudinale et une forte diversité. Leur évolution biogéographique et l'évolution de leur diversité pourraient ainsi traduire les modifications climatiques ayant eu lieu au cours de la période de récupération. Ce travail consiste à appréhender l'impact des paramètres physiques du milieu, et notamment du climat, sur les processus de récupération biotique des organismes à stade(s) planctoniques(s).
Habituellement, la recherche expérimentale demande de faire des hypothèses et de les tester en conditions contrôlées. A défaut, l'utilisation des simulations numériques informatiques peut permettre, moyennant quelques précautions, de tester de nombreuses hypothèses relatives à divers paramètres supposés contrôler l'évolution d'un système dynamique donné. Par une modélisation numérique de la biogéographie permo-triasique, nous nous proposons d'étudier l'évolution de la biodiversité du Trias inférieur des organismes marins présentant un ou des stades planctoniques selon certains paramètres fondamentaux qui sont : les déplacements selon les courants, les différences de température des eaux de surface (SST), l'intervention de l'intervalle thermique de vie des espèces ainsi que les taux de spéciation et d'extinction.
Une simulation numérique a ainsi été élaborée, en utilisant un algorithme se rapprochant des automates cellulaires, et programmée sous IDL®. Celle-ci se divise en plusieurs modules qui interagissent les uns sur les autres via des boucles d'action ou de rétroaction. Notre modèle peut se décomposer en un programme principal qui se consacre à la reconstruction de la paléogéographie et gère les déplacements, spéciations et extinctions ainsi que deux programmes annexes respectivement dédiés à la gestion de l'effet des paléocourants et du gradient de SST.

Le modèle paléobiogéographique développé dans ce travail indique que la diversité des organismes marins possédant un ou plusieurs stades planctoniques, dépend essentiellement des valeurs limites (= amplitude) et de la forme du gradient de SST, ainsi que de la localisation des premières espèces du groupe taxonomique considéré. Pour obtenir un gradient de richesse taxonomique, il n'est pas nécessaire de faire intervenir des taux d'apparition et d'extinction différentiels en fonction de la latitude. Les courants interviennent dans la rapidité de propagation des espèces mais n'ont aucun effet sur la forme et l'intensité du gradient de richesse taxonomique. La longue période de récupération consécutive à la crise permo-triasique pourrait donc bien être le reflet de la persistance d'un gradient thermique peu marqué et globalement chaud durant les premiers millions d'années du Trias inférieur.

CRETACEOUS OCEANIC ANOXIC EVENTS: THE ITALIAN RECORD

RODOLFO COCCIONI
Istituto di Geologia e Centro di Geobiologia dell'Università "Carlo Bo"
Campus Scientifico, Località Crocicchia
61029 Urbino
cron@info-net.it

The Cretaceous Oceanic anoxic events (OAEs) were short-lived episodes of organic carbon burial that are distinguished by their widepread distribution as discrete beds of black shale and/or pronounced carbon isotopic excursion. These Cor-rich deposits were the result of marked oceanographic changes that drastically affected biogeochemical cycling and marine ecosystems, resulting in geographically extensive or global oxygen-deficient water masses.
The Cretaceous OAEs are recognised in different palaeoenvironmental and palaeoceanographic settings throughout Italy from the Southern Alps to Sicily.
Surface outcrops and cored material contain a complete stratigraphical and organic carbon record through the critical black shale intervals and provide informative data sets for documenting and understanding worldwide changes in the paleoenvironment, biota, geochemistry, and paleotemperature. Remarkably, the type localities for the late Early Selli (OAE1a) and the latest Cenomanian Bonarelli (OAE2) Events are found in the Umbria-Marche Apennines. In addition, some studied sections were proposed as "reference sections" for low latitudes.
After two decades of investigations carried out throughout Italy also with a view to improve our understanding of the nature and cause of OAEs, it seems that an overview would be in order.

READING PALAEOCEANOGRAPHY FROM THE MICROFOSSILS: THE PLANKTONIC FORAMINIFERA ACROSS THE SELLI (OAE1A, LATE EARLY APTIAN) AND THE BONARELLI (OAE2, LATEST CENOMANIAN) EVENTS

RODOLFO COCCIONI[(1)] & VALERIA LUCIANI[(2)]

[(1)]Istituto di Geologia e Centro di Geobiologia dell'Università "Carlo Bo", Campus Scientifico, Località Crocicchia, 61029 Urbino (Italy)
cron@info-net.it
[(2)]Dipartimento di Scienze della Terra dell'Università, Corso Ercole I d'Este, 32, 44100 Ferrara (Italy)
lcv@dns.unife.it

The investigation of the two major episodes of Corg-rich black shales of the Cretaceous Period, namely the Selli (late Early Aptian) and Bonarelli (latest Cenomanian) Levels and their equivalents corresponding to the global Oceanic Anoxic Events OAEla and OAE2, gives the opportunity to clarify how the planktonic foraminifera responded to marked palaeoceanographic changes. Planktonic foraminifera, which are greatly sensitive to chemical-physical parameters and readily preserved, can record evidence of environmental stresses through time. The record of planktonic foraminiferal distribution and assemblage composition across the Selli and Bonarelli Levels and their equivalents was provided by several sections surveyed in detail in Italy (Umbria-Marche Appenines as type-area, Southern Alps, Gargano Promontory, Sicily), SE Spain, SE France, SE England, Tunisia, and Morocco. When progressive, rapid deterioration of the environmental conditions developed, reaching the climax in coincidence of the Selli and Bonarelli Events, some species and genera responded by showing a preference for the new conditions, others by showing varying levels of tolerance or intolerance. These kinds of behaviour are reflected in the shifting patterns of species diversity, dominance, abundance, and size that extend well outside the established limits of variability. Some discrete acmes and crises have been identified. New species and genera appeared and previous existing species and genera underwent serious loss and even extinction. In addition, morphological and coiling ratio changes occurred together with the increase in abundance of specimens bearing test abnormalities. The first taxa to disappear were the more specialized ones, and the survivors were the generalists with greater tolerance to environmental stress. Similarly, the forms proliferating across the critical intervals and the first colonizers were opportunists, typically very small in size. Based on diversity, abundance, composition, and overall size of assemblages, some discrete phases of different degree of environmental perturbation within the marine ecosystem have been distinguished throughout the intervals across the Selli and Bonarelli Events. Some species and genera prove to be useful indicators for extremely stressed environments in low-middle latitude during the Early-early Late Cretaceous, even sheding light upon the intensity of the environmental perturbation that took place.

CRETACEOUS PELAGIC SEDIMENTS AND TROPICAL ATLANTIC PALAEOCEANOGRAPHY AS RECORDED ON DEMERARA RISE (OFF SURINAM). PRELIMINARY RESULTS OF ODP LEG 207

T. DANELIAN* , L. LE CALLONNEC* , J. ERBACHER, D. C. MOSHER, M. J. MALONE, D. BERTI, K. L. BICE, H. BOSTOCK, H.-J. BRUMSACK, A. FORSTER, C. GLATZ, F. HEIDERSDORF, J.E HENDERIKS, T. J. JANECEK, C. JUNIUM, K. MACLEOD, P. A. MEYERS, J. H. MUTTERLOSE, H. NISHI, R. D. NORRIS, J. G. OGG, M. A. O'REGAN, B. REA, P. SEXTON, H. STURT, Y. SUGANUMA, J. W. THUROW, P. A. WILSON & S. W. WISE

** Département de Géologie Sédimentaire, Université Paris VI, CNRS-FR 32, C.104, 4, place Jussieu, 75252 Paris Cedex 05, France*

With 13 holes drilled at five sites of Demerara Rise, situated on a depth transect (from 1900 to 3200 m) of its northwestern edge, ODP Leg 207 recovered expanded Cretaceous sequences, the main characters of which are as follows:

- Silty calcareous claystones of early to late Albian age are the oldest sediments recovered. They are part of the syn-rift sequence of the Atlantic margin off Surinam and are always found below a widespread angular uncorformity on Demerrara Rise. Abundant shell debris and terrigenous material (including angular quartz) argue for a proximal sedimentary setting, while the absence of sedimentary structures and burrows suggests a relatively deep and/or protected environment, which recorded high sedimentation rates. Radiolaria are well-diversified and similar to those known from typical Tethyan sections (i.e. Italy), which argues for a good communication between Tethyan and Demerara waters;
- a *ca.* 60-m thick black shale sequence of Cenomanian to Santonian age. The dominant facies consists of dark, laminated calcareous claystones and laminated limestones, rich in organic matter (*ca.* 7-9 % TOC on average). The shales are quite rich in CaCO3 (50 % on average) due to the presence of calcareous nannofossils, foraminifera, shell debris and carbonate debris of unknown origin. Sediments accumulated in a dysoxic environment, possibly due to a stagnated water column and/or impingement of an expanded oxygen-minimum zone. Alternation of carbonate-rich and carbonate free fine laminae may be suggestive of alternating levels of calcareous plankton productivity. Radiolaria are relatively rare but surprisingly well-preserved. The fauna is of low diversity and seems dominated by "spongy Spumellarians", in contrast with typical Tethyan assemblages. This might suggest a certain independence of Demerrara waters from Tethyan influence.
- Campanian siliceous chalk with well-preserved and diversified radiolarian assemblages. Abundant traces of intense bioturbation argue for well-oxygenated bottom water conditions. The contact with the underlying black shales is sharp and underlined by a condensed glauconitic irregular horizon, which represents an interval of reduced sedimentation and sea-floor scouring by currents. It might be the result of opening of the equatorial Atlantic gateway above a critical point, which allowed the establishment of upwelling waters.
- Maastrichtian nannofossil chalk with foraminifera and clays. Sediments are moderately burrowed and contain barite and pyrite concretions. Campanian and Maastrichtian chalk displays pronounced cyclic color bands which reflect cyclic changes in lithology and will give the opportunity for the establishment of an orbital chronostratigraphic framework.

For further information

http://www-odp.tamu.edu/publications/prelim/207_prel/207toc.html

ENREGISTREMENT À HAUTE RÉSOLUTION DES MODIFICATIONS ENVIRONNEMENTALES INSCRITES DANS UN CADRE TÉPHROCHRONOLOGIQUE (BASSIN DU WESTERN INTERIOR, PASSAGE CÉNOMANIEN TURONIEN)

DESMARES D., GROSHENY D., BEAUDOIN B. & GARDIN S.

Les formations déposées dans le Bassin du Western Interior au cours du Crétacé supérieur renferment de nombreux horizons de cendres volcaniques facilement reconnaissables et corrélables à travers la majeure partie du bassin sur plusieurs millions de km^2. Evènements instantanés à l'échelle des temps géologiques, ceux-ci constituent des repères chronologiques avérés et indépendants. Grâce à ce cadre chronostratigraphique parfait, il va être possible d'intégrer d'autres signaux stratigraphiques (lithologique, biologique, géochimique) sur lesquels s'appuient classiquement les corrélations et ainsi de « tester » leur synchronisme.

A l'issue des premières missions de terrain, cinq niveaux majeurs de bentonites ont été reconnus pour l'intervalle Cénomanien Turonien, le long d'un transect couvrant plus de 1000 km de la bordure occidentale du bassin (Arizona) à sa marge orientale stable (Kansas). Sur une période de 2 millions d'années, comprise entre les zones d'ammonites à *Sciponoceras gracile* et à *Mammites nodosoides*, ces repères nous ont non seulement permis de confirmer les corrélations régionales banc à banc, mais aussi de révéler des lacunes dans l'enregistrement sédimentaire, et ce à différentes échelles de temps et d'espace.
Ainsi, si l'on s'intéresse aux coupes levées dans le Sud-Est du Colorado, on constate une variabilité du signal lithologique laissant présumer d'un certain nombre de petits hiatus, notamment à Pueblo, coupe de référence.
Plus à l'Ouest, à El Vado (Nouveau Mexique), on constate l'absence de plusieurs niveaux repères (bancs marqueurs carbonatés). Malgré le manque de données microfauniques, les indications fournies par les horizons de bentonite et par la nannoflore soulignent un hiatus d'au moins 300 ka. Celui-ci pourrait être lié au positionnement de la coupe sur une zone surélevée en réponse à l'orogenèse de la chaîne Sevier en marge ouest du bassin. Ce bombement a vraisemblablement eu un impact majeur sur la circulation des courants au sein de cette grande mer intérieure où s'affrontaient masses d'eau téthysienne et boréale.

L'étude des foraminifères planctoniques, réalisée sur différents affleurements (du centre du bassin à Pueblo à sa marge orientale) atteste que les occurrences de *R. cushmani* et *H. helvetica* sont diachrones et soulignent en conséquent la grande variabilité de la zone à *W. archeocretacea* à l'échelle du bassin. Ce diachronisme est vraisemblablement dicté par des paramètres propres aux masses d'eau (température, taux d'oxygène dissous). Ainsi, l'analyse fine des microfaciès et leur classification systématique suivant deux pôles (anoxique et oxygéné) révèlent la dépendance de certains taxons aux conditions d'oxygénation du milieu. Cet outil de corrélation à haute résolution, nous a donc convaincu de la légitimité d'un contrôle stratigraphique externe avant toute proposition de corrélations régionale (voir globale) sur la seule base de la biostratigraphie ou de la chimiostratigraphie.

Des affleurements localisés dans les zones méridionales et septentrionales du bassin seront également examinés afin de mieux contraindre les propriétés inhérentes aux masses d'eau et les fluctuations de leur front. En outre, par l'exploration de la bordure nord-ouest du bassin (Montana et Alberta), nous espérons retrouver la présence de formes planctoniques carénées (rotalipores) déjà mises en évidence par certains auteurs et qui suggéraient l'existence d'un bras de mer reliant l'Océan Pacifique à cette mer intérieure.

CONTEXTE SÉQUENTIEL DU BLACK SHALE DE LA LIMITE CÉNOMANIEN-TURONIEN DANS LE BASSIN SUBALPIN FRANÇAIS

SERGE FERRY(1), DANIÈLE GROSHENY(2) ET FABRICE MALARTRE(3)

Université de Lyon – Géologie, UMR 5125, 41 Bd du 11 Novembre, 69622 Villeurbanne cedex
Université Louis Pasteur EOST, UMR 7517, 1 rue Blessig, 67084 Strasbourg cedex
ENSG, rue du Doyen Marcel Roubault, BP 40, 54501 Vandoeuvre-lès-Nancy cedex

Sur la marge occidentale du bassin (Gard rhodanien, Baronnies), on enregistre au passage Cénomanien-Turonien la plus forte des régressions forcées de la période crétacée, avec un recul de la ligne de rivage d'environ 80 km. Dans les Baronnies, l'équivalent local du black shale connu dans le bassin vocontien oriental s'intercale dans un petit système turbiditique qui s'enracine lui-même dans les faciès à rides de vagues du prisme détritique de bas niveau marin.

L'étude en cours de la marge sud-vocontienne (arc subalpin de Castellane) ne montre en revanche aucune régression significative au-dessus des faciès néritiques à exogyres du Cénomanien supérieur de la région du Bourguet. Plus au Sud (région de Bargème), les calcaires fins turoniens sont ici discordants sur le Cénomanien supérieur.

Le point commun entre tous ces secteurs est donc l'intervention d'une phase tectonique qui provoque des mouvements de profondeur déphasés selon les endroits.

Des comparaisons à plus grande échelle montrent le même phénomène. Il serait donc bien hasardeux de vouloir lier les couches riches en matière organique de la transition Cénomanien-Turonien (événement anoxique OAE2) à de quelconques mouvements eustatiques, notamment une transgression censée favoriser une hyperproductivité temporaire des eaux de surface.

CAUSES AND CONSEQUENCES OF CARBONATE PLATFORM DROWNING EVENTS DURING THE EARLY CRETACEOUS

K.B. FÖLLMI (1), B. VAN DE SCHOOTBRUGGE (1,2), A. GODET (1), S. BODIN (1), P. LINDER (1), T. ADATTE (1)
(1) Institut de Géologie, University of Neuchâtel, Switzerland
(2) Institute of Marine and Coastal Sciences, University of New Jersey, Rutgers, New Brunswick, USA
karl.foellmi@unine.ch

During the early Cretaceous, the carbonate platform attached to the northern Tethyan margin experienced a series of platform drowning episodes, which can be widely traced. The five episodes recognized cover the early Valanginian to early Hauterivian (D1), middle Hauterivian (D2), late Hauterivian to early Barremian (D3), early to early late Aptian (D4), and late Aptian to early Albian (D5). The particular sensitivity towards drowning in this platform system was probably related to its marginal paleoposition (ca. 30 degree N) with regards to reef growth, to its attachment to the European continent (a periodic source of reef-unfriendly weathering products), as well as to prevailing paleoceanographic conditions (sea-level change, upwelling intensity, presence or absence of connections to the boreal realm).
Drowning episodes are usually preceded by changes in carbonate production from a chlorozoan to a foramol mode, with important increases in accumulation rates. The drowning episodes themselves are documented by erosional surfaces and/or by the formation of strongly condensed beds rich in coarse sand, glauconite, phosphate, and biosilica. The presence of ammonites is a key to their dating.
If resolvable, the onset of drowning appears to be diachronous, and its evolution is by stepwise onlap onto the platform (D1, D4). Termination of drowning appears in all cases synchronous. Drowning episodes D1, D4, and D5 are correlated to positive excursions in the delta C-13 record, albeit with a slight diachronity in their onsets (drowning episodes lead the delta C-13 record), whereas episode D2 correlates to a negative excursion and episode D3 to a long and steady increase in delta C-13 values. This suggests that no uniform mechanism can be assumed for all five episodes but that each episode needs to be examined in its own context. An important element in all episodes is the change in weathering style and intensity in the continental hinterland, which profoundly affected detrital and nutrient fluxes.

DEEP-WATER FLUCTUATIONS IN THE EARLY MAASTRICHTIAN ATLANTIC OCEAN: EVIDENCE FROM STABLE ISOTOPES AND BENTHIC FORAMINIFERA

O. FRIEDRICH (1), J. O. HERRLE (1,2), P. KÖßLER (1), C. HEMLEBEN (1)
(1) Institut für Geowissenschaften, Universität Tübingen, Sigwartstrasse 10, 72076 Tübingen, Germany
(2) present address: Geologisches Institut, ETH Zürich, Sonneggstrasse 5, 8092 Zürich, Switzerland
oliver.friedrich@uni-tuebingen.de/Fax: +49-7071-29-5766

In contrast to the extremely warm mid-Cretaceous the latest Cretaceous Campanian to Maastrichtian interval marks the onset of waning greenhouse conditions for the Cretaceous period. It coincides with three second-order regressions that may have been linked to changes in the carbon cycle, ice shield formation in Antarctica, and diversification of marine biota (e.g., Li and Keller, 1998; Frank and Arthur, 1999; Miller et al., 1999). However, the feedback mechanisms between climate and oceanic circulation as well as their impact on marine ecosystems during the early Maastrichtian are yet relatively unknown.
Based on a high-resolution stable isotope record (resolution up to ~8 kyr) of planktic and benthic foraminifera for the early Maastrichtian (~71.3 - ~69.6 Ma) from the Blake Nose Plateau (DSDP Site 390A, North Atlantic), we propose that the observed short-term stable isotope fluctuations reflect changes in high- and low-latitude intermediate to deep water sources. Sources of these waters may be the low-latitude eastern Tethys and high-latitude North Atlantic. Changes in intermediate to deep water sources were probably steered by eccentricity-controlled insolation fluctuations. Lower insolation favoured the formation of high-latitude deep waters due to positive feedback mechanisms resulting in a high-latitude cooling. This led to a displacement of low-latitude deep waters at the Blake Nose Plateau. Higher insolation reduced intermediate to deep water formation in high latitudes, yielding a more northern flow of low-latitude deep waters.
An additional study of benthic foraminiferal assemblages of the same time interval (~71.3 - ~69.6 Ma; DSDP Site 390A, North Atlantic) supports the change from a more low-latitude dominated deep water system (dominated by the low oxygen indicator *Praebulimina ventricosa*) to a more high-latitude dominated deep water system (dominated by the high oxygen indicators *Gavelinella beccariiformis*) in the North Atlantic during the early Maastrichtian.

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THE EARLY APTIAN ANOXIC EVENT IN THE BASIN OF THE RUSSIAN CRATON

YURI O. GAVRILOV*, EKATERINA A. SHCHERBININA*, ELENA V. SHCHEPETOVA*, EVGENY YU. BARABOSHKIN**
**Geological Institute of Russian Academy of Sciences, Moscow, Russia*
***Moscow State University, Moscow, Russia*

The lower Aptian organic carbon-rich sediments are spread in the central Russian craton and represent the reference horizon. They were studied in the transect from Ulianovsk to Saratov (middle reaches of Volga R.), where a layer of bituminous shale (BS) (4-7 m, TOC up to 9.6%) is embedded into clayey sequence. In the middle part of BS there is a bed of carbonatic lenses up to 0.7 m thick so-called "Aptian plate".

The stratigraphic range of BS (the ammonite Zone *Deshayesites volgensis* = *Deshayesites forbesi* and nannofossil Zone *Parhabdolithus angustus* = upper part of CC7 Zone) indicates that they are a regional manifestation of the global geological episode defined as Oceanic Anoxic Event-la (OAE la, Selli Event). Rare and rather poor preserved nannofossils are found only within BS and entirely absent in embedded sediments. In the early diagenetic stages, the most part of nannofosils was dissolved and redistributed $CaCO_3$ was concentrated in form "Aptian plate". Dissolution was probably the main process governed the formation of monospecific nannofossil assemblage. In sediments surrounding the "Aptian plate", the nannoplankton assemblage is dominated by the most resistant to dissolution and calcium overgrowing forms *Watznaueria* spp. (*W. barnesiae, W. britannica, W. ovata*) (>90%). Clear dissolution marks in coccoliths and the predominance of *Watznaueria* spp. (>50%) were also observed at higher levels of BS. At the same time, *Watznaueria* spp. are "low fertility group", and their ubiquitous prevalence over the eutrophic group (*Zeugrhabdothus*, *Biscutum*, *Parhabdolithus*) likely indicates a deficiency in nutrients in the basin. Nevertheless, such oligotrophic conditions as occurred during BS accumulation seems to be much more favorable for nannofossil survive than the environment before and after BS accumulation. The relative abundance of *Parhabdolithus* spp. (*P. angustus, P. splendens, P. asper*) against other non-*Watznaueria* spp. evidently indicates warm surface water.

Based on petrography and geochemistry of organic matter (OM), the basinal OM is predominant in the bituminous unit, while the embedded sediments contain mainly terrestrial OM. The enrichment in OM was caused by a bloom of bioproductivity of various marine plankton species including the bacteriaplankton and phytoplankton. The contribution of terrestrial OM to the total OM budget of BS was negligible.

Many chemical elements, in particular, biophile (C, P, and Fe) and redox-sensitive (Mo, Se, a.o.) elements are concentrated within BS. The clay mineral assemblage is composed of mixed-layered smectite-mica, hydromica, chlorite, and kaolinite, which increase in content coastward. The kaolinite content is also somewhat higher in the BS than in embedded sediments. The abundance of authigenic minerals proves high intensity of diagenetic processes in lower Aptian sediments. The thin lamination of bioturbation-free BS, the lack or extremely rare occurrence of high-tolerant benthic fauna, and the geochemical signature attest the sedimentation under anoxic conditions.

We suggest that accumulation of BS occurred under warm humid climate conditions during a very rapid eustatic transgression followed the vigorous regression. The increased supply of nutrients from drowned organic-rich coastal area resulted in increased primary productivity of bacteria, microplankton, and algae, leading to the accumulation of organic-rich sediments.

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ALBANIAN TETHYS OCEANIC SEGMENT FROM ITS SPREADING TO THE CLOSURE

KADRI GJATA[+] & ALAUDIN KODRA [++]
[+]*Albanian Geological Survey, Tirana, Albania, e-mail: gjata_k@yahoo.fr*
[++]*Geological Regional Branch, Tirana, Albania*

Albania supplies good records showing the tectonic history of the Albanian Tethys oceanic segment from its spreading to the closure. In Mirdita zone, the large and complete sections of the Triassic and Jurassic ophiolites and the related peripheral continental associations are developed. The surprising analogy of the continental sequences recognized in both sides of ophiolites suggested the existence of two continental passive margins respectively belonging to the Adria plate in the west and to the Korabi-Pelagonian micro block in the East.

There are recognized two parallel belts of the Triassic-Liassic (T_2-J_1) ophiolites, clearly separated from the Jurassic ophiolites (J_2). The first ones are composed of limited outcrops of ultrabasic, basic rocks and MORB type basaltic volcanics. The radiolarian cherts, which are interlayer and coeval to basalts, belong to the Middle, Upper Triassic and Lias age. The inception of the Triassic-Jurassic oceanic basin is preceded by the Late Anisian continental crust break-up. The Middle Jurassic (J_2) ophiolites are represented of "two" conjugate (closely juxtaposed) belts. The so-called "western" ophiolites show a general Ti enrichment. Cpx bearing harzburgites, reduced gabbro sections and MORB type extrusives crop out. No sheeted dike complex is evidenced. More voluminous ophiolites are exposed in the "eastern" belt. The geological section is constituted of a thick harzburgite mantle, followed by the transition zone (dunite, pyroxenite etc.), layered gabbro, isotropic and foliated gabbro, sheeted dike complex (with various geochemical type dikes), MORB-type extrusives, boninite suite volcanics and IAT-type extrusives (andesites, dacites, rhyolites). Important wehrlite and plagiogranite intrusions are developed. Nevertheless the general diversity, the mixing and diffuse petrologic characteristics between two ophiolitic belts is the most striking feature. MORB-type magmatic series are frequently evidenced within "eastern" ophiolites, while boninite dikes etc. are found in the Western type basalts.

The Middle Jurassic radiolarian cherts are found within and at the top of dacite-rhyolites and boninites. Middle Jurassic metamorphic sole signals the boundary between the Triassic-Jurassic ophiolites and Middle Jurassic "two" belt ophiolites. On the contrary, the boundary between "two" ophiolite belts of the Middle Jurassic doesn't show field evidence. It seems that successive transitions are more probable.

The microstructural data suggest the bidivergent emplacement of Middle Jurassic "young" oceanic lithosphere onto the Triassic-Jurassic "old" one (*intraoceanic stage*). The available structural data from the continental units found at the ophiolite periphery support also the Late Jurassic bidivergent ophiolites paleoemplacement onto the continental basement (*marginal stage*). The northwestern component is evidenced as well as. Generally, this stage marks the closure of the Mirdita oceanic basin.

Tithonian-Valanginian flysch sediments are set with unconformity either on the ophiolites or on the continental margins. These deposits post-date the closure of Mirdita oceanic basin. Hauterivian orogenesis and the Barremian-Senonian molasses transgression note the definitive closure of the oceanic basin.

The assertions on the formation of Triassic and Jurassic ophiolites within Mirdita oceanic basin are in contrast with reconstructions supporting either the Vardarian origin of Albanian ophiolites, transported from east to west or Pindos-Cukali original ophiolite setting with transport from west to east.

NORTHERN TETHYAN CARBONATE PLATFORM DROWNING D3: A GLOBAL EVENT NEAR THE HAUTERIVIAN-BARREMIAN BOUNDARY?

ALEXIS GODET*, STÉPHANE BODIN*, THIERRY ADATTE* & KARL B. FÖLLMI*
** Institute of Geology, University of Neuchâtel, rue Emile Argand 11, CH-2007, Neuchâtel, Switzerland.*
alexis.godet@unine.ch

The evolution of the shallow-water carbonate platform that developed along the northern Tethyan margin during the Jurassic and early Cretaceous is punctuated by a series of drowning events (Föllmi *et al*., 1994; Weissert *et al*., 1998). Our focus is on the event that took place close to the Hauterivian-Barremian boundary (D3 in Föllmi *et al*., 1994), which we will study by the following approaches:

1. A first goal of this study is to identify and date as precisely as possible the formations that were deposited during this drowning event in the historical type areas around Neuchâtel. Here we use biostratigraphic (macro- and microfaunas), chemostratigraphic (stable carbon and strontium isotopes), as well as sequence stratigraphic and sedimentological tools. The formations we investigate comprise (from base to the top) the "Pierre Jaune de Neuchâtel", the "Urgonien jaune", and the "Urgonien blanc" (e.g., Remane *et al*., 1989; van de Schootbrugge, 2001). We hope to correlate this important but controversially dated succession to coeval successions in the Helvetic, Vercors and Vocontian areas.

2. A second goal is to study this drowning episode in the Helvetic Alps, where it is documented in the so-called "Altmann Beds" (e.g., Funk *et al*., 1993). The Altmann beds are composed of glauconitic and phosphatic sediments, which are generally highly condensed. The purpose of this study is to precisely document the evolution of this drowning event and its effects on the platform. Important here will be the evaluation, if this drowning event occurred in a diachronous, stepwise fashion, or in a synchronous fashion.

3. A third goal will be the correlation of the drowning event with an event of increased organic carbon burial during the latest Hauterivian, which is documented in the "Faraoni level", known from the "Pré-Alpes", Vocontian, and Apulian areas (Cecca *et al*., 1995; Baudin *et al*., 1999).

With the data to be expected from these surveys, we hope to establish an integral model of platform development during this period, in we put emphasis on the temporal and spatial evolution of platform drowning (regional versus global event?), and on the mechanisms involved in drowning (sea level change, nutrients, temperature, paleo CO_2, etc.).

ANALYSE QUANTITATIVE DES BIOASSOCIATIONS ET CARACTERISATION DES ENSEMBLES PALEOGEOGRAPHIQUES ET DES CORTEGES SEDIMENTAIRES DE LA SERIE DU CENOMANO-TURONIEN (AURÈS ET TELL ORIENTAL)

M. HERKAT
FSTGAT USTHB 16111 BP 32 Alger

L'analyse des taux des constituants de la microfaune a permis d'établir des courbes de variations des pourcentages dans les différentes coupes étudiées des Aurès et du Tell oriental à la fois pour les moyennes des divers constituants dans la série du Vracono-Cénomanien ainsi que pour leurs proportions dans les différents cortèges sédimentaires identifiés dans les séquences.

-Taux des constituants dans la série : Les taux de foraminifères benthiques, des foraminifères pélagiques et des ostracodes se corrèlent de façon significative aux ensembles paléogéographiques compris entre la plateforme interne et le bassin et permettent également de caractériser les morphologies locales du substratum marin induites par les blocs basculés. C'est ainsi que le taux de foraminifères benthiques s'abaisse progressivement dans la zone de transition au bassin de 60 % à 20 % en moyenne. Dans cette zone les foraminifères planctoniques globuleux sont prédominants (entre 35 et 45 % des constituants) alors que les foraminifères planctoniques carénés ne deviennent en proportion équivalents aux foraminifères planctoniques globuleux que dans les zones les plus profondes du bassin tellien. Les ostracodes sont les meilleurs discriminants entre la zone de transition au bassin et le bassin tellien où ils ne représentent que moins de 5 % des constituants. Les taux de fréquence des échinides, des ostréidés et des autres lamellibranches estimés à partir de leurs poids dans les tableaux d'analyse factorielle montrent également une bonne corrélation avec les différents domaines paléogéographiques et subissent l'influence des remontées locales du substratum liées aux blocs basculés.

-Taux des constituants dans les cortèges sédimentaires : Le rapport des pourcentages des foraminifères benthiques aux foraminifères pélagiques permet de mettre en évidence leurs variations mutuelles dans les cortèges sédimentaires liés à l'eustatisme. Il apparaît que la baisse la plus significative du taux, marquant une chute importante de la proportion des foraminifères benthiques par rapport aux foraminifères pélagiques, intervient dans la partie orientale du bassin aurésien , dénotant d'une proximité du domaine marin ouvert de cette région. Elle est bien exprimée par les courbes du prisme de haut niveau marin. La courbe du rapport des pourcentages dans l'intervalle transgressif montre une élévation très nette du rapport dans les zones d'apex de blocs distales, caractérisées par une diminution de profondeur favorable aux organismes benthiques. Les courbes des taux de foraminifères planctoniques globuleux et de foraminifères planctoniques carénés dans les intervalles transgressifs des séquences sont celles qui montrent l'élévation la plus nette du pourcentage entre les zones distales du bassin aurésien et le bassin tellien passant de 10 % à 40-50 % en moyenne. Alors que ces pourcentages observés dans le cortège de haut niveau marin montrent une évolution moins nette. Enfin les foraminifères planctoniques carénés sont dominants dans les intervalles transgressifs et inversement les foraminifères planctoniques globuleux sont plus abondants dans les cortèges de haut niveau marin. Le taux des foraminifères benthiques arénacés baisse graduellement dans les différents cortèges sédimentaires depuis la zone de transition au bassin au bassin tellien alors que celui des foraminifères benthiques calcaires n'est pas significatif.

En conclusion : Les courbes réalisées permettent de mieux caractériser les différents domaines paléogéographiques étudiés et de montrer des répartitions des taux de constituants évoluant différemment dans les cortèges sédimentaires. Ceci suggère la nécessité de la prise en compte de l'étude des cortèges sédimentaires dans les interprétations paléoécologiques.

EVIDENCE FOR RAPID CLIMATE CHANGE IN THE MESOZOIC–PALAEOGENE GREENHOUSE WORLD

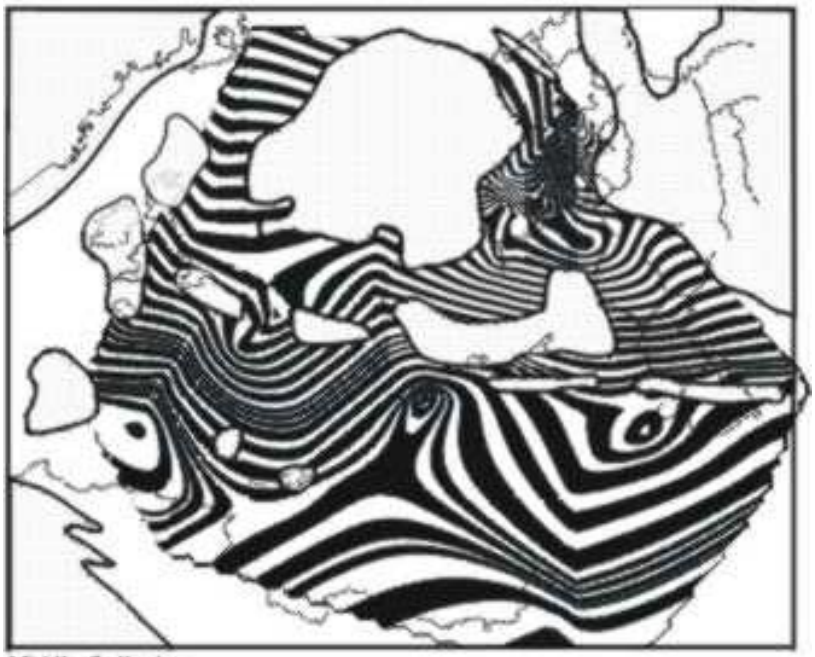
HUGH C. JENKYNS

Department of Earth Sciences, University of Oxford, Parks Road, Oxford, OX1 3PR

The best-documented example of rapid climate change that characterized the so-called 'greenhouse world' took place at Palaeocene-Eocene boundary time: introduction of isotopically light carbon into the ocean-atmosphere system, accompanied by global warming of 5-8º C across a range of latitudes, took place over a few thousand years. Dissociation, release and oxidation of gas hydrates from continental-margin sites and the consequent rapid global warming from the input of greenhouses gases are generally credited with causing the abrupt negative excursions in carbon- and oxygen-isotope ratios. The isotopic anomalies, as recorded in foraminifera, propagated downwards from the shallowest levels of the ocean, implying that considerable quantities of methane survived upward transit through the water column to oxidize in the atmosphere. In the Mesozoic Era, a number of similar events have been recognized, of which those at the Triassic–Jurassic boundary, in the early Toarcian (Jurassic) and in the early Aptian (Cretaceous) currently carry the best documentation for dramatic rise in temperature. In these three examples, and in other less well-documented cases, the lack of a definitive timescale for the intervals in question hinders calculation of the rate of environmental change. However, by analogy with the Palaeocene-Eocene Thermal Maximum (PETM), these older examples could have been comparably rapid. In both the early Toarcian and early Aptian cases, the negative carbon-isotope excursion precedes global excess carbon burial across a range of marine environments, a phenomenon that defines these intervals as Oceanic Anoxic Events (OAEs). Osmium-isotope ratios ($^{187}Os/^{188}Os$) for both the early Toarcian OAE and the PETM show an excursion to more radiogenic values, demonstrating an increase in weathering and erosion of continental crust consonant with elevated temperature. The more highly buffered strontium-isotope system ($^{87}Sr/^{86}Sr$) also shows relatively more radiogenic signatures during the early Toarcian Oceanic Anoxic Event, but the early Aptian and Cenomanian-Turonians OAEs show the reverse effect, implying that increased rates of sea-floor spreading and hydrothermal activity dominated over continental weathering in governing seawater chemistry. The Cretaceous climatic optimum (late Cenomanian to mid-Turonian) also shows evidence for abrupt cooling episodes characterized by episodic invasion of boreal faunas into temperate and sub-tropical regions and changes in terrestrial vegetation; drawdown of carbon dioxide related to massive marine carbon burial (OAE) may be implicated here. The absence of a pronounced negative carbon-isotope excursion preceding the Cenomanian-Turonian OAE indicates that methane release is not necessarily connected to global deposition of marine organic carbon, but relative thermal maxima are common to all Oceanic Anoxic Events. 'Cold snaps' have also been identified from the Mesozoic record but their duration, causes and effects are poorly documented.

RECONSTRUCTION OF THERMAL AND HYDROLOGICAL REGIMES OF THE CALLOVIAN - OXFORDIAN SEA BASINS OF NORTHWEST EURASIA BY DISTRIBUTION OF AMMONITES

D.N. KISELEV
Yaroslavl State Pedagogical University



The interrelation of ammonites of a different origin for one ammonite assemblage is convenient for expressing through relative paleotemperatural coefficient (RPC) - the total of an origin probabilities of all species for each relatively isolated basin (Kiselev 1998, in press). 4 large centers of ammonites origin are considered in region of Northwest Eurasia: European, Tethical, Central Russian, Arctic ones. Each of ammonite species has determined an origin probability in each of these basins. It is constructed 6 isoline pictures for 6 time pieces of the Callovian and Oxford corresponding to Substage (on **figure** the picture only for the Middle Callovian is shown) on distribution RPC of 54 sections groups of Northwest Eurasia. Reliability of the obtained patterns directly depends from number of the points describing certain sections. The greatest denseness of the points of the model is located in the European Russia (first of all) and W.Europe.

The same regularity in distribution of ammonites are characteristic for all time intervals: 1) Zonality - RPC "cooling" to the north and "warming" to the south. 2) Similar bending of isolines. The isolines arcuations, reflecting the basic pathes of ammonites migrations, coincide with trajectories of prospective sea currents. It is traced boreal current of the Central Russian sea and tethical ones from a southeast, and also the system of more shallow counterflows; 3) The direction of isolines arcuations in most cases does not contradict to Coriolis effect. During Callovian and Oxford certain dynamics of changes in distribution RPC, aside it "cooling" (k-1, k-3, ox-1, ox-3) or "warming" (k-2, k-2), in basic affected the Subboreal latitudes is observed. The area of the most stable RPC values place at North Spain-Italy-North Caucasus latitude. It is not observed global "warming" or "cooling" RPC in the territory for one interval of time. It can mean, that prospective changes of temperatures of water mass explain not so much the climatic causes, how many changes in system of oceanic circulation.

Explanation to figure: distribution RPC for the Middle Callovian. Interspaces between the next isolines are painted over for revealing it arcuations. The paleogeographical ground is given in the simplified view.

Kiselev D.N. (1998) - Relative paleotemperatural changes in the Central Russian sea of Callovian-Oxford time. In: Ecosystem restructures and the evolution of biosphere. Moskow: Paleont. Inst. Publ. Issue 3: 96-105. (In Russian).

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NORTHERN TETHYAN CARBONATE PLATFORM DROWNING D3: A GLOBAL EVENT NEAR THE HAUTERIVIAN-BARREMIAN BOUNDARY?

PASCAL LINDER*, HELMUT WEISSERT**, HANSPETER FUNK** & KARL B. FÖLLMI*
** Institut de Géologie, Université de Neuchâtel, Rue Emile-Argand 11, 2007 Neuchâtel, Switzerland, E-Mail: pascal.linder@unine.ch, karl.foellmi@unine.ch*
*** Geologisches Institut der ETH Zürich, Sonneggstrasse 5, 8092 Zürich, Switzerland, E-Mail: helmut.weissert@erdw.ethz.ch, h.funk@swissonline.ch*

In the region of Anzeindaz (Canton of Vaud, Switzerland) the sedimentary succession of urgonian limestones of the Schrattenkalk Formation (late Barremian to early Aptian in age) and of glauconitic sandstones and phosphorites of the Garschella Formation (early Aptian to late Cenomanian in age) is well developed. These outcrops in the helvetic Morcles Nappe are particularly appropriate to study the events that led to the demise of the Urgonian Carbonate Platform and the subsequent development towards a sedimentary regime of condensation and authigenesis.

Cavities with infillings of Garschella Formation sediments penetrating the Schrattenkalk limestone up to 20 meters deep are interpreted as karstic erosional cavities and/or neptunian dikes. The most interesting finding was the special way in which the surface of the Urgonian Carbonate Platform is preserved. At one outcrop (La Corde) thin relics of a bed interpreted as an equivalent of the Upper Orbitolina Beds seem to be integrated in the Garschella Formation since it separates relics of at least two phosphoritic horizons, probably the Luitere Bed (the oldest known bed of the Garschella Formation) but perhaps also an older bed not yet formally described. In fact a diploma student at the University of Neuchâtel, François Gainon just recently rediscovered and correctly interpreted a similar but less condensed succession in the nearby Rawil region that was first described (but misinterpreted) by Schaub in 1936. Gainon named the corresponding older phosphoritic horizon of the Rawil region "Plaine Morte Bed" and he was able to date it with an ammonite of the earliest Aptian Weissi/Tuarkyricus Zones. In both the Rawil and Anzeindaz regions the whole ensemble is deposited over an erosive unconformity cutting off the Schrattenkalk limestone.

The sedimentary succession of the Garschella Formation in the Anzeindaz region contains equivalents of nearly all beds described and defined in the type outcrops of eastern Switzerland and Austria. The study of these sediments - in particular of nodular glauconitic sandstones - revealed new evidence for sedimentary processes related to condensation and authigenesis, especially cyclic processes comparable to Baturin Cycles. These observations allow for new interpretations about the character of the original sediments and the concept of condensation in general.

In continuation of the above-mentioned observations, a four-year Ph.D. thesis will be carried out. It will focus on the stepwise demise of the northern thetyan Urgonian Carbonate Platform(s) and the subsequent evolution of the mid-cretaceous oceanographic regime. For this purpose, detailed field and lab studies using a wide range of sedimentological, stratigraphical, palaeontological, geochemical and mineralogical methods, but also an extensive review of existing studies are foreseen. The study will concentrate on the Delphino-Helvetic realm from Austria to France and will focus on the high resolution description (and dating) of key regions but will also include the study of a larger number of single outcrops interesting for this question.

PRODUCTION ET DIVERSITÉ DES KYSTES DE DINOFLAGELLÉS EN RÉPONSE AUX VARIATIONS DE SALINITÉ ET AUX REMONTÉES D'EAU PROFONDE AU LARGE DU PORTUGAL À L'ALBIEN

EDWIGE MASURE
Département de Géologie Sédimentaire, Université Paris VI, CNRS-FR 32, C.104, 4, place Jussieu, 75252 Paris Cedex 05, France

Les deux sites d'étude localisés l'un sur la marge interne et l'autre dans le bassin permettent de comparer la production phytoplanctonique à l'Albien d'environnements côtiers et océaniques.

Le site côtier est représenté par des coupes qui s'échelonnent le long des côtes portugaises de part et d'autre de la serra de Sintra, à l'Ouest de Lisbonne. Elles appartiennent au Bassin occidental portugais dont les plus anciens dépôts marins carbonatés, d'âge Albien moyen, succèdent aux dépôts détritiques des « grès supérieurs d'Almargem ». A l'Albien supérieur, une plate-forme carbonatée envahit la région. Les environnements côtiers sont plus ouverts sur l'Océan au Sud de la serra Sintra (coupe de Guincho) qu'au Nord (coupes de Folcao- Magoito, Magoito-Aguda) (Berthou, 1979). Le site océanique est illustré par le puits 398D foré à une profondeur de 3 900m, lors de la croisière 47B du Glomar Challenger du programme D.S.D.P. 300 km séparent les deux sites et leurs environnements.

L'enregistrement fossilifère est exceptionnel. Les lectures qualitatives et quantitatives des associations nous renseignent sur les paléoécosystèmes situés aux extrémités des échelles de salinité et de température d'un même domaine. A l'Albien, la marge portugaise se situaient vers 25° de latitude Nord et les populations planctoniques appartenaient au domaine tropical téthysien.

La diversité des kystes est plus élevée sur le site du forage (Masure, 1984) qu'aux niveaux des coupes à terre (Hasenboehler, 1984). La diminution de la diversité entre les écosystèmes océaniques et côtiers correspond à l'absence des espèces spécialisées, et à la dominance des espèces ubiquistes et opportunistes. Les espèces tropicales océaniques appartiennent entre autre aux genres *Codoniella Hapsocysta* : *C. campanulata, H. dictyota.* En terme de stratégie de vie, ces espèces demandaient des environnements stables à température régulière et salinité normale.

Les dominances successives (50 à 90%) constatées dans les échantillons de la marge interne témoignent des efflorescences côtières. Comme pour les actuelles, des eaux riches en éléments nutritifs et périodiquement calmes étaient nécessaires. *Palaeoperidinium cretaceum* et *Microdinium opacum* se comportaient comme des espèces pionnières qui colonisaient les premiers paléoécosystèmes saumâtres de l'Albien moyen et supérieur. A ces premiers peuplements succèdaient au Nord de la serra ceux de *Ovoidinium tenue, Trichodinium castanea, Chichaoudinium vestitum, Odontochitina ancala, Kiokansium williamsii* et *Xiphophoridium alatum.* Les stratégies de vie de ces espèces demandaient des salinités et des températures rencontrées dans les estuaires et les lagunes. Leurs successions spatio-temporelles alternées traduisent l'instabilité des écosystèmes côtiers. Ces espèces fleurissaient également en domaine tempéré.

L'enrichissement des associations en péridinioïde indique l'activité d'upwelling côtiers au cours de l'Albien. Les remontées d'eau froide sont confortées par l'abondance des *Chichaouadinium vestitum*, espèce de l'Arctique canadien.

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TIMING AND CORRELATION OF SUCCESSIVE PALAEOCEANOGRAPHIC CHANGES DURING THE EARLY TOARCIAN ANOXIC EVENT (JURASSIC): THE EVIDENCE OF CALCAREOUS AND ORGANIC PHYTOPLANKTON

EMANUELA MATTIOLI[1]*, BERNARD PITTET[1], RAFFAELLA BUCEFALO PALLIANI[2], HANS-JOACHIM RÖHL[3], ANNETTE SCHMID-RÖHL[3], ELENA MORETTINI[4]

1 Université Claude Bernard Lyon 1, UMR 5125, 2 rue Dubois, 69622 Villeurbanne, France

2 Dipartment of Earth Sciences, Perugia University, Piazza Università, 06123 Perugia, Italy

3 Hornschustasse., 5 – 72074 Tübingen, Germany

4 Shell International Exploration and Production, Volmerlaan 8, Netherlands

The duration and causes of the early Toarcian anoxic event are still matter of debate. Integration of calcareous and organic phytoplankton data provides a biochronologic frame that allows precise correlations across the western Tethys. In particular, the *C. superbus* nannofossil Zone seems to be very useful to correlate the levels enriched in organic matter and the related $\delta^{13}C$ negative excursion. Although a variable duration is given in the literature for this negative excursion, it is likely that it lasted between 520 and 700ky. Increased atmospheric pCO_2, related to excess volcanic emissions (magmatic activity in the Karoo and Ferrar Provinces) had an impact on climate and ocean chemistry, and marked the inception of a biotic crisis affecting different organisms. The beginning of the crisis of shallow carbonate platforms, documented at southern latitudes, pre-dates the levels enriched in organic matter. Dinoflagellate cysts experienced a decrease in abundance in the *C. superbus* Zone, until a disappearance event. Nannoplankton crisis was twofold: a decrease in size and low calcified specimens are observed besides a drastic decrease in absolute abundance. The increased atmospheric pCO_2, due to the magmatic activity and temporarily amplified by transient methane release, could have been the trigger for the biocalcification crisis, which first affected the probably more reactive neritic system, and eventually the nannoplankton community.

HIERARCHY, NOMENCLATURE AND DESCRIPTION OF THE ARCTIC JURASSIC BIOGEOGRAPHIC UNITS

MELEDINA S.V., SHURYGIN B.N.
Institute of Petroleum Geology, Siberian Branch of the RAS, Novosibirsk, Russia

The paleobiogeography is called up to study the laws controlling the distribution of groups of organisms in space over particular periods of geological time and to analyze their reasons. The zoning of aquatoria implies their separation into co-ordinative biogeographic units (biochoremas). The range of the latter is determined by the areal of specific taxa and their rank is estimated by the rank of index-taxa, time of existence and extent of areals.

In zoning the aquatoria we used the following hierarchy: Superrealm, Realm, Province. The highest units are referred to as "Panboreal and Tethys-Pantalassa Superrealms". The names for the realms of the northern hemisphere were proposed by V.N Saks and his disciples as early as in the 70th of the last century. These are the Arctic (circumpolar), Boreal-Atlantic and Boreal-Pacific Realms. Change of the rank of taxa endemism on retention of the place and range of biochoremas involves the change of the rank of biochorema rather than its name. The authors follow certain rules when describing the realms and provinces. By analogy with rubrications used in the descriptions of biostratons, there are indicated: 1) type area (chorotype); 2) nomenclature (who and when proposed the name); 3) synonymy; 4) type age (chronotype); 5) extent; 6) the composition of biochorema (enumeration of realms for superrealm and provinces for the realms); 7) fauna evidence: ammonites, belemnites, bivalves and other available groups; 8) indication of changes introduced in all mentioned items after initial description of the biochorema.

The part of paleobiochorema in which its taxonomic originality is most pronounced should be considered the type area (chorotype). It is obvious that borders are not the case in point, since the fauna composition to a greater or lesser extent is always affected by adjacent biochoremas. One of the realms (provinces), where fauna specificity is manifested in more pure state and over a long period of time should serve as the chorotype for paleobiogeographic superrealm (realm). In Panboreal Superrealm in Jurassic, the Arctic Realm serves as the chorotype and the North Siberian Province is the chorotype for the Arctic Realm.

According to presented methods of approach, the authors have composed a standardized description of the Arctic biogeographic Realm (Late Pliensbachian – Hauterivian) with North Siberian Province (Bathonian – Hauterivian) as the type area (with standardized description also) and Boreal-Atlantic Realm (Late Pliensbachian – late Jurassic). The West European Province is suggested to be its type area.

THE CHRONOLOGY OF THE MIDDLE JURASSIC MOLLUSK ASSOCIATIONS AND BIOGEOGRAPHY OF THE ARCTIC BASIN

MELEDINA S.V., SHURYGIN B.N. & DZYUBA O.S.
Institute of Petroleum Geology, Siberian Branch of the RAS, Novosibirsk, Russia

In the Arctic seas (northern Eurasia, Canada, Alaska, Arctic islands; to the north of the 50th parallel) the mollusks retained their specific features over the Jurassic time: impoverished taxonomic composition (as compared to that of the seas of low latitudes) and the availability of endemic families, genera and species. The latter had their ancestors in adjacent aquatoria of the North Atlantic and Pacific. Certain of local families evolved in the Arctic sometimes during the course of many ages.

It was established that the Arctic cephalopods and bivalves developed by stages. The phases of taxonomic associations levelling alternate with those of their differentiation over large areas. The limits of taxa distribution were greatly dependent on many environmental factors (climate fluctuations; change in land and sea boundaries; edaphic reasons). The degree of taxonomic differences of the associations of ammonites, belemnites and bivalves and the rank of endemic taxa all this provides a good basis for the recognition of various paleobiogeographic realms and provinces. For the periods of time with more sharp differentiation, the superrealms are established. The names for the superrealms are proposed by G. Westermann and for realms and provinces by domestic scientists.

Delimitation of the Arctic, Boreal-Atlantic and Boreal-Pacific Realms occurred in Late Pliensbachian. The realms are united into the Panboreal Superrealm. The ammonites reached into the Arctic from both east and west. The Toarcian was the time of penetration and wide distribution of belemnite in the Arctic seas. In Early Toarcian, the differences between the high-latitude Boreal and low-latitude Tethyan seas leveled. The Boreal-Atlantic Realm became a part of Tethys-Pantalassa Superrealm and such was the situation right up to the Callovian. The Arctic Realm now enlarged in the east due to the Boreal-Pacific Realm (Early Toarcian), now both the realms regained their value (Late Toarcian, Aalenian, Bajocian, Bathonian). The Panboreal Superrealm embraces only the Arctic and Boreal-Pacific Realms.

In the Callovian, the Boreal-Atlantic Realm (the north of West and East Europe) judging from mollusks composition was again found to belong to the Panboreal Superrealm along with the circumporlar Arctic and Boreal-Pacific (northern Pacific) Realms.

The subdivision of some realms into the provinces on the basis of various groups of mollusks changed from age to age and was maximum for the Callovian. Beginning in the Aalenian, the Siberian and Far-Eastern Provinces are recognized in the Arctic Realm each province containing a diverse sets of genera and species of cephalopods and bivalves. In the Bathonian and Callovian the Arctic Realm falls into three provinces: Greenladic, North Siberian and North Pacific.

JURASSIC BIOTIC TRANSFORMATIONS AND THEIR TRIGGERS IN THE ARCTIC SEAS

MELEDINA S.V., SHURYGIN B.N. & DZYUBA O.S.
Institute of Petroleum Geology, Siberian Branch of the RAS, Novosibirsk, Russia

The development of the Jurassic biota in the Arctic seas proceeded by stages, that is manifested in irreversible graduated change of taxonomic composition of fauna due to evolutionary and migratory transformations. Phylogenetic trends of diverse groups of marine fauna have formed in different parts of the particular basins. The course of evolution was affected by many concurrent factors of environment, i.e, global variation in climate, change in paleolandscape conditions, extent and depth of aquatoria and so on.
The families of cephalopods (ammonites and belemnites) represented by cosmopolitan genera and species or transformed into new taxa have penetrated into the Jurassic Arctic seas from adjacent northern paleopacific or north and west European seas as the result of invasions. New taxa have experienced generally further taxonomic flourish transforming into endemic long-live families and genera which occupied a large areals, while at the closing stage they were characterized by impoverished taxonomic composition up to a total extinction. The Jurassic ammonites in the Arctic show three distinct major stages the limits of which are characterized by sharp change in dominant taxa: pre-Late Pliensbachian, Late Pliensbachian–Early Bajocian and the stage beginning in the Late Bajocian and closing in the Early Cretaceous. Endemic forms increased quantitatively from stage to stage: from species endemicity in early Jurassic to subgeneric and generic ones in late Early Jurassic–Aalenian, to the genus, subfamily and family endemicity in Late Bajocian–Early Cretaceous. The belemnites have reached into the Arctic seas only in the Toarcian and it is associated with the climate warming. Two stages in the development of belemnites can be recognized which are coincident with those of ammonites though showing their own specific characters. Unlike the ammonites, the Arctic endemic forms of the high rank in belemnites are marked at the initial stage (Toarcian–Early Bajocian), whereas at the closing stage (Late Bajocian – Early Cretaceous) belemnites demonstrate only species endemicity.
In the Jurassic Arctic seas three distinct stages (waves) in the rise of taxonomic variability in bivalve mollusks (pre-Toarcian, Toarcian–Early Bajocian and post-Early Bajocian) are determined, the initial development of which is characterized by low taxonomic diversity replenished mainly with immigrants and the closing step by differentiation and (along with persisted penetration of the Lower Boreal immigrants) autochthonous development of some local (occasionally endemic) taxa. Bivalves taxonomic diversity at the first and second stages grew primarily due to immigrants. At the third stage (post-Bajocian and Late Jurassic) the local taxogenesis plaied a large role in this. The stages of levelling and differentiations of bivalve assemblages gave way to a sharp reconstructions and crises, which were responsible for drastic decrease in taxonomic diversity, simplification of the structure of benthos catenas and related to the destabilization of balance in the complex of global abiotic factors and chorologic system they control. The pre-Toarcian crisis of the first type may be thus dictated by the causes of global nature, for example, eustatic fall – change in water circulation – rise seasonal contrast in temperatures – cooling – sharp impoverishment of biota. The crisis of the second type was determined by local paleogeographic (or tectonic) reasons, however in Paleoarctic (ocean boundary zones) critical ecotones, for example, there took place local paleogeographic isolation at the interfaces between the Arctic seas and Paleoatlantic (regions of North sea and Greenland) in early Bajocian – change of water circulation system – variation in direction of emigration and immigration – relatively quick reconstruction of the assemblages. Compared to cephalopods, the changes in the structure of bivalve assemblages are closely related to ecologic and paleogeographic reconstructions.
The comparative analysis of the main stages in the reconstruction of the assemblages of bivalves (macrobenthos), ammonites and belemnites (nekton and nektobenthos) in the Arctic Jurassic paleobasins has shown their considerably good relationship. Nevertheless they had their specific features and the rise and fall in taxonomic diversity in different groups of benthos and nekton were not in close agreement (noncatastrophic changes with lagging or outstripping).

CENOMANIAN AMMONOID DIVERSITY PATTERNS AND THE END-CENOMANIAN ANOXIC EVENT

MONNET C. [1], BUCHER H. [1], GUEX J. [2], ESCARGUEL G. [3]
[1] *Paläontologisches Institut und Museum der Universität Zürich, Karl Schmid Strasse 4, CH-8006 Zürich ; Claude.Monnet@pim.unizh.ch ; Hugo.Bucher@pim.unizh.ch*
[2] *Institut de Géologie et Paléontologie, BFSH-2, Université de Lausanne, CH-1015 Lausanne ; Jean.Guex@igp.unil.ch*
[3] *UMR-CNRS 5125 Paléoenvironnement et Paléobiosphère, UFR des Sciences de la Terre, Université Claude Bernard Lyon 1, 2 rue Dubois, F-69622 Villeurbanne Cedex ; Gilles.Escarguel@univ-lyon1.fr*

Diversity patterns of ammonoids are analyzed and compared with the timing of anoxic deposits around the Cenomanian/Turonian (C/T) boundary in the Vocontian, Anglo-Paris, and Münster basins of Western Europe. Differing from most previous studies, which concentrate on a narrow time span bracketing the C/T boundary, the present analysis covers the latest Albian to Early Turonian time interval for which a high resolution, ammonoid-based biochronology, including 34 Unitary Associations zones, is now available. During the latest Albian-Middle Cenomanian time interval, ammonoid diversity reveals a first dynamical equilibrium oscillating around an average species richness of 20, whereas the Late Cenomanian-Early Turonian interval displays a second equilibrium centered on an average value of 6. The marked onset of the decline of species richness thus largely predates the spread of oxygen-poor water masses onto the shelves, and only minimal values of species richness coincide with the Cenomanian-Turonian boundary. The protracted decline of species richness during the entire Late Cenomanian seems to result from lower origination rates rather than from higher extinction rates. This result is also supported by the absence of statistically significant changes in the extinction probabilities of the poly-cohorts. Separate analyses of species richness for acanthoceratids and heteromorphs, the two essential components of the Cenomanian ammonoid community, reveal that heteromorphs declined sooner than acanthoceratids. Moreover, acanthoceratids showed a later decline at the genus level than at the species level. Such a decoupling is accompanied by a significant increase in morphological disparity of acanthoceratids resulting from the origination of new genera. Last, throughout the Late Cenomanian, evolutionary radiation of acanthoceratids was dominated by paedomorphic processes, juvenile innovations and reduction of adult sizes. Hence, the decrease in ammonoid species richness, and their major evolutionary changes, significantly predates the spread of anoxic deposits. Other environmental constraints such as global flooding of platforms, warmer and more equable climate, as well as productivity and oceanic circulation changes better correlate with the timing of diversity changes and evolutionary patterns of ammonoids and therefore, provide more likely causative mechanisms than anoxia alone.

PRODUCTIVITY AND CONTINENTAL WEATHERING IN THE WESTERN INTERIOR DURING OCEANIC ANOXIC EVENT 2: AN EXAMPLE FROM THE PUEBLO STRATOTYPE, COLORADO

H. MORT[1], T. ADATTE[1], P. STEINMANN[1], G. KELLER[2], D. STUEBEN[3] & Z. BERNER[3]
[1]*Institut de Géologie, 11 Rue Emile Argand, 2007, Neuchâtel, Switzerland, haydon.mort@unine.ch / fax +41 (0) 32 7182601*
[2]*Department of Geoscience, Princeton University, Princeton NJ 08544, USA*
[3]*Institut für Mineralogie und Geochemie, Universität Karlsruhe, Germany*

We present a multidisciplinary study in which the palaeoenvironment of the Pueblo Section, Colorado is studied. Small surface dwelling planktic foraminifera *Hedbergella planispira* register a +2.0 to 2.5‰ $\delta^{13}C$ excursion across the Harland Shale and the Bridge Creek Limestone members (late Cenomanian-early Turonian in age respectively). Coincident with this positive shift is the progressive extinction of 5 surface planktic species (*Rotalipora deekei*, *R. greenhornensis*, *R. cushmani*, *P. inornata*, *G. bentonensis*) which are replaced by foraminifera with high depth and low O_2 tolerances. $\delta^{18}O$ values also increase from around -11‰ to -7‰, indicating that although a marine transgression certainly occurred, a large fresh water influence still remained. The sediments of the Greenhorn Formation are clearly post-depositionally altered, however it is deemed that such negative $\delta^{18}O$ values cannot be explained by diagenetic overprint alone. XRD mineralogy and Rock-Eval analysis reveals increases in calcite, a decline in phyllosilicates and a switch in dominance from OI to HI (continental to marine derived organic matter), indicating generally higher sea levels and enhanced preservation. Phosphate (PO_4) and Aluminum (Al) accumulation data show a close correlation with each other. Although considerable scattering is displayed, a clear drift towards lower values is seen to occur with the onset of the $\delta^{13}C$ excursion, fostering the notion of less terrestrial input and high sea levels and low productivity. Biogenic Barium ($Ba_{(biogenic)}$) accumulation displays a short increase during the primary phase of the $\delta^{13}C$ excursion but drops abruptly (by around 200 ppm) with the last occurrence datum (LAD) of the 5 surface planktic species (approximately the first peak of the $\delta^{13}C$ excursion). This may indicate that although there may have been no net biodiversity loss (introduction of deeper species) there may well have been a drop in marine surface productivity resulting from the extinction and anoxia. Aside from the main focus of this study, the mid-Cenomanian event was possibly identified lower in the section with a short lived positive $\delta^{13}C$ shift and negative $\delta^{18}O$ shift. Interestingly PO_4 accumulation shows a sharp spike in concentrations, more than doubling to over 1000 ppm. It is also at this point that OI values begin to exceed the HI suggesting a possible sea level regression and an enhanced continentally derived organic matter influx.

RÉPARTITION MONDIALE DES FAUNES D'AMMONITES AU JURASSIQUE MOYEN (AALÉNIEN À BATHONIEN MOYEN) : RELATIONS ENTRE BIODIVERSITÉ ET PALÉOGÉOGRAPHIE

S. MOYNE, J. THIERRY, P. NEIGE & D. MARCHAND
Université de Bourgogne et UMR CNRS 5561 "Biogéosciences-Dijon",
6 Bd Gabriel, 21000, Dijon, France. sebastien.moyne@ u-bourgogne.fr

L'éclatement de la Pangée intervient au Jurassique; ses conséquences paléocéanographiques sont l'ouverture de couloirs marins, en particulier à l'emplacement des futures aires océaniques atlantique et indienne. Au Toarcien, et de l'Aalénien au Bathonien moyen, l'existence d'un «corridor hispanique» (Enay 1980; Elmi 1993) entre la «Téthys orientale» et la «Bordure pacifique américaine», via la «Téthys Caraïbe», ainsi que le contournement par le Nord de la Laurasie, et du Gondwana par le Sud (Thierry, 1976), sont des voies d'échanges possibles, mais peu argumentées.

A la fin de l'Aalénien, le sous-ordre des Ammonitina connaît un important renouvellement faunique. Les derniers Hammatoceratacеae, superfamille bien représentée au Lias, donnent naissance à trois superfamilles qui vont dominer jusqu'à la fin du Jurassique (Haploceratacеae, Stephanoceratacеae et Perisphinctaceae). L'analyse de cette radiation à l'échelle mondiale met en évidence des différences et des similitudes entre les provinces biogéographiques classiquement reconnues.

Les domaines Téthysien, Pacifique et Boréal, et leurs plates-formes associées, sont divisés en seize «provinces géographiques»; les taxons d'ammonites répertoriés concernent vingt trois sous-familles et le cadre temporel Aalénien supérieur-Bathonien moyen comporte quinze biozones.

Le dénombrement des espèces de chaque sous-famille au sein des différentes provinces paléobiogéographiques met en évidence des ressemblances en terme de biodiversité totale entre les provinces. Pour ce faire, une analyse en «cluster» est utilisée: les résultats sont présentés sous la forme d'un arbre relationnel dont les branches les plus proches correspondent aux provinces dont les biodiversités sont les plus semblables.

Les provinces nord-ouest téthysiennes (plates-formes européennes) ont de fortes similitudes entre elles et avec les provinces de la marge sud-ouest de la Téthys (Maghreb). Les provinces circum pacifique sont regroupées, soulignant ainsi leurs grandes similitudes. Enfin, les provinces présentant de forts taux d'endémisme sont isolées: secteur Boréal et marge sud-est Téthysienne.

Le suivi de la variation de la diversité totale au cours du temps est exprimée par le comptage des espèces répertoriées pour chaque biozone. Un premier signal global est obtenu, puis il est subdivisé par province paléobiogéographique.

La comparaison entre les deux signaux montre des différences d'évolution de la diversité dans les différentes provinces au cours du temps. Les pics de maximum de diversité sont souvent diachrones: Bajocien inférieur en Amérique du Nord; Bajocien supérieur sur la plate-forme Nord-ouest Européenne.

Enfin, la distribution paléogéographique de chaque sous-famille est utilisée pour mettre en évidence les diverses voies de communication pouvant exister entre les différentes provinces.

Les cartes réalisées pour les taxons répertoriés montrent que certaines voies de communication comme le «corridor hispanique», le sud du Gondwana ou bien encore la Mer de Bering ont certainement été utilisées par les ammonites pour occuper les différentes provinces. Certains groupes présentent néanmoins des distributions dont les causes restent encore problématiques.

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A HIGH-RESOLUTION STUDY OF RADIOLARIAN ASSEMBLAGES FROM WITHIN AND AROUND BONARELLI HORIZON (UMBRIA MARCHES ITALY)

BENJAMIN MUSAVU-MOUSSAVOU[1], TANIEL DANELIAN[1] & RODOLFO COCCIONI[2]
[1] : *Département de géologie Sédimentaire, Université Pierre et Marie Curie (Paris6), 4 place jussieu, 75252 Paris cedex 05, France, e- mail :* bmusavu@ccr.jussieu.fr, danelian@ccr.jussieu.fr
[2:] *Istituto di geologica Centro di geobiologia Laboratoirio di micropaleontologia Ambientale universita degli Studi Carlo Bo campus scientifico Localita Crocicchia I-61029 Urbano (Italy)*
e-mail:cron@info-net.it

The middle Cretaceous (Barremian-Turonian) interval records several paleobiologic and paleoceanographic events which coincide with several Oceanic Anoxic Events (OAE) considered as the result of increased levels of productivity in the oceans, following the input of enormous amounts of volcanogenic CO2 in the oceans and atmosphere and a greenhouse climate.

The Bonarelli Horizon (BH), of late Cenomanian early Turonian age, corresponds to Oceanic Anoxic Event 2 (OAE2). It is an important regional level in the Umbria –Marches characterised by organic carbon accumulation and preservation. From a sedimentary point of view, BH resulted in deposition of black laminated, silica-rich beds, or "black shales". This interval is devoid of any carbonate. In this study we present preliminary results of a high resolution study of radiolarian assemblages from the Bonarelli Horizon. The studied samples come from one surface outcrop, namely the Valle del Bottaccione section. In this section, which is the type section for the BH, the latter measures eighty-two centimetres and consists of black mudstone, shale, silty shale and beds of radiolarian siltstone and fine sandstone. It is limited below and above by the 'Scaglia Bianca' limestone.

In total, sixty-three samples have been processed so far: 41 coming from within the BH and sampled every 2cm, eleven sampled below BH and eleven more above BH, sampled every 5-10 cm. Four out of five samples within the BH yielded radiolarians of a quite good preservation. Preservation is better in the overlying and underlying limestones.These preliminaries studies based on ten assemblages studied taxonomically so far, allow us to recognize: (1) the two radiolarian assemblages, as defined by Marcucci *et al.* (1991), with their transition situated between 24cm and 40cm above the base of the BH. This transition is marked by the last occurrence of species *Xitus mclaugulini* and the first occurrences of *Alevium superbum* and *Pseudoaulophacus putahensis*. Following Marcucci et al. this radiolarian faunal transition coincides with the C/T boundary. (2) the dominance of "Spumellaria" over Nassellaria in the limestones surrounding the BH in agreement with previous observations by Salvini et al (1998). Withing the BH, "Spumellaria" are rare and relatively badly preserved. Nassellaria dominate the assemblages, made essentially of the mutlicyrtid genera *Archaeodictyomitra, Dictyomitra, Pseudodictyiomitra*, *Stiochiomitra* and *Xitus*. (3) the total absence of members of the Saturnalidae within the BH, while they are abundant in the studied limestone samples situated above the BH (15-20% of the total assemblage). Saturnalidae are also common in the studied limestone samples studied below the BH. However, Saturnalidae seem to be present, although extremely rare in the BH of other sections (Salvini et Pasareni, 1998). The absence/paucity of Saturnalidae within the BH could probably imply a particular ecological preference of members of this family to oligotrophic waters.

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THE *CHRONOS* NETWORK FOR EARTH HISTORY DATABASES

JAMES G. OGG
Purdue University, Indiana, USA (jogg@purdue.edu)

The geological science programs of the U.S. National Science Foundation are embarking on an ambitious development of a "geoinformatics" network, and ***CHRONOS*** has just been designated as one of the lead projects. The goal of ***CHRONOS*** is to unify current and future stratigraphic databases into a powerful system for producing a dynamic global time scale for Earth history and for understanding the complex relationships of past geologic, climatic and evolutionary trends. A small core staff of information-technology and geoscience professionals under the scientific guidance of the International Commission of Stratigraphy (under IUGS) will be responsible for developing and administering ***CHRONOS***, especially its central hub and geologic time scale products. Web-services and an extensive on-line suite of toolboxes will allow global researchers and the general public to access, analyze and visualize chronostratigraphic information. In addition to its primary goals of enabling networking of international databases and facilitating creative research, the ***CHRONOS*** outreach programs will promote education of Earth's fascinating history.

The ***CHRONOS*** concept and development plan is described in more detail at *http://www.eas.purdue.edu/chronos/*, and the future hub portal will be at *www.chronos.org*.

THE OXFORDIAN, A MAJOR TURNING POINT IN MESOZOIC OCEANOGRAPHY

PAULINE RAIS, BEAT LOUIS, STEFANO BERNASCONI, HELMUT WEISSERT
Geological Institute ETH Zurich,
Sonneggstr. 5, 8092 Zurich, Switzerland
pauline.rais@erdw.ethz.ch, beat.louis@erdw.ethz.ch, stefano@erdw.ethz.ch, helmi@erdw.ethz.ch

Oxfordian sediments of the European Tethys Region record peculiar and still enigmatic depositional and paleoceanographic conditions. (1) Early Oxfordian sediments are often condensed or even absent. Hardgrounds, iron-oolitic marls, limonitic crusts are found in many sections. However, in sedimen-tary sinks like subsident basins, organic-carbon rich sediments were accumulated, sometimes at high rates (e.g. the "Terres Noires" formation). (2) Sedimentation recovers in the whole region in late Early to Middle Oxfordian and hardgrounds are widely replaced by marlstones. (3) A transition to carbonate-rich sediments occurs in the Transversarium ammonite zone of middle to late Middle Oxfordian age. (4) Carbonate sedimentation decreases again and widespread marl deposition takes place, before (5) in the Late Oxfordian carbonate production likely seems to explode, giving rise to the Late Jurassic "carbonate world".

Other features of the Oxfordian do as well contribute to the image of a "time of major change":

- The Sr-isotope record shows a turnover from a decreasing to an increasing trend, with the turning point probably in the Early Oxfordian. Furthermore, the lowest values of $^{87}Sr/^{86}Sr$ in the Phanerozoic are registered at this time.
- Nd-isotope values of Tethyan and Pacific sediments begin to separate and individualize.
- In the late Jurassic, probably the Oxfordian, planktic carbonate producers expand from coastal areas into the pelagic realm.
- The isotope-stratigraphy of both organic and carbonate carbon records a negative spike – with a drop of up to 3‰ – at the end of the Transversarium zone. Padden et al. (2001) suggested, that this spike is the signal of a release of methane hydrates.

The project includes two Ph.D. thesis and asks – among others – the following questions:

- Does the end of hardground formation in different Tethyan paleogeographic environments correspond to the reorganization of deep-water circulation pattern?
- Do high northern Tethyan C_{org}/C_{carb} burial rates during Callovian-Oxfordian correspond to a local or global carbonate crisis at a time of low weathering rates and peculiar climate (as recorded in the Sr-isotope curve)?
- Is there further evidence for a methane spike (or for two spikes) in the mid-Oxfordian? If yes, were these methane-events triggered by the opening/ deepening of the Panama seaway or by climate change?
- What is the origin of the micrite in limestones, before planktic foraminifera and nannofossils began to expand into the pelagic realm?

CADMIUM ANOMALIES IN JURASSIC CARBONATES

CLAIRE RAMBEAU*, KARL B. FÖLLMI*, THIERRY ADATTE*, VIRGINIE MATERA*, PHILIPP STEINMANN*, PHILIPPE VEUVE*
** Institute of Geology, University of Neuchâtel, rue Emile Argand 11, CH-2007, Neuchâtel, Switzerland.*
claire.rambeau@unine.ch

Selected soil profiles in the Swiss and French Jura, as well as in other French regions such in Burgundy (Baize, 1997; Benitez-Vasquez, 1999; Veuve, 2000), are characterized by elevated cadmium contents, which reach values of up to 10.4 ppm. These concentrations largely exceed the official guideline values in Switzerland (0.8 ppm) and France (2 ppm).

In the Jura, it has been demonstrated that these positive anomalies are related to the rock substratum, which consists of oolitic carbonates of Bajocian and Oxfordian/Kimmeridgian age. In specific horizons, these rocks show cadmium enrichments of up to 8.15 ppm, whereas the average cadmium concentration in carbonates rocks is 0.03 ppm (Tuchschmid, 1995).

Veuve (2000) revealed that cadmium anomalies are restricted to the cortex of the ooids (or to entire ooids in the case they are micritized). This leads us to think that enrichments occurred early in the sediment history, either during oolite formation, or during early diagenesis.

Our goal is to characterize, map and date more precisely these anomalies, by studying reference sections for Bajocian and Oxfordian carbonates, in the Swiss and French Jura. Samples are analysed for cadmium content (by ICP-MS), mineralogy (by XRD), and facies (by thin sections). These reference sections will be compared with sections from different areas (France, Spain, Italy…), of the same ages, with different carbonate facies, going from shallow platform to basin environments.

A further goal consists in the analysis of rock substratum underneath soils with established cadmium enrichments.

We also plan to trace elements that could specifically be associated with cadmium (for example, elements characteristic of volcanic events, such as Mo, V…). The relation between cadmium enrichments and shifts in isotopic curves (carbon and strontium stable isotopes) will also be considered.

With this research we hope to elaborate the sedimentary and paleoenvironmental conditions and changes that led to cadmium enrichment in carbonates.

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QUANTITATIVE VARIATIONS OF AMMONOID FAUNA RELATED TO CHANGES IN TROPHIC CONDITIONS ACROSS THE OCEANIC "ANOXIC" EVENT 1D (BREISTROFFER INTERVAL, LATEST ALBIAN).

REBOULET STÉPHANE, GIRAUD FABIENNE & PROUX OLIVIER

UFR Géosciences – UMR 5125, Paléoenvironnements et Paléobiosphère – Batiment Géode, Rue Raphaël Dubois, Université Claude Bernard Lyon I, F-69622 Villeurbanne cedex, France.

The aim of our study is to analyze the abundance variations and changes in assemblages of ammonoids with respect to the palaeoceanographic event OAE1d, named the Breistroffer interval in southeast France. Results are based on the quantification of the Late Albian nektonic and benthic macrofauna of the Blieux section (Alpes de Haute Provence), represented by argillaceous marls and marls containing organic matter. Changes in assemblages and abundance of ammonoids are mainly interpreted in terms of food availability. Trophic conditions in the water column were established by the analysis of the abundance and diversity of nannofossils (Giraud et al, in press). Ammonoid assemblages are characterized by a high generic richness. The 20 genera are mainly assigned to 7 morphologic units: involute to evolute planispirals, orthocones, turrilicones, scaphitocones, ancylocones and hamitocones (with 2 distinct morphotypes). Uncoiled ammonoids are dominant in the lower part of the Breistroffer interval. They represent 50 to 90 % of the ammonoid assemblages. The presence of turrilicones (*Turrilitoides* and *Mariella*) is restricted on two intervals (mainly in the lower part of the Breistroffer interval and at the top of the section) and their relative abundance never exceed 30%. *Lechites* (orthocones) are present in all the section and they are the most abundant (until 1500 specimens/m^3). Both taphonomy and sedimentary dilution may have partly controlled the variations in macrofaunal abundance. The opposite trends observed between benthic and nektonic faunas and between different ammonoid genera can be interpreted more likely in terms of response to palaeoenvironnemental changes and of different palaeoecologies of the analyzed taxa. The peaks of absolute and relative abundances of turrilicones are relatively well correlated to those of the nannofossil species *Biscutum ellipticum.* As the abundance of this taxon is characteristic of mesotrophic conditions in the Blieux section (Giraud et al., in press), we suggest that relatively nutrient-rich surface waters could be favorable to the installation and development of turrilicones in this distal paleoenvironment. In the North-Provencal platform, the Upper Albian ammonoid assemblage is respresented by the high dominance (80%) of Turrilitidae. This allows to consider that *Turrilitoides* and *Mariella* may have been quasiplanktic and mainly inhabited shallow-water palaeoenvironments where trophic conditions are good. These turrilicones can occupy more distal palaeoenvironments as the Blieux section when food supplies increase. *Lechites* is interpreted as an opportunistic species able to change from a quasiplantik to a deep-nektonic mode of life related to the trophic conditions. The great capacity for vertical mobility of orthocones would have permitted to *Lechites* to move up and down to scan food-rich layers in the water column. The mode of life of other uncoiled and coiled ammonoids is also discussed.

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THE RADIOLARIAN AND GEOCHEMICAL RECORD OF APTIAN-ALBIAN OCEANIC ANOXIC EVENTS IN THE IONIAN ZONE OF ALBANIA

C. RICORDEL [a], T. DANELIAN [a], L. EMMANUEL [a], F. BAUDIN [a], I. FILI [b], E. MASURE [a] & K. MUSKA [b]

[a] *Département de géologie sédimentaire, Université Pierre et Marie Curie, CNRS-FR32, 75005 Paris*

[b] *Centre de recherche des hydrocarbures Firi, Albania*

The impact of environmental perturbations produced during the mid-Cretaceous Oceanic Anoxic Events (OAEs) is of great interest to Palaeoceanography. Moreover, micropaleontological and chemostratigraphical proxies offer new research perspectives towards improved understanding of the paleoceanographic changes which took place during these intervals of major perturbation of the carbon cycle.

In order to assess the record of mid-Cretaceous OAEs in the Ionian zone of Albania we studied the so called « upper siliceous zone » of the Sopoti section, at the top of Mali Gjere mountain. The studied interval records a major change in lithology from pelagic carbonates to siliceous shales and marls and can be subdivided into two distinct horizons.

Radiolarian biostratigraphy suggests that the two siliceous horizons accumulated during the early Aptian and latest Aptian-early Albian, respectively. Dinoflagellates identified in *ca.* 1 m-thick black shales present towards the top of the upper siliceous horizon suggest an earlyAlbian age. Chemostratigraphic correlation of the carbon isotope curve established at Sopoti with other Tethyan sections (La Bédoule section, SE France; Cismon and Piobicco sections, Italy) is used to refine the chronostratigraphic framework. Based on the above integrated stratigraphic data and the presence of abundant organic matter (up to 7 % TOC), the lower siliceous horizon can be correlated with the Fourcade, Selli and Goguel levels of Greece, Italy and France, respectively. It can be therefore regarded as the expression of the globally known OAE1a. In the same way, the lower Albian black shales at the top of the upper siliceous horizon can be considered as the expression of the OAE 1b.

In parallel with the above stratigraphic studies, the radiolarian record was also used as a proxy to assess biotic changes (i.e. evolutionary trends, blooms of particular ecological groups) which might be due to palaeoenvironmental perturbations associated with the OAEs. Particular attention was paid on the evolutionary trends and relative abundance of two genera, namely *Dictyomitra* and *Thanarla*, both part of the family Archaeodictyomitridae. Based on the newly studied material and a phenetic analysis of all morphospecies previously assigned to the above two genera we test the currently available phylogenetic trees. Phenetic analysis was subsequently used as a guide for a new stratophenetic proposition.

In this way, a major bioevent is revealed within the lower part (latest Aptian) of the upper siliceous horizon, which greatly increased both the diversity and abundance of the above two radiolarian genera. Our data suggest that Archaeodictyomitrid diversification, and associated blooms, took place before the set up of OAE 1b and might be due to currently unspecified palaeoenvironmental perturbations, as suggested by some important shifts in geochemical proxies.

CHANGES IN THE LATEST KIMMERIDGIAN-MIDDLE VOLGIAN MOLLUSCAN FAUNAS OF THE RUSSIAN PLATFORM AND SIBERIA VERSUS SEA LEVEL CHANGE, PALEOCLIMATE AND REGIONAL TECTONIC PATTERNS

ROGOV M.A.
Geological Institute of RAS (Moscow, Russia)

Development of the marine faunas and their composition depends from the some external cases. Major factors, restricted distribution of the modern molluscs, are food (especially for the recent Cephalopods), temperature, salinity, currents and existing of the geographical barriers. Ammonite assemblages of the studied ages and areas reveal few sharp shifts reflecting changes in the eustasy, palaeoclimate and regional tectonics. Biostratigraphy of the Lower Volgian recently have been reviewed by the author (Rogov 2002), but without special regards to the relatively change in the ammonite faunas and climate. Faunas of the latest Kimmeridgian – earliest Volgian (till *efimovi* hemera) of the Russian platform (RP) show a major role of the ammonites with Mediterranean affinities (mainly oppeliids) attaining a maximum in the *steraspis-solenoides* level (up to 80% of the whole assemblage). Close ammonite assemblages recently described from Poland by Kutek & Zeiss (1997). Perhaps a big amount of the Mediterranean ammonites on the RP may be connected with superimposed influences of the both Polish and Caucasian Basins. During the Sokolovi Chron and Pseudoscythica Subchron, conversely, Subboreal/Boreal ammonites were predominating. New mass migration of the Mediterranean ammonites (mainly aspidoceratids, up to 60% of the whole assemblage) marked in the *neoburgense* hemera. This event fixed in the RP on account of Tethyan transgression from Caucasus during sea-level highstand in the Semiforme Chron (mentioned in the Tethyan areas by Schweigert et al. 2002). Since the *puschi* hemera only solitary Miditerranean/Submediterranean ammonites penetrated into the RP. Ammonite assemblages of the Siberia (East Taimyr, Subpolar Ural) reveal strong Arctic influence: only Arctic ammonites occur in the Taimyr since *taimyrensis* Chron (latest Kimmeridgian) and in the Subpolar Ural – since *subcrassum* Chron (lowermost Volgian).

Shifts in the ammonite assemblages reflected eustasy and palaeotemperature changes only until end of the Panderi Chron on the RP. Sea-level highstand as well as high temperature measured on the belemnite rostra in the Middle Volgian of the Siberia and RP (Sahagian et al. 1996) accompanied by the absence of the "heat-loving" ammonites. Although palaeotemperature determinations based upon belemnite guards from the silty sand horizons of Middle Volgian (RP) due to high Fe and Mn values indicative of diagenetic alteration, are not accurate (Ruffel et al. 2002), climate warming during the Middle and Late Volgian supported by the independent data. Palaeotemperature maximum in these levels fixed in the other north areas – in the North Sea (Abbink et al. 2001, spore-pollen data) and Greenland Norvegian Sea (Swientek 2002, isotopes of the belemnite rostra and bivalves) and in the RP confirm with distribution of clay minerals (Ruffell et al. 2002).

Only during the episodes of the existence of seaways ammonite assemblages reflected palaeotemperature changes and eustasy (including direction of the transgressions). Ammonite faunas, respectively, are a good tool for the determination of the tectonic events. Seaway connecting RP and Siberian basins via Ural perhaps vanished in the earliest Volgian; penetrations of the Sphinctoceras into the RP during the Sokolovi Chron already connected with Pechora strait. Ammonite exchanges between Caucasian and RP basins abruptly decreased in the beginning of *puschi* hemera and ceased close to end of Panderi Chron. Plausible reason of this event probably was extensive evaporate deposition during the Middle-Late Volgian in the Caspian region mentioned by Baraboshkin (1999).

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SIGNATURE OF THE CLIMATIC CHANGES IN THE AMMONITE AND SPORE-POLLEN ASSEMBLAGES AND THEIR COMPARISON WITH PALAEOTEMPERATURE DATA FROM THE LATE CALLOVIAN TILL EARLY OXFORDIAN

ROGOV M.A. & KISELEV D.N.

Callovian/Oxfordian boundary throughout in the Northern Hemisphere is characterized by the sharp change in the ammonite assemblages called "Boreal Spread" since Arkell (1956). This migration event, as a rule, connected by the researchers with the Boreal transgression and succeeding fall of the average annual temperature in the epicontinental seas of Europe. Now we have a much data about faunal changes in this level as well as few publications devoted to the temperature measurements on the belemnite rostra, reflecting alterations in the sea environments, while spore-pollen assemblages reveals changes in the terrestrial conditions. In spite of the difficulties of the methods, their comparison by the example of the Callovian-Oxfordian transition in the Europe reveals the coincidence of the main tendencies. Isotope ratios on the belemnite rostra for this level yet have been studied only for Russia (Riboilleau et al. 1998; Barskov, Kijashko 2000) and shows sharp fall of the mean temperature (fig.). After changes in the spore-pollen assemblages (Smirnova et al. 1999; Abbink et al. 2001) the climate reached its relatively coolest and most humid conditions in the Late Callovian–Early Oxfordian interval. Ammonite spectra investigated here mostly have been recorded from the France and adjacent areas by the Dr. D. Marchand and his collaborators, partially from Germany (Pappler et al. 1982) and comprise data obtained by ourselves through the studying in the few sections in the Central Russia. During the Lamberti Zone and lowermost Oxfordian, as a rule, quick increase of the ratios of the Boreal ammonites (Cardioceratidae) is observed throughout from the Saratov Volga area till SE France. Fluctuations within Lamberti Zone ("warming" in the *mojarowskii* horizon from the vicinity of the Saratov) fixed only in the some sections and probable connected with the local forces (warm currents). Peak of the abundance of Boreal ammonoids shift from the *lamberti* horizon (local events) till uppermost Scarburgense Subzone with a common maximum in the *scarburgense* horizon. Intensity of the faunal changes attains the highest magnitude in the Subboreal areas. In the southernmost (SE France) and northernmost (North of the Central Russia) sections peaks are less expressional.

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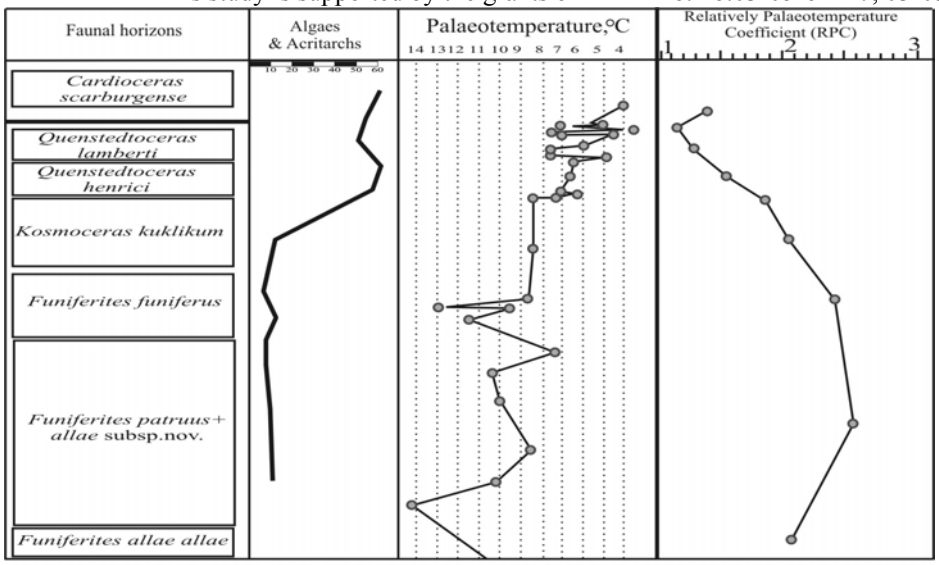

Relatively Palaeotemperature Coefficient (RPC), from Kiselev (1998) with some changes: 1xB+2xSb+3xSt/100 (B – Boreal ammonites, %; Sb – Subboreal ammonites (%), St – Subtethyan ammonites (%)

Fig. Changes in the spore-pollen & ammonite assemblages reflecting palaeotemperature measured on belemnite rostra in the Mikhailov site (Ryazan area, Russia); data about pore-pollen assemblages obtained from Smirnova et al., 1998; about palaeotemperatures – from Barskov, Kijashko 2000.

MIGRATION AND EVOLUTION OF EARLY CRETACEOUS PLANKTONIC FORAMINIFERA IN THE BOREAL REALM

RÜCKHEIM, S., BORNEMANN, A. & MUTTERLOSE, J.
Institut für Geologie, Mineralogie und Geophysik, Ruhr-Universität Bochum, Universitätsstr. 150, 44801 Bochum.
E-mail: sylvia.rueckheim@ruhr-uni-bochum.de

First planktonic foraminifera have been described from low-latitudinal sections of Early Jurassic age. This group experienced a first radiation in the Early Cretaceous, when they become widely distributed. From the Boreal Realm they are known since the Barremian. In order to investigate migration patterns and the evolution of planktonic foraminifera in the Boreal Realm three sections from NW Europe (Rethmar section, Gott section, BGS Borehole 81/40) covering sediments of Barremian to Albian age have been studied.
A revised stratigraphy based on planktonic foraminifera and calcareous nannofossils of the BGS Borehole 81/40 (Central North Sea Basin) was developed. According to this stratigraphy the first occurrence of planktonic foraminifera in the North Sea Basin was unequivocally dated as Early Barremian. In NW Germany the first specimens appeared during the Fischschiefer event (OAE 1a). It is proposed that planktonic foraminifera migrated from the Tethys via an open seaway west of England and south of Scotland towards the Boreal Realm.
Planktonic foraminifera occur only in low abundances in Barremian sediments of the North Sea Basin and lowest Aptian sediments of the Lower Saxony Basin. These early assemblages are characterized by low absolute abundances and diversities. From the Early Aptian onwards the assemblages show higher absolute abundances and diversities. This suggests optimized conditions for planktonic foraminifera in the Boreal Realm. The planktonic foraminiferal assemblages of both the North Sea Basin and the Lower Saxony Basin are dominated by small sized trochospiral and opportunistic hedbergellids. The episodical occurrence of planispiral specimens of *Globigerinelloides*, *Leupoldina* and *Ticinella* let us assume that different phases of water mass exchange between the Tethys and Boreal Realm took place during the Barremian to Albian interval.

THE SENONIAN – EOCENE OF NAPPES DOMAIN IN NORTHERN TUNISIA, SYNOROGENES DEPOSITS

JALILA SAADI[1], FAOUZI DAHA[2], DALILA TURKI[3], ZEINEB AMRI[3] & JOSEPH SALAJ[4]
1, INRST, BP.95. Hammam lif. 2050.Tunisia. email: saadi.jalila @inrst.rnrt.tn;2, ONM, Charguia, Tunis, Tunisie. 3, Faculté des Sciences, El Manar, Tunis Tunisie.4,

The sedimentologic study of carbonated series, from Senonian to Eocene, at the Fernana - Ain Draham area (Northern of Tunisia) improves paleogeography and understanding of internal domains of the Magrebine Chain. Named Mogod and Kroumirie, the studied domain is situated at the northwest part of Tunisia, close to Algerian frontier, and corresponds to the internal Tellian domain of the Alpine Chain.

Major objectives of this work are to describe type of deposits in syntectonic basins created by progressive deformation in an accretionary wedge. On the other side, this work try to elucidate complex structural zones by news stratigraphics results, as a relationship between Ediss / Adissa / Atafa Units and the "autochthone" and "paraautochtone" sensu Rouvier (1985). The comparison between stratigraphic logs studied at the autochtone, paraautochtone, Ediss Unit and Ain draham - Adissa Unit (*sensu* Rouvier 1985) and the stratigraphic's revision support in general these structural units, with news results.

***Senonian*:** The Adissa/Ain draham unit corresponds to the distal domain of the basin and are represented by thin slumped limestones turbidites (late Campanian to Maastrichtian). The autochtone/paraautochtone and Ediss unit correspond to the proximal globally hemipelagic carbonated slope deposits (entirely Campanian in age). The Maastrichtian-Paleocene is represented by a large olistostrom series (over 1000 m in thickness), showing lateral grading of olistoliths from north to south.

***Eocene (Ypresian)*:** We distinguish three major domains: Adissa/Ain Draham unit, Ediss/Kasseb unit and autochtone/paraautochtone unit corresponding respectively to distal basin (thin slumped limestones turbidites), hemipelagic slope and an isolated carbonated shelf.
A better knowledge of paleogeography of Campanian and Ypresian reservoir in the fold /thrust belt of the Magrebine chain in northern of Tunisia.

CLIMATIC VARIATIONS AROUND THE JURASSIC/CRETACEOUS BOUNDARY : COMPARING PALYNOLOGICAL, MINERALOGICAL AND GEOCHEMICAL DATA, FROM ENGLAND TO TUNISIA

JOHANN SCHNYDER (1,2), FRANÇOIS BAUDIN (2), JEAN-FRANCOIS DECONINCK (3), LAURENT EMMANUEL (2), BRUNO GALBRUN (2), ROGER JAN DU CHENE (2), LAURENT LAMBERT (4), MOHAMMED SOUSSI (5)

1 : Université de Lille 1, Sciences de la Terre, Bât. SN5, Processus et Bilans des Domaines Sédimentaires, FRE 2255 CNRS, 59655 Villeneuve d'Ascq Cedex, France

2 : Université Pierre et Marie Curie, Paris 6, laboratoire de Stratigraphie, FR 32 CNRS, Case 117, 4 pl. Jussieu, 75252 Paris Cedex 05, France

3 : Université de Rouen, Laboratoire de Géologie
UMR 6143 CNRS, 76821 Mont Saint Aignan, France

4 : Université de Bourgogne, Centre des Sciences de la Terre UMR 5561 CNRS
Biogéosciences, 6 bd Gabriel 21000 Dijon, France

5 : Faculté des Sciences de Sfax, route de la Soukra, km 35, 3018, Sfax, Tunisie

e-mail : schnyder@ccr.jussieu.fr

A large-scale climatic change is known in Europe at the J/K boundary, where a wet phase begining at the late Jurassic (Tithonian) is replaced by a more humid phase at the dawn of the Cretaceous (middle/late Berriasian). The wet phase is associated with a large-scale sea-level fall, leading to the deposit of the so-called regressive purbeckian facies in Europe, and the more humid phase is associated with a sea-level rise, recorded both in shallow settings (e.g. purbeckian facies of England) and basin settings (e.g. Vocontian Trough facies of France). This climatic pattern has also been recently identified on the russian platform.

In this study, we use palynological (relative proportions of the pollens *Classopollis*) as well as mineralogical (clay minerals) data in the purbeckian facies of England and France in order to compare the climatic record of the two countries. In the basinal facies of the Vocontian Trough in France, in the northern margin of the Tethys, we use clay minerals and trace elements in carbonates as a proxy of detrital input linked to the more humid conditions. Comparison with available carbon-isotope curves in the studied sections show a coincident shift of kaolinite in the clay fraction, trace elements (Mn, Sr, Fe) and a positive carbon-isotope inflexion during the middle/late Berriasian. This pattern is also recorded in a pelagic section of Spain (Sierra de Fontcalent). The kaolinite shift recording the onset of the more humid phase has also been observed in Tunisia, on the southern margin of the Tethys, during a sea-level rise, contemporary with the sea-level rise observed on the northern margin of Tethys, using available biostratigraphic data.

A GEOCHEMICAL AND FORAMINIFERAL COMPARISON BETWEEN THE OAE1A AND OAE2 FROM THE HYBLA FORMATION AT CALABIANCA, NW SICILY, ITALY

G. SCOPELLITI (1*), A. BELLANCA (1), R. NERI (1), R. COCCIONI (2), V. LUCIANI (3), F. BAUDIN (4)

*(1) Dipartimento di Chimica e Fisica della Terra e Applicazioni alle Georisorse e ai Rischi Naturali (CFTA), Università di Palermo, Via Archirafi 36, 90123-Palermo, ltaly, (2) Istituto di Geologia, Universita' degli Studi, Campus Scientifico, Localita' Crocicchia, I-61029 Urbino, Italy, (3) Dipartimento di Scienze della Terra, Università di Ferrara, Corso Ercole I D'este 32, 44100-Ferrara, ltaly, (4) CNRS-FR 32, Département de Géologie Sédimentaire, Université P. et M. Curie, 4 Place Jussieu, 75252 Paris Cedex, France. *(giovanna-s@libero.it).*

Oceanic Anoxic Events (OAEs), whatever their exact nature and cause, were thought to promote deposition of coeval C_{org}-rich sediments across different environments ranging from deep oceans to shelf seas. Among the black-shale events, identified both on land and in oceans, two major organic-rich horizons, one dated as late early Aptian (Selli Level, SL: OAE1a), the other belonging to the latest Cenomanian (Bonarelli Level, BL: OAE2), have proven to be of global distribution. In this study, we propose a comparison between geochemical and foraminiferal features of this two organic-rich levels peculiarly exposed along one, even if not continuous, section (Calabianca, NW Sicily, Italy). The SL equivalent is about 0.7 m thick, is composed of black shales characterized by moderate to intense bioturbation, and shows TOC values up to 4%. The BL equivalent is about 1.5 m thick, consists of cm-thick couplets of radiolarian cherts or cherty mudstones and black shales, and exhibits higher TOC values reaching up to 26%. Both OAE1a and OAE2 are generally interpreted as high surface productivity episodes and concurrent excess global carbon burial that are illustrated by distinct positive carbon-isotope excursions. In the $\delta^{13}C$ record of the SL equivalent a pronounced negative excursion immediately predates the positive shift, which is interpreted as due to dissociation of methane hydrates related to Ontong Java and Manihiki Plateaus formation (Bellanca et al., 2002). Following this interpretation submarine volcanism is though to influence global climate, ocean chemistry and nutrient availability. As to the BL equivalent, the enhanced productivity may have been triggered by changes in ocean circulation and water column structure rather than volcanic activity. However, plateau volcanism at 93-90 Ma is recorded from the Pacific and Caribbean plate and may also be implicated in the genesis of this event; in this case, a potential negative $\delta^{13}C$ excursion could have been obliterated by other processes, such as a steady rise in global carbon burial rates during the late Cenomanian. Consistently, the enhanced productivity is more marked in the BL equivalent (presence of radiolarian-rich levels, relatively higher Ca/Al, Si/Al ratios, and P_2O_5 concentrations) than in the SL equivalent. The Ba/Al depth-profiles show a generally increase in SL equivalent with respect to the overlying and underlying sediments; on the contrary, this ratio exhibits lower values in BL equivalent. This different behaviour is probably due to a diagenetic mobilization of Ba in the sulphate reduction zone, which is consistent with very high V/(V+Ni) ratios indicative of significant presence of H_2S in the water column.

Planktonic and benthic foraminifera, which are greatly sensitive to chemical-physical parameters and readily preserved, record shifting patterns of species diversity, dominance, abundance, and size which testify the response to the progressive and rapid deterioration of the environmental conditions, reaching the climax in coincidence with the Selli and Bonarelli Events. These changes show that the intensity of environmental perturbation was much stronger during the deposition of the BL equivalent than the SL equivalent. Furthermore, the features of the foraminiferal assemblages indicate less extreme environmental conditions during the deposition of the SL and

BL equivalents of the Calabianca section in comparison with analogous levels of the Umbria-Marche Basin type area.
In a previous work, Scopelliti et al. (2003), applying power-spectral analysis to the Ca/Al ratio of the BL equivalent in the same section, have recognized cyclicity induced by periodic orbital-climatic cycles and proposed for this event a duration of 350±20 ky with a sedimentation rate of 3.5-4.0 m/Myr. For the SL equivalent the application of the same analysis allows us to find similar cyclicities by which it is possible to calculate a duration of 250±20 ky and a sedimentation rate of 2.8-3.0 m/Myr. The last value is not much greater of that found, on a biostratigraphic base, for the interval preceding the SL equivalent of Calabianca by Bellanca et al. (2002).

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MID-CRETACEOUS DEPOSITS OF EASTERN CAUCASUS: A CASE OF OCEANIC ANOXIC EVENTS

EKATERINA A. SHCHERBININA, YURI O. GAVRILOV
Geological Institute of Russian Academy of Sciences, Moscow, Russia

In the mid-Cretaceous, the Great Caucasian underwent subsidence and became the deepest part of a wide relatively shallow epicontinental basin of northeastern Peri-Tethys, where the most complete sedimentary sequences accumulated. They were composed of calcareous deposits with intervals of sediments rich in organic matter. The most interesting and representative mid-Cretaceous section is exposed in the bank of Khalagork R. (Dagestan) where several intervals correlated to Oceanic Anoxic Events (OAEs) are found. The sequence demonstrates clearly visible three-folded composition: dark marls (upper Aptian-lower upper Albian, nannofossil Zones CC7-CC8), light marls and limestones (upper upper Albian-lower lower Turonian, Zones CC9-CC11), and red limestones (upper lower-middle Turonian, Zone CC12).

The lowermost part of section is made up of dark gray to black thinly laminated marls (18 m of exposed thickness) with discrete intercalations of hard yellowish limestones and contains abundant macrofossil remains (belemnites, inoceramids, ammonites) which shows small and thin shells indicating unfavorable (possibly disoxic) environment. Several intervals with sediments rich in organic matter (up to 2.5%) are found in this sequence: the upper part of nannofossil Zone CC7 (OAE1b, Jacob Level?), lower part of Zone CC8 (OAE1b, Paquier Level?), upper part of Zone CC8 (OAE1c?).

The sharp sedimentological change occurs at the CC8/CC9 boundary (late Albian) when the sediments rich in organic matter give the way to alternation of light marls and limestones (~30 m). Nevertheless, there are isolated intercalations of dark organic carbon- and clay-rich sediment at the lowermost Zone CC9 (OAE1d, Breistroffer Level?) and in the Zone CC10 (OAE2, Bonarelli Level).

The thin (1 cm) bentonite layer separates the uppermost sequence composed of hard pink to dark red limestones (~7 m) of CC12 Zone (Turonian) which form a distinct bench in relief.

Nannofossils of this section are not very various and shows rather poor preservation. *Watznaueria* spp. (with high predominance of *W. barnesiae*), which is believed to be low fertility taxa, consists more than 40% of nannofossil assemblage reaching maximal contents (up to 90%) in the light and red limestones underwent hard diagenetic alternation, where only this diagenetically resistant taxon could be preserved. The increase in content of "high fertility group" (*Biscutum, Zeugrhabdotus, Eprolithus,* and *Parhabdolithus* with high predominance of the latter), is marked toward the top of dark-colored sequence with maxima (up to 50%) within organic carbon-rich intervals, but they progressively decline within light-colored sequence coincidentally with increasing of nannofossil variety. This proves the euthrophic conditions of the basin in course of OAE1, but it is not the case of OAE2, when nannofossil total abundance and the content of "high fertility group" decrease. The peak of *Parhabdolithus* spp. in the top of dark sequence evidently attests the temperature optimum in the basin in the early late Albian.

As a whole, the mid-Cretaceous sediments of Eastern Caucasus are characterized by clear rhythmicity caused by both Milankovich and eustatic cycles. In addition, uneven tectonic subsidence controlled the formation of long-term sedimentary cycles.

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THE LATE VALANGINIAN CARBON ISOTOPE EVENT: A HIGH-RESOLUTION MULTIPROXY STUDY

MARIO SPROVIERI[1], RODOLFO COCCIONI[2] & FABRIZIO LIRER[1]
[1]*IAMC-Geomare (CNR), Naples, Italy*
[2]*Istituto di Geologia e Centro di Geobiologia dell'Università*
Campus Scientifico, Urbino, Italy

The aim of this presentation is to show the preliminary results of an international project focused to a high resolution multidisciplinary study of a Cretaceous pelagic composite record from the Umbria-Marche Basin. Several papers have provided a high-resolution planktonic foraminiferal and calcareous nannofossil bio- and magnetostratigraphy for the whole sedimentary records exposed in this area, and a detailed chronostratigraphic model for the entire Cretaceous. The integration of this huge data set with a new high-resolution stable isotope stratigraphy may provide an unique opportunity to produce a most accurate Cretaceous stratigraphic framework and new insights on the palaeoceanographic events that punctuated this time interval within the Tethyan region.

This abstract is focused on the results of bulk sample carbon isotopes of the Berriasian-Hauterivian 250 m-thick limestone sedimentary sequence of the Maiolica Formation exposed throughout the Chiaserna-Monte Acuto section (near Cagli, Central Italy) combined with integrated (ammonites, calcareous nannofossils, planktonic foraminifera, and radiolarians) biostratigraphy and palaeomagnetic data.

High-frequency sampling rate (about 1 sample/0.5 m, corresponding to an average time periodicity of 23 ky) allowed us to well-define the timing of the known ~2‰ Valanginian positive carbon isotope excursion and to verify the reliability of the proposed hypothesis of an "greenhouse" effect during the early Cretaceous. Comparison with available carbon isotope data collected from the Tethyan region and DSDP Sites confirmed the synchronicity of this episode and the usefulness for large-scale stratigraphic correlations. However, the high-resolution analysis of our sedimentary record enabled us a most accurate description of the carbon isotope event characterised by high-frequency fluctuations superimposed on the already known long-term positive excursion. In particular, we have subdivided the $\delta^{13}C$ positive shift in four discrete intervals characterised by well-distinct average carbon isotope values, possibly corresponding to different palaeoceanographic response to global forcing. Spectral analysis performed on the carbon isotope record and based on a reliable time-framework has highlighted the presence of a high-frequency response modulating the studied signal (range $\delta^{13}C$ of variability ~0.5‰) of and responding to long-term and, possibly, short-term eccentricity orbital cyclicity. Finally, palaeoceanographic mechanisms to explain orbital scale modulation of the ocean-atmosphere CO_2 cycle during the early Cretaceous are proposed.

BIOTIC RESPONSE OF CALCAREOUS NANNOFOSSILS TO PALAEOCEANOGRAPHIC CHANGES IN THE LAST 300 K.Y OF THE MAASTRICHTIAN . ANALYSIS OF THE BJALA SECTION (EASTERN BULGARIA)

NICOLAS THIBAULT[1], SILVIA GARDIN[1], BRUNO GALBRUN[1], THIERRY ADATTE[2], GERTA KELLER[3]

[1] *FR32, Laboratoire de Micropaléontologie, case 104, Université Pierre et Marie Curie, 4 Place Jussieu, 75252 Paris cedex 05, France, nithibau@ccr.jussieu.fr, gardin@ccr.jussieu.fr, bgalbrun@ccr.jussieu.fr*

[2] *Institut de Géologie, Université Neuchâtel, CH-2007 Neuchâtel, Switzerland, thierry.adatte@unine.ch*

[3] *Department of Geosciences, Princeton University, Princeton, New Jersey 08544, USA, gkeller@princeton.edu*

A detailed paleoecological analysis of calcareous nannofossils was performed on the Bjala section (Eastern Bulgaria), spanning from the last 300 k.y of the Maastrichtian (zone CC 26b) to the Early Danian (zone NP1).

Calcareous nannofossil assemblages are moderately rich (40 to 50 species) and characteristic of low to middle latitude; preservation is moderate to poor. In order to outline paleoecological features of calcareous nannofossil species during Late Maastrichtian, both absolute and relative abundances were determined.

Three peculiar trends were observed all along the studied section : 1) a marked decrease of *Z. spiralis* in the upper part of the section, which could suggest low productivity conditions (Eshet and Almogi-Labin, 1996), 2) a strong increase of high dissolution-resistant form *M. decussata*, 3) a decrease in the total abundance of calcareous nannofossils.

High abundances of *M. decussata* were observed in several Upper Maastrichtian sites and can be related both to preservation and the onset of stressful conditions. Our data show an inverse correlation between absolute abundances of *M. decussata* and calcite ratio. This might suggest that the main part of the calcite is of diagenetic origin, corresponding to the CaCO3 recrystallization of dissolved nannofossils and being *M. decussata* the main carbonate producer during the latest Maastrichtian.

A statistical analysis was performed on calcareous nannofossil assemblages (cluster analysis with Ward's method). Three groups of samples, corresponding to three distinct stratigraphic intervals, can be distinguished. The comparison of these data with clay mineralogy (Adatte et al., 2002) shows that the first two intervals can be related to climatic events while the third one corresponds to the maximum of carbonate dissolution below the K-T boundary.

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CONTROLS ON ORGANIC ACCUMULATION IN LATE JURASSIC SHALES OF NORTHWESTERN EUROPE AS INFERRED FROM TRACE-METAL GEOCHEMISTRY

N. TRIBOVILLARD [a] , A. RAMDANI [b] ; A. RIBOULLEAU [a] & F. BAUDIN [c]

[a] *Université Lille 1 & CNRS UMR 8110-FR 1818, Sciences de la Terre, bâtiment SN5, 59655 Villeneuve d'Ascq cedex (France)*

[b] *Université Paris Sud-Orsay, Sciences de la Terre, 91405 Orsay cedex (France)*

[c] *Université Pierre et Marie Curie & CNRS FR 32, 4 place Jussieu 75252 Paris cedex (France)*

In the Kimmeridge Clay Formation of the Wessex-Weald Basin, five organic-matter-rich intervals (or ORIs), dated from Kimmeridgian-Tithonian times, can be correlated from distal depositional environments in Dorset and Yorkshire (UK) to the proximal environments in Boulonnais, Northern France. The ORIs are superimposed on a meter-scale cyclic distribution of organic matter (OM), referred to as primary cyclicity, which is commonly interpreted to result from Milankovitch climate forcing. The present work addresses the distribution of redox-sensitive and/or sulfide-forming trace metals and selected major elements (Si, Al and Fe) in Kimmeridge Clay shales from the Cleveland Basin (Yorkshire) and the Boulonnais cliffs with two objectives: 1) to determine whether the ORIs formed in similar palaeoenvironments, and 2) to identify the mechanism(s) of OM accumulation. High-resolution geochemical data from primary cycles in the Yorkshire boreholes (Marton and Ebberstone boreholes), were studied and the results are then applied with lower resolution sampling at the ORI scale in the Flixton borehole and Boulonnais cliff.

Good correlations are found between total organic carbon (TOC) vs. Cu/Al and Ni/Al, but relationships between TOC and Mo/Al, V/Al and U/Al are more complex. Cu and Ni enrichment is interpreted to have resulted from passive accumulation with OM in an oxygen-deficient basinal setting, which prevented the subsequent loss of Cu and Ni from the sediment. Mo and V were significantly enriched only in sediments where considerable amounts of OM (TOC>7%) accumulated, the result of strongly reducing conditions and OM burial. At the scale of the Flixton ORIs, the samples with the highest Mo and V concentrations also show relative Fe enrichment, suggesting pyrite formation in the water column (combination of euxinic conditions and presumably low sedimentation rates). Samples from all ORIs were slightly enriched in Si relative to Al, interpreted as reflecting decreased sediment flux during transgressive and early-highstand systems tracts.

The data show that in some ORIs, OM accumulation proceeded while productivity was not particularly high and sediments were not experiencing strong anoxia. In other ORIs, OM accumulation was accompanied by widespread anoxia and possibly euxinic conditions in distal settings. Though somewhat different from each other, the ORIs have all developed during episodes of reduced terrigeneous supply (transgressive episodes). The common feature linking these contrasted episodes of enhanced OM storage (ORIs) must be the conjunction of productivity coupled with a decrease in the dilution effect by the land-derived supply, in a depositional environment prone to water stratification and, therefore, favorable to OM preservation and accumulation.

THE OCEANIC ANOXIC EVENT (OAE) 1B IN THE IONIAN BASIN, NW GREECE: ORGANIC GEOCHEMICAL EVIDENCE

TSIKOS, H.[1], KARAKITSIOS, V.[2], BOMBARDIERE, L.[3], VAN BREUGEL, Y.[4], SINNINGHE-DAMSTÉ, J.[4], SCHOUTEN, S.[4], FARRIMOND, P.[3], TYSON, R.V.[3], & JENKYNS, H.C.[1]

[1]Department of Earth Sciences, University of Oxford, Parks Road, Oxford OX1 3PR, UNITED KINGDOM
[2]Department of Geology, National University of Athens, Panepistimiopolis 15784, Athens, GREECE
[3]Newcastle Research Group in Fossil Fuels & Environmental Geochemistry (NRG), University of Newcastle upon Tyne, Newcastle NE1 7RU, UNITED KINGDOM
[4]Department of Marine Biogeochemistry & Toxicology, Royal Netherlands Institute of Sea Research (NIOZ), 1790 AB Den Burg, THE NETHERLANDS

The Lower Cretaceous Vigla Formation in the Ionian zone of NW Greece comprises a thick succession of pelagic carbonate rocks, and is host to a series of organic matter-rich marlstones and shales (Vigla shale member) spanning the Albian-Cenomanian. We examined a suitable outcrop section in the Gotzikas area of NW Epirus, Greece, containing at least 20 dm-thick, organic-rich calcareous mudstones and shales enclosed in partially silicified Vigla limestone. Samples were collected on a cm- to dm-scale in the lower part of the section where organic-rich intervals are most abundant, and on a metre-scale in the uppermost portion. All samples were analyzed for bulk carbonate/organic carbon stable-isotope (C,O) ratios, whereas a more detailed organic geochemical study on bulk and solvent-extractable organic matter was conducted on a representative suite of ten organic-rich samples across the section.

Bulk organic carbon (TOC, 1 to 6 wt%), Hydrogen Index (HI, mean: 321 mg/g) and $\delta^{13}C_{TOC}$ (–26.5±1.0‰) data show little variation across the lower part of the Gotzikas section. Particulate organic matter composition is dominated by amorphous fluorescent particles (more than 80%) and minor percentages of dinoflagellates and woody particles. A sharp positive shift in $\delta^{13}C_{TOC}$ by approximately 4.5 per mil is observed in the uppermost black-shale unit (-22.1‰), which also has the highest TOC content (28.9 wt%) and HI (529 mg/g) and is most enriched in amorphous organic matter. T_{max} values (400-425 °C) and C_{31} 17α,21β(H) hopane ratios 22[(S/(S+R)] (0.50-0.55) indicate a level of thermal maturity just below the oil-window.

Saturated, apolar lipid fractions show essentially identical composition for all but the uppermost samples of the Vigla shales, comprising mixtures of *n*-alkanes, isoprenoids, steranes, hopanes and to a lesser extent alkylated benzothiophenes and napthalenes. The uppermost, TOC-enriched and isotopically heaviest black-shale sample contains, in addition to the aforementioned compounds, significantly elevated concentrations of cyclic isoprenoids. Compound-specific $\delta^{13}C$ values for nor-pristane, pristane and phytane show a marked increase of ca. 10 ‰ from the lower organic-rich samples (-30 to -32‰) to the uppermost black shale (-19 to –22‰), whereas no such change is observed with respect to the $\delta^{13}C$ values of steranes and hopanes. In addition, cyclic isoprenoid $\delta^{13}C$ values are also particularly high (up to -16‰), indicating derivation from an archaeal source. On these grounds, the uppermost Vigla black-shale shares important similarities, both compositionally and isotopically, with lower Albian black shales from site ODP 1049C (North Atlantic) and the Vocontian basin of SE France ("Niveau Paquier"). We therefore conclude that at least the uppermost part of the Vigla shale member constitutes a new manifestation of the Oceanic Anoxic Event (OAE) 1b, whose sedimentary record is best developed in the Tethys-Atlantic region.

APPORT D'UNE TECHNIQUE DE MICRO-FILTRATION À LA CARACTÉRISATION DE LA MICRO ET NANNO-BIOPRODUCTION CARBONATÉE OCÉANIQUE : LE TRANSECT DU GREAT BAHAMA BANK (ODP LEG 166).

MÉLANIE TURPIN, FABRICE MINOLETTI, LAURENT EMMANUEL, MARC DE RAFELIS ET MAURICE RENARD.
Université Paris VI, Département de Géologie des Bassins Sédimentaires, 4 Place Jussieu, 75252 Paris cedex 05.

L'interprétation et la quantification de la sédimentation carbonatée océanique fine (micrites constituées de micro- et de nanno-particules) restent un des problèmes majeurs dans l'élaboration des bilans sédimentaires au cours des temps. Ce problème est primordial dans les bassins profonds où il est particulièrement important de faire la part entre la production pélagique *in situ* et l'exportation de boues depuis les zones de plates-formes (boues péri plates-formes).
Pour les séries post-Jurassique supérieur, les producteurs carbonatés pélagiques sont connus même si leurs affinités phylogénétiques sont encore souvent floues (part respective des coccolithophoridés, des dinoflagéllés et des « incertae sedis »). S'il est alors possible de les mettre en évidence dans les sédiments, la quantification de leur participation en terme de masse produite reste très incertaine car il est très délicat de reconnaître optiquement leur débris par rapport aux particules fines issues de l'abrasion mécanique ou de la précipitation chimique ou biochimique (whitings, Robbins et Blackwelder, 1992) sur les plates-formes. Certains voient une participation pélagique majoritaire d'autres, au contraire, la tiennent pour anecdotique (Mattioli et Pittet, 2002).

Le but de ce travail est la caractérisation et la quantification des différents types de particules carbonatées fines en essayant de distinguer celles ayant une origine biogène directe, celles ayant une origine biogène indirecte (métabolismes micro-alguaires ou bactériens) et celles tirant leur origine d'une précipitation directe à partir de l'eau de mer. Pour se faire, nous utilisons un protocole expérimental de séparation mis au point dans notre laboratoire (Minoletti *et al*., 2001) qui permet d'obtenir des fractions granulométriques quasiment pures, mono- ou oligo-spécifiques.

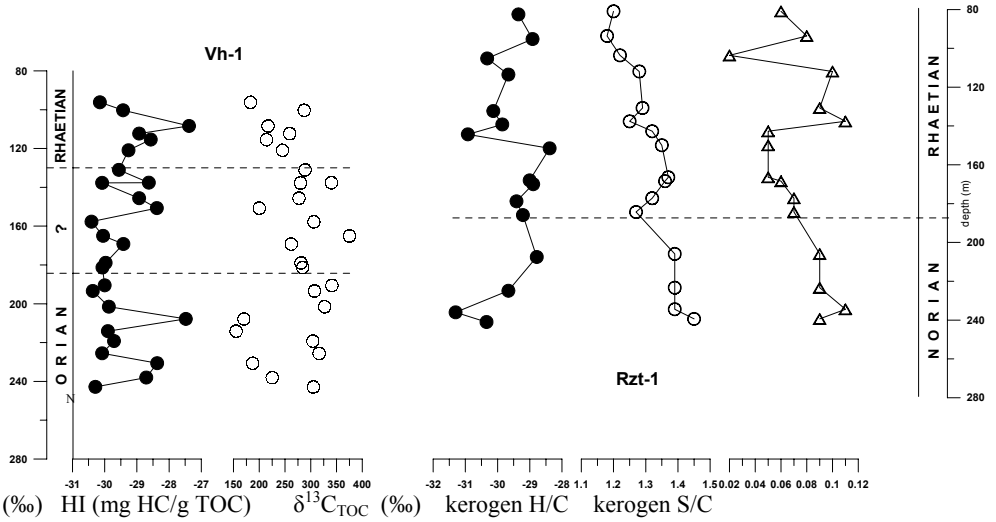
Les résultats présentés ici sont issus d'un transect : le haut-fond carbonaté d'environnement chaud des Bahamas. Les échantillons proviennent de quatre forages disposés sur la pente suivant un gradient proximal-distal et se situent aux alentours du réflecteur K (Miocène moyen) identifié sur un profil sismique (Eberli *et al*., 1997). Le choix des échantillons, à l'intérieur de l'intervalle stratigraphique étudié, est effectué sur la base de corrélations géochimiques (Emmanuel *et al*., 1999).

Dans un second temps, l'étude géochimique et cristallographique des bio-micrites pélagiques de ce transect pourra permettre de faire la part entre une production pélagique stricte et une production d'exportation de type boue péri plates-formes.

THE POSITIVE $\delta^{13}C_{TOC}$ EXCURSION AT THE NORIAN-RHAETIAN BOUNDARY WAS NOT A GLOBAL PHENOMENON

ISTVÁN VETŐ*, MAGDOLNA HETÉNYI**, ZSUZSA SZÁNTÓ***
**Geological Institute of Hungary **University of Szeged, Hungary ***ATOMKI, Debrecen, Hungary*

Recently a positive $\delta^{13}C_{TOC}$ excursion has been reported at the Norian-Rhaetian (NR) boundary from two marine sections. Sephton et al. (2002) suggest that it is a global phenomenon caused by an increase in the global storage of ^{12}C-rich organic matter (OM) in sedimentary rocks. Here the stratigraphic variation of $\delta^{13}C_{TOC}$ from two immature marine carbonate-marl NR boundary sections in Hungary is presented (Fig. 1).



The Vh-1 core section displays four 2 – 2.5 ‰ amplitude positive isotope peaks (Fig. 1). The Hydrogen Index (HI) curve is clearly mirroring the $\delta^{13}C_{TOC}$ curve. This finding suggests that the excursions observed reflect changes in mixing ratio of marine and terrestrial OM and/or degree of bacterial degradation.

No positive isotope peak is displayed in the Rzt-1 core section (Fig. 1). Contrasting with the saw-tooth nature of the Vh-1 isotope curve that of the Rzt-1 core section consists of two upward increasing portions, separated by a 2.5 ‰ drop of the $\delta^{13}C_{TOC}$ at about 40 m above the NR boundary. The upward increasing C-isotope trends are consistent with the upward increase of the terrestrial OM contribution reflected by the upward decrease of the kerogen atomic H/C ratio. Above the drop the $\delta^{13}C_{TOC}$ and the kerogen S/C ratio co-vary. These findings show again the close relationship between organic C-isotope variations and changes in mixing ratio of marine and terrestrial OM and/or degree of bacterial degradation.

The above results do not support the development of a global positive C-isotope excursion at the NR boundary and underscore the importance of analytical technics suitable for characterising origin and bacterial degradation of the OM for the study of the marine C-isotopic disturbances.

Haas 2002 Geologica Carpatica, 53, 159-178., Hetényi et al. 2002 Organic Geochemistry, 33, 1571-1591., Sephton et al. 2002 Geology, 30, 1119-1122.

ORBITAL CONTROL ON THE MID-CENOMANIAN CARBON CYCLE PERTUBATION

SILKE VOIGT, *University of Cologne, silke.voigt@uni-koeln.de*
ANDY GALE, *University of Greenwich, asg@nhm.ac.uk*

The Mid-Cenomanian Event is characterised by a double-spiked 1 ‰ positive $\delta^{13}C$ excursion, but is not associated with widespread oceanic anoxic conditions. The excursion reflects a global signal, is documented from sections in southern England, Italy and the Western Interior Seaway, and coincides with a prominent third-order sea level lowstand and subsequent transgression.
Mid-Cenomanian successions in NW Europe consist of rhythmically bedded chalk-marl alternations, which are orbitally forced by the precession signal. We present high resolution stable isotope records of organic carbon and diagenetic unaltered brachiopod shell calcite from two sections in southern England (Southerham and Folkstone), from where the Mid-Cenomanian Event was first described. Brachiopod $\delta^{18}O$ values show cyclic variations between -1.3 ‰ and -0.3 ‰, and reveal variabilities in the frequencies of precession (20 kyr) and eccentricity (100 kyr), whereby the amplitude of precession related $\delta^{18}O$ variations is highest during times of maximum eccentricity. Two climate cooling pulses (~3 °C) culminate in the *arlesiensis* and the cast beds, both yield a characteristic boreal macroinvertebrate fauna, and reflect maximum climate differences within a single precession cycle. Cenomanian climate modeling results suggest that summer run-off is lowest if the northern hemisphere winter is at perihelion (chalk deposition), whereas higher precipitation and run-off occurred during the remaining orbital conditions. Orbital tuning of the positive carbonate $\delta^{13}C$ excursion shows that its conspiciuos double-spiked shape is forced by the 100 kyr eccentricity cycle. Jumplike $\delta^{13}C$ increases occurred if the earth´s orbit changed from a northern hemisphere winter at perihelion to a spring equinox at perihelion position (*arlesiensis* and cast beds) causing increased release of nutrients and enhanced productivity. The combined consideration of organic and carbonate $\delta^{13}C$ records reveals a complex response of the carbon cycle to orbital forcing. Whereas the first $\delta^{13}C$ step (*arlesiensis* bed) is caused by increased isotopic fractionation between inorganic and organic carbon during low sea level, the second step is controlled by enhanced burial of organic carbon during transgressive sea level. The Mid-Cenomanian Event precede the Cenomanian-Turonian Boundary Event about 2.2 Myrs and similar initial orbital conditions could have also triggered OAE 2.

INDEX AUTEURS

Adresses e-mail des participants

ADATTE Thierry ..... Thierry.Adatte@unine.ch
AMINU Abdallah ..... aminu_a@yahoo.co.uk
AMODIO Sabrina ..... ciclisti@gms01.geomare.na.cnr.it
BARTOLINI Anachiara ..... chiara@ccr.jussieu.fr
BAUDIN François ..... frbaudin@ccr.jussieu.fr
BEAT Louis ..... beat.louis@erdw.ethz.ch
BEAUDOIN Bernard ..... beaudoin@cges.ensmp.fr
BELLANCA Adriana ..... bellanca@unipa.it
BELLIER Jean-Pierre ..... bellier@ccr.jussieu.fr
BELTRAN Cathy ..... beltran@ccr.jussieu.fr
BILLON-BRUYAT Jean-Paul ..... jp.billon@univ-poitiers.fr
BLECHSCHMIDT Ingo ..... blechsch@ruby.unibe.ch
BODEUR Yves ..... Yves.Bodeur@chimie.univ-nantes.fr
BODIN Stéphane ..... stephane.bodin@unine.ch
BORNEMANN André ..... andre.bornemann@rub.de
BRAYARD Arnaud ..... arnaud.brayard@univ-lyon1.fr
COCCIONI Rodolfo ..... cron@info-net.it
COLLETE Claude ..... a.geol.aube@wanadoo.fr
DANELIAN Taniel ..... danelian@ccr.jussieu.fr
DE WEVER Patrick ..... dewever@mnhn.fr
DESMARES Delphine ..... desmares@illite.u-strasbg.fr
DUMITRICA Paulian ..... Paulian.Dumitrica@igp.unil.ch
DZYUBA Oksana S. ..... dzyuba@uiggm.nsc.ru
FERRY Serge ..... serge.ferry@univ-lyon1.fr
FÖLLMI Karl ..... karl.foellmi@unine.ch
FRICOT Claude ..... fricot@wanadoo.fr
FRIEDRICH Oliver ..... oliver.friedrich@uni-tuebingen.de
GASPARD-MARTINCHE Danièle ..... gaspard@geol.u-psud.fr
GAVRILOV Yuri O. ..... gavrilov@geo.tv-sign.ru
GIRAUD Fabienne ..... Fabienne.Giraud@univ-lyon1.fr
GJATA Kadri ..... gjata_k@yahoo.fr
GODET Alexis ..... alexis.godet@unine.ch
GROSHENY Danièle ..... grosheny@illite.u-strasbg.fr
GUIOMAR Myette ..... myette.guiomar@libertysurf.fr
HAMDIDOUCHE Rachid ..... rhamdidouche@yahoo.fr
HERKAT Missoum ..... mherkat@email.com
JENKYNS Hugh ..... hughj@earth.ox.ac.uk
KISELEV D.N. ..... dnkiselev@front.ru
LINDER Pascal ..... pascal.linder@unine.ch
MASURE Edwige ..... edmasure@ccr.jussieu.fr
MATTIOLI Emanuela ..... mattioli@univ-lyon1.fr
MONNET Claude ..... Claude.Monnet@pim.unizh.ch

MORT Haydon P. .....haydon.mort@unine.ch
MOYNE Sébastien .....sebastien.moyne@u-bourgogne.fr
MUSAVU-MOUSSAVOU Benjamin.....bmusavu@ccr.jussieu.fr
MUSKA Ktristaq ..... qkshdirection@red.com.al
MUTTERLOSE Jörg.....Joerg.Mutterlose@ruhr-uni-bochum.de
NEIGE Pascal .....Pascal.Neige@u-bourgogne.fr
NERAUDEAU Didier.....didier.neraudeau@univ-rennes1.fr
NERI Rodolfo .....neri@unipa.it
OGG James .....jogg@purdue.edu
RAIS Pauline .....pauline.rais@erdw.ethz.ch
RAMBEAU Claire .....Claire.Rambeau@unine.ch
RICORDEL Caroline.....carorico@netcourrier.com
ROGOV Mikhail.....mrogov@pisem.net
RUECKHEIM Sylvia .....sylvia.rueckheim@ruhr-uni-bochum.de
SAADI Jalila .....jalila.saadi@inrst.rnrt.tn
SCHNYDER Johann.....schnyder@ccr.jussieu.fr
SCOPELLITI Giovanna .....giovanna-s@libero.it
SHCHERBININA Ekatarina .....shcherbinina@geo.tv-sign.ru
SHURYGIN Boris .....shurygin@uiggm.nsc.ru
SPROVIERI Mario.....sprovier@gms01.geomare.na.cnr.it
THIBAULT Nicolas .....nithibau@ccr.jussieu.fr
THIERRY Jacques .....Jacques.Thierry@u-bourgogne.fr
TRIBOVILLARD Nicolas.....Nicolas.Tribovillard@univ-lille1.fr
TRICHET Jean.....Jean.Trichet@univ-orleans.fr
TSIKOS Harilaos.....Harilaos.Tsikos@earth.ox.ac.uk
TURPIN Mélanie .....mturpin@ccr.jussieu.fr
VETO Istvan.....vetoi@mafi.hu
VOIGT Silke .....silke.voigt@uni-koeln.de
WEISSERT Helmut .....helmut.weissert@erdw.ethz.ch