

## **Microfossils in Stratigraphy**



## **Improving palaeoecological understanding of the Cenomanian units in Lisboa-Sintra region: the S. João das Lampas section**

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The S. João das Lampas section, in Sintra region (Lusitanian Basin, Portugal), exhibits a highly fossiliferous marl-limestone succession, assigned to the Cenomanian and belonging to the Caneças Formation. In this work we present data from ongoing studies on ostracods and microfacies addressing palaeoecological issues within the regional framework. The fossil assemblage comprises ostracods (very abundant, mainly represented by brackish and marine littoral species), benthic foraminifers, dasycladalean and bryopsidalean algae, bivalves, gastropods, serpulids, echinoderm remains. The succession mainly consists of oyster-rich marls and marly limestones, interbedded with skeletal/microfossil rich carbonate and marly layers and skeletal, storm beds or lenses. The whole data point to a low-moderate energy marginal-marine setting with frequent salinity variations.

**Keywords:** Ostracods, Foraminifers, Dasycladales, S. João das Lampas, Cretaceous, Portugal.

## **Miocene dinoflagellate cyst assemblages - preliminary correlation between the Lower Tagus and Algarve Basins (Portugal)**

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Biostratigraphical studies, established in several sections and a borehole (Belverde) of the Lower Tagus Basin, based on Miocene dinoflagellate cyst assemblages, have allowed a detailed stratigraphical investigation. Assemblages are very diverse and abundant and can be used as important biostratigraphical guides. More recently, a palynostratigraphical study based on dinoflagellate cysts was developed in two offshore wells, Ruivo-1 and Corvina, from the Algarve Basin (South of Portugal). The recovered dinoflagellate assemblages are less abundant and diverse than those obtained in the Lower Tagus Basin. New inferences are made regarding the correlation between the dinoflagellate cysts known from the Lower Tagus Basin with the recently recovered assemblages from the Algarve Basin. Species of selected dinoflagellate cyst assemblages recovered are similar in both basins.

Continuing progress within these new palynological studies and biostratigraphical data will help to refine and correlate Portuguese Miocene deposits.

**Keywords:** Dinoflagellate cysts, Lower Tagus Basin, Algarve Basin, Miocene, Portugal.

## **Palynostratigraphical data of the Buntsandstein and Muschelkalk facies from the Iberian Ranges (Spain)**

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This work presents results from the compilation of all published palynological data as well as addition of others unpublished data to propose a unified palynological biozonation for the Buntsandstein and Muschelkalk facies from the Iberian Ranges (Spain).

**Keywords:** Palynostratigraphy, Permian, Triassic, Iberian Ranges.

## **New sedimentological and palynology data of the Permian and Triassic of the Paris Basin, France**

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The aim of the study is to define the depositional environment of the Permian succession within the southwest part of the Paris Basin, from core, well-log and seismic data. A detailed palynological study allows specify precisely the palynological evolution of the Middle-Upper Triassic succession in the Paris Basin.

**Keywords:** Palynostratigraphy, Sedimentology, Permian, Triassic, Paris Basin.

## **Frasnian ostracods of the East European Platform, Russia - biostratigraphic implications**

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The study concerns the ostracod local biozonation and interbasinal correlation of the Frasnian strata within the East European Platform. The biozones are mainly environmentally controlled local assemblage zones. The taxonomic composition and stratigraphic distribution show great similarities that have proved to be useful for intrabasinal correlations.

**Keywords:** Frasnian, ostracods, biostratigraphy, palaeoecology, East European Platform, Russia.

## **Advances on Calcareous Nannofossil biostratigraphy based on Toarcian-Aalenian sections from the Lusitanian Basin (Portugal)**

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Quantitative analyses of Early-Middle Jurassic calcareous nannofossil assemblages from two sections of the Lusitanian Basin (Portugal) were performed for biostratigraphic purposes. This study was carried out on samples spanning from Lower Toarcian to Middle Aalenian strata from the Rabaçal and Cabo Mondego sections. All samples were quantitatively studied for calcareous nannofossils. One species last occurrence (LO) and four species first occurrences (FOs) have been recorded in the Lower to Middle Toarcian section of Rabaçal. Regarding the Upper Toarcian to Middle Aalenian section studied in Cabo Mondego, three species FOs and four species LOs were recognized. The continuous calcareous nannofossil record allows the nannofossil biohorizons and zone boundaries calibration with respect to the ammonite zones, and to precise events across the Toarcian and Aalenian stages in the Lusitanian Basin.

**Keywords:** Calcareous nannofossils, Toarcian, Aalenian, Lusitanian Basin.

## **Cenozoic marine diatom zonations: peculiarities of biostratigraphic schemes constructions and application**

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The current state of the Cenozoic marine diatom biostratigraphy and the principles of construction of oceanic zonations are reviewed. High-resolution oceanic diatom zonations that are widely used for the detailed subdivision, dating and correlation of Cenozoic sediments of the World Ocean are also discussed. The successful application of these zonations in studies of sequences on land and in marginal seas is critical to biochronology. Some difficulties and obstacles in the application of zonal subdivisions based on marine diatoms are discussed. Among the main existing problems are the following: the use of different types of zones whose boundaries are marked by various datum levels; geographic constraints of diatom zonations; difficulties in correlation of diatom assemblages across different marine facies; and the presence of a certain amount of diachroneity in the boundaries of biostratigraphic zones.

**Keywords:** Cenozoic, diatom biostratigraphy, application of diatom zonations.

## **The Mississippian-Pennsylvanian boundary in the Lviv-Volyn coal Basin (Western Ukraine) on the basis of playnological data**

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The Lviv-Volyn basin (LVB) is situated within the Volyn-Podillya margin of the East-European platform and composed of Carboniferous (Mississippian and Pennsylvanian) coal-bearing deposits. The main problem of

regional stratigraphy is the definition of the Mississippian–Pennsylvanian boundary in local sequences of LVB. This definition is only possible with a detailed study of the major industrial and coal-bearing sediments of LVB – the Bug formation. Facies-palynological study of the Carboniferous of the LVB demonstrates that the boundary between the Mississippian and Pennsylvanian and dating of the Bug formation can be clearly characterized by palynological data. In the Bug formation two palynozones – *Raistrikia nigra*–*Bellisporites nitidus* (NN) and *Neoraistrikia splendidus*–*Raistrikia fulva* (SF) are established. The lower NN zone, distinguished in the interval between the limestone  $N_3$  and coal bed  $n_7$ , is an Assemblage Zone. It is defined by two index species – *Raistrikia nigra* and *Bellisporites nitidus*. In general, in this palynozone, 65 taxa (43 with wide spreading, 32 typical) were identified. Nine species disappeared in the top of the zone and one appeared close to its base. Based on the miospores composition, NN zone corresponds to Serpukhovian (Mississippian). SF zone is recognized in the upper part of the Bug formation, in the interval between coal bed  $n_7$  and limestone  $B_1$ . It is a Concurrent-range Zone, which is defined by two index species – *Neoraistrikia splendidus* and *Raistrikia fulva*. In this palynozone 60 taxa are recorded: 31 with wide spreading and 29 typical, five of which appear at the base of the zone. They are: *Florinites similis*, *Radiizonates aligerens*, *Alatisporites pustulatus*, *Cirratiradites saturni*, *Raistrikia fulva*. These species are typical for the Pennsylvanian of surrounding regions. Deposits of the SF zone and, accordingly, the upper part of the Bug formation of LVB are included to the Bashkirian of Pennsylvanian. Thus, according to palynological data, the Bug formation corresponds to the following ages: the lower part is the Serpukhovian (Mississippian) and the upper one is the Bashkirian (Pennsylvanian). A considerable turnover of spores and pollen assemblages is observed at the level of coal bed  $n_7$ . This is the boundary between NN and SF palynozones. This level is the boundary between the Mississippian and Pennsylvanian in the LVB.

**Keywords:** palynology, palynozones, Mississippian – Pennsylvanian boundary, Lviv–Volyn basin, Ukraine.

## Refurbishing the Urgonian biostratigraphy: A key section at L’Estellon, Drôme, France

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In a basinal section of the Vocontian trough, “freshly” reworked shallow-water assemblages (orbitolinids and dasycladales) can be calibrated directly with ammonite zones. It documents for instance the oldest record of *Palorbitolina lenticularis* or those of the so-called “typical Early Aptian” representatives of the genus *Orbitolinopsis* in Lower Barremian strata.

**Keywords:** Barremian, orbitolinids, dasycladales, ammonites, biostratigraphy, calibration.

## Upper Pliensbachian-Middle Toarcian foraminiferal assemblages in the Camino Section (Basque-Cantabrian Basin, Spain)

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We recorded boreal foraminiferal faunas in the Upper Pliensbachian-Middle Toarcian in the Camino Section (Western Sector of the Basque-Cantabrian Basin, Spain). The results reveal step-wise extinction, replacement and renewal events along the Pliensbachian-Toarcian transition. Extinction of typical long-ranging Lower Jurassic foraminiferal species takes place mainly in the Tenuicostatum Zone of the Toarcian. Furthermore, the most significant renewal event occurs in the Serpentinum Zone with the first appearance of the genus *Citharina* represented by various species. Typical Lower Toarcian species were recorded in the Tenuicostatum Zone both in the Paltum and Semicelatum Subzones.

**Keywords:** Foraminifera, Biostratigraphic Events, Lower Jurassic, North Spain.

## Paleoclimatic implications of Permian fusulinids and carbonates from Baoshan Block, SW China

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Permian fusulinids and carbonate facies from the Baoshan Block, SW China have been analyzed to understand the Permian climatic condition of this block. Fusulinid assemblages of Sakmarian, Murgabian and Midian ages are recognized. All these assemblages are with much lower generic diversity than coeval fusulinids from tropical region. Furthermore, dominant elements changed from eurytopic genera to typically warm-water ones from Sakmarian to Midian. Besides, Sakmarian carbonate facies is similar to heterozoan association and Murgabian-Midian carbonate facies belongs to Chlorofoam facies of photozoan association. Such changes of fusulinid composition and carbonate facies consistently imply that the Baoshan Block experienced a climatic amelioration from warm-temperate water to tropical warm water during Sakmarian-Midian interval.

**Keywords:** Fusulinid, Carbonate facies, Paleoclimate, Permian, Baoshan Block.

## New palynological and floral information from the Potí Formation (late Visean), Riacho do Roncador creek, Parnaíba Basin, northern Brazil

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The aim of this contribution is to present the first palynological assemblage recovered from surface deposits of the Potí Formation cropping out in the Riacho do Roncador, northeastern Brazil. The lower Pennsylvanian Piauí Formation unconformably overlies this unit, and unconformably is underlain by the Longá Formation. The Potí Formation consists mainly of sandstones with minor proportions of carbonaceous shales and other siliciclastic

lithologies in part fossiliferous, containing plant remains, bivalves, and palynomorphs of early late Visean age. The formation accumulated in fluvial to marine environmental settings. From an outcrop of 5 m thick, five carbonaceous shales and siltstones (3m thick) yielded diverse and abundant well-preserved palynomorphs. The assemblage is composed of 62 indigenous species, of which 57 are spores and 5 are algae, and 32 are reworked species (9 spores and 23 microplankton). First records for the Mississippian of Brazil and South America are also recorded. Stratigraphically significant species, some of them not previously recorded in subsurface investigations, include: *Anapiculatisporites concinnus*, *Tricidarisorites phippiae*, *Punctatisporites subvaricosus*, *Foveosporites pellucidus*, *Grandispora maculosa*, *Knoxisorites ruhlandi*, *Verrucosisorites morulatus*, *Retusotriletes mirabilis*, *Waltzispora polita*, which confirm the late Visean age of the Mag Zone Melo and Loboziak. Worldwide comparison of the Brazilian association indicates greater affinity with coeval palynofloras from Gondwana region (South America and North Africa) and North America. The degree of similarity is likely to be determined by paleolatitude. Sedimentologic features along this section clearly reflect depositional environments between brackish deltaic to estuarine facies. The dominance of *Botryococcus* with varied morphologies throughout this section, the presence of reworking restricted to the uppermost level and the plant remains found into the basal part, support this interpretation.

**Keywords:** Palynomorphs, biostratigraphy, palaeoenvironment, Potí Formation, Parnaíba Basin, Brazil, late Visean.

## Planktonic foraminiferal biozonation of the Oligocene in the North Adriatic Sea

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Samples for detailed micropaleontological research were selected from two deep exploration wells (Istra more-3 and Istra more-4) in the Adriatic Sea. On the basis of index taxa and selected species of planktonic foraminifera standard planktonic foraminiferal zonation for Oligocene sediments after WADE et al. (2011) have been applied (Zone O1-O7). The investigated deposits are overlying the upper Eocene (E16) sediments, and are overlain by lower Miocene rocks (Zone M1). Distinct changes in composition of the planktonic foraminiferal assemblage have been observed near the Eocene/Oligocene boundary. In the latest Eocene, at the Eocene /Oligocene boundary, genera *Cribohantkenina*, *Globigerinatheka* as well as most species of the genus *Turborotalia* (*T. cerroezulensis*, *T. cunialensis*, *T. cocoaensis*) became extinct. *Chiloguembelina cubensis* appears just before the E/O boundary, and *Cassigerinella chipolensis*, *Chiloguembelina* sp., *Dentoglobigerina tapuriensis*, *D. tripartita*, *D. venezuelana*, *Dentoglobigerina* sp., *Subbotina* sp. appear above the boundary. Transition between Eocene and Oligocene is also characterized by the size reduction of the specimens of genus *Pseudohastigerina* as well as of species *Chiloguembelina cubensis* and *Ch. ototara*. The boundary between the lower and upper Oligocene is defined by the high common occurrence (HCO) of *Ch. cubensis*, i.e. proportion of this species in planktonic foraminiferal community in the small size fraction (125-63  $\mu\text{m}$ ) is > 5%. The Oligocene/Miocene boundary is marked by the first appearance of species *Paragloborotalia kugleri*.

**Keywords:** biostratigraphy; Oligocene; planktonic foraminifera; north Adriatic.



## **Refining the biostratigraphy and biochronology of the Belverde borehole (Setúbal Peninsula, Portugal): calcareous nannofossil data**

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In this proposal we present a combined study of planktonic foraminifera and calcareous nannofossils, in order to refine the previously established stratigraphic framework of the Belverde Borehole (Portugal). For the first time, some of the classical miocene lithostratigraphic units of the Lower Tagus Basin are correlated with standard biozones of calcareous nannoplankton: top of IVa unit - NN3; IVb, Va1, Va2, Va3, Vb and Vc units - NN4; VIa unit - NN5; VIb unit - NN6; VIc and VIIa-b units - NN7 or later.

**Keywords:** Calcareous nannofossils, planktonic foraminifera, biostratigraphy, biochronology, Belverde borehole, Neogene, Atlantic, Portugal.

## **Calcareous microfossils as tracers of major palaeoceanographic perturbations: the case of the onset of the Messinian salinity crisis in the Tertiary Piedmont Basin (NW Italy)**

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Different types of sedimentary rocks (primary gypsum, laminated shale) record the onset of the Messinian Salinity Crisis in the Mediterranean successions; this event occurred synchronously at 5.96 Ma. The disappearance of calcareous microfossils is one of the proxies used so far to identify this timeline. In the Tertiary Piedmont Basin calcareous microfossils disappear before, at or after the onset but, when present, they show a very distinctive stratigraphic sequence of bioevents. This allows us to place the onset of the MSC in distal, intermediate, and marginal settings independently from gypsum deposition.

**Keywords:** Calcareous microfossils, Tertiary Piedmont Basin, Messinian salinity crisis, climate and environmental change.

## **New biostratigraphical data of the late Valanginian-Hauterivian in the Mateur area (Lansarine chain, Northeastern Tunisia) based on foraminifers and ammonites**

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The Early Cretaceous series in the Lansarine chain is not yet differentiated. The study of the Jebel Boulahoujeb section allowed defining new biostratigraphical data for the area. The discovery of an abundant ammonite association in significant levels of the section rich and diversified microfossil material allowed establishing a chronostratigraphical and a biostratigraphical subdivision of Lansarine chain in the Mateur area. The main lithostratigraphic units in the section are represented by clay, dark marls and limestones. Over the red Triassic gypsum and sandstones, occur several sequences (200m thick) of limestones, dark marls interbedded with deposits of gray olistolites. These basal units contain ammonite association of *Oclostephanus nicklesi* subzone from Trindodosum Zone which characterizes the middle part of Upper Valanginian.

Above, Hauterivian series (400m thick) are constituted by dark marls intercalated by limestones beds. In the upper part of the section, there are thick levels of limestones bench straightened which make the relief and form the cliff of Jebel Boulahoujeb. This part of the section is attributed to the uppermost part of Hauterivian because of the presence of rich ammonite association of *Pseudothurmannia cattuli*, *P. angulicostata*, *P. aff. picteti*.

The foraminifera allowed us to define a biostratigraphical assemblages for the study area. Benthic foraminifera are found since the base of the section. Several associations are identified, characterized by the presence of *Lenticulina roemeri*, *Lenticulina eichenbergi*, *Lenticulina madosa* characterizing the upper Valanginian.

Four associations of benthic foraminifera species are considered as characteristic of the Hauterivian in the Lansarine chain: *Lenticulina multicella*, *Dorothia kummi*, *Dorothia zedlerae*, *spirillina neocomiana*.

Upper Hauterivian is characterized by *Gorbachikella kugleri*, a planktonic foraminiferal zone.

**Keywords:** Biostratigraphy, Valanginian, Hauterivian, ammonite, foraminifera, Tunisia.

## Early Cretaceous pollen-spore and mesofossil associations of the Bombarral Formation (Lusitanian Basin, western Portugal)

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The Lower Cretaceous of the Lusitanian Basin (western Portugal) contains rich assemblages of plant remains. The study of the palynological and mesofossil flora of the Berriasian Bombarral fm. in Vale Painho, near Juncal, contributes to enlighten the environmental conditions, the vegetation diversity and the unit's age. The fossil site is just below the base of the Figueira da Foz Fm., a basinwide breakup paraconformity. Regional correlation with biostratigraphically dated units (Lourinhã *p.p.*, Farta Pão, Porto da Calada and Serreira) points to a Berriasian age for the top of the Bombarral fm. The Vale Painho palynological assemblage is clearly dominated by fern spores and gymnosperms pollen. The mesofossil flora is characterized by seeds of conifers or *taxa* related to the Bennettitales-Erdtmanitecales-Gnetales (BEG) group, in agreement with palynomorphs. No angiosperm remains were recognized. The assemblage is very similar to the Berriasian to Valanginian Bornholm flora (Denmark). Plant features and sedimentary proxies indicate a hot climate with a marked seasonality in precipitation.

**Keywords:** Bombarral Formation, Lower Cretaceous, Berriasian, mesofossils, palynomorphs, Portugal.

## **The question of the Turonian-Coniacian boundary in Western Georgia (on the basis of planktonic foraminifera)**

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The Upper Cretaceous sediments are widely spread in the Western Georgia (Gagra-Java zone). Upper Turonian – Lower Coniacian deposits in the western part of the Abkhazia-Racha of facies type (the basin of the rr. Chanistkali and Ochkhomuri) (Gambashidze, 1979), are represented mainly by firm carbonate rocks. Here is exposed the Gumurishsk suite. And within Odishi-Okriba facies type the significant role is played by terrigenous-volcanic rocks, formed on the general background of carbonate sedimentation. There are the pro-layers, enriched with a tufogenny material, among white and red calcareous. They were marked under the name of the suite "Mtavari" (K2t3-K2st) (Meffert, 1931; Tsagareli, 1946). This suit is composed by brick-red, brown, yellowish-gray basalt and porphyritic effusive with pro-layers of calcareous and sandstones. It should be noted that in the majority of the works, devoted to stratigraphy of Abkhazia-Racha and Odishi-Okriba facies types, the major attention was always devoted to studying of macrofauna. And fatsias microfauna is represented in terrigenous-volcanic by poor complexes.

**Keywords:** Facies, foraminifera, Georgia, Mtavari, Turonian, Coniacian.

## **Biostratigraphy as a basic tools to validate high resolution OSL, CRN and sequence stratigraphic data**

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We present the biostratigraphic study of the Enza section which provides a robust constraint on timing of deposition where the lack of magnetic polarity reversals in the marine part of the section is not sufficient to obtain age constraints

**Keywords:** Stratigraphy, Biostratigraphy, Calcareous nannofossils, Foraminifera, Pleistocene.

## **Thrombolite from the Neoproterozoic Bhandar Group, Vindhyan Supergroup, central India**

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The paper records well preserved clotted fabric of thrombolite from the black bedded cherts of the Bhandar Limestone, Maihar area, Satna district, Madhya Pradesh. This is the first record of thrombolite from any carbonate horizon of the Upper Vindhyan Supergroup. Thrombolite is very local in Proterozoic and are reported

mostly from late Neoproterozoic and Cambrian, however it is long ranging. Form is well associated with algal laminites, which is trapped in silica gel.

**Keywords:** Thrombolite, Neoproterozoic, Bhandar Limestone, Vindhyan Supergroup, India.

## **Correlation of Upper Cretaceous sequences of Eastern Europe based on radiolarians**

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As throughout the most part of the Late Cretaceous there was a communication of the European Peri-Tethyan Ocean with Boreal and Arctic areas, their correlation through a planktonic group of microfauna - i.e., the radiolarians - is feasible. Worldwide, there has not been much study of Late Cretaceous radiolarians, although there has been considerable progress in research on the Early Cretaceous, Jurassic, and especially Triassic radiolarians. In recent years, researchers from the Geological Institute, Russian Academy of Sciences, have shown, however, that the Late Cretaceous radiolarians of Eastern Europe are very taxonomically and morphologically diverse, and can be successfully used in studying the biostratigraphy of Upper Cretaceous deposits.

The results of a comprehensive radiolarian analysis have shown that the following biostratigraphic subdivisions based on radiolarians can be distinguished in several regions of Eastern Europe: five - within the Cenomanian - Lower Campanian interval of the Voronezh anticline, six - within the Cenomanian - Lower Campanian interval of the Moscow syncline, seven zonal subdivisions within the Cenomanian - Campanian interval of the Crimean-Caucasian area, and nine - within the Turonian - Maastrichtian interval of the Ulyanovsk-Saratov depression.

The Turonian *Alievium superbum* radiolarian zone has a global distribution, whereas the Upper Campanian *Prunobrachium articulatum* radiolarian zone is local and recognized only in Eastern Europe.

The proposed biostratigraphic subdivisions based on radiolarians of Eastern Europe provide good correlations with the coeval zonal radiolarian units of Western Siberia and Northeastern Russia. Some radiolarian subdivisions of Eastern Europe can be traced into Western Europe.

**Keywords:** Radiolarian biostratigraphy, zones, Eastern Europe, Russia.

## **Radiolarian and foraminiferal Upper Cretaceous zonal subdivisions of the Crimean-Caucasian region**

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This report contains biostratigraphic data concerning high resolution stratigraphy of the Crimean-Caucasian region. Carbonate lithofacies - limestone, marl, clayey-limestone and chalk prevail in the Upper Cretaceous. The new proposed foraminiferal scheme consists of 15 zones: Upper Albian *Thalmaninella appenninica*, Lower Cenomanian *Thalmaninella globotruncanoides*, Lower - Middle Cenomanian *Thalmaninella deecke*, Middle - Upper Cenomanian *Rotalipora cushmani*, Upper Cenomanian - Lower Turonian *Whiteinella archaeocretacea*, Lower Turonian *Hedbergella helvetica*, Middle Turonian *Marginotruncana pseudolinneiana*, Upper Turonian-Lower Coniacian *Marginotruncana coronata*, Middle - Upper Coniacian - Lower Santonian *Concavotruncana concavata*, Lower - Upper Santonian *Contusotruncana asymetrica*, Upper Santonian - Lower Campanian *Globotruncana elevata*, Middle Campanian *Globogirinelloides multispinus*, Upper Campanian *Contusotruncana morozovae*, Upper Campanian - Lower Maastrichtian *Globotruncanita stuarti*, Maastrichtian *Abathomphalus*

*mayaroensis* with 18 infrazonal bioevents. The radiolarian scheme consists of six zones: Upper Albian *Crolanium cuneatum*, Cenomanian *Holocryptocanium barbui* - *Pseudodictyomitra pseudomacrocephala*, Turonian *Alievium superbum*, Coniacian *Alievium praegallowayi* - *Pseudoaulophacus praefloresensis*, Santonian *Alievium gallowayi* with two subzones, the Lower Santonian radiolarian zone *Alievium gallowayi* - *Pseudoaulophacus floresensis* and the Upper Santonian radiolarian zone *Euchitonia santonica*-*Archaeospongoprimum nishiyamae*. In addition, six infrazonal bioevents have been recognized: the first occurrence of *Holocryptocanium tuberculatum* in the Cenomanian, *Crucella cachensis* in the Turonian, *Orbiculiforma quadrata*, *O. vacaensis* in the Coniacian, *Neosciadiacapsa diabloensis* in the Santonian, *Amphipyndax pseudoconulus* in the Campanian and the last occurrence of *Pseudodictyomitra pseudomacrocephala* in early Turonian.

**Keywords:** Radiolarians, planktonic foraminifers; biostratigraphy; Crimea; Caucasus.

## Upper Devonian and Lower Carboniferous Foraminiferal Facies Associations from Melekesskian Depression

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Foraminifers from the borehole 1001 Trudoljubovskaya (East-European Platform, Volgo-Ural region) are studied. Foraminiferal assemblages are studied in several stratigraphic levels in Upper Devonian and Lower Carboniferous deposits. Upper Frasnian complex corresponds to slope facies. In the Middle Famennian deposits presented by slope facies and facies of back-reef apron, associations of two foraminifer zones – *Septaglomospiranella primaeva* and *Euendothyra communis* – are tracked. The Tournaisian deposits, represented by carbonate slope fans, contain one association in the Lower Tournaisian and two associations, in the Upper Tournaisian (the zones *Chernyshinella glomiformis*-*Septabrunsiina krainica*-*Paleospiroplectamina tchernyshinensis* and *Spinoendothyra costifera*). In the Upper Viséan deposits represented by formations of an open shallow shelf, are recognized foraminifers of two zones – *Archaediscus krestovnikovii*-*Endothyranopsis compressa* and *Archaediscus gigas*. The quantitative and qualitative characteristics of facies complexes are given.

**Keywords:** Foraminifers, facies, Upper Devonian, Lower Carboniferous, Melekesskian depression.

## Paleogene radiolarian-bearing strata from Tibet and its geological implications

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A diverse abundant and well-preserved radiolarian fauna in Jiazhu, Zhongba County of Tibet, in the western sector of Yarlung Zangbo Suture Zone is assigned to a late Paleocene radiolarian zone, the *Buryella pentadica* interval zone, spanning 59-56.5Ma. The late Paleocene radiolarian fauna and the tectonic attribution of the radiolarian cherts and the basalt block indicate that oceanic crust persisted in Zhongba area until the late Paleocene and initial collision between the India and Eurasia plates post-dates the late Paleocene. It is inferred that the Neo-Tethys transformed into a remnant oceanic basin in the late Paleocene, at the terminal stage of the oceanic crust subduction, and the closure of the remnant oceanic basin in the studied region took place after the late Paleocene.

**Keywords:** Radiolarians, late Paleocene, remnant oceanic basin, west sector of Yarlung Zangbo Suture.

## **Vertebrate microfossils as tools in stratigraphy: example of the Lower Devonian Andrée Land Group, Spitsbergen**

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Vertebrate microremains from the Lower to Middle Devonian of the Andrée Land Group, which comprises Wood Bay Fm. and Grey Hoek Fm, have been studied. We have defined two new thelodont assemblages, which represent different depositional phases of the late Lower - early Middle Devonian of the Andrée Land Group. Definition of these two new thelodont assemblages allows to precise the relative age of the Lower – Middle Devonian strata. Rare earth element (REE) abundances have been measured in a number of thelodont and chondrichthyan microfossil dental tissue biomineral, using laser ablation inductively coupled plasma mass spectrometry (LA-ICP-MS). Prior to these analyses, the evaluation of fossil preservation level has been made by semi-quantitative spot geochemistry analyses on fine polished scale thin sections, using Energy Dispersive X-ray Spectroscopy (EDS), and Electron Backscattering Diffractometry (EBSD) was applied in order to detect recrystallization. Stable oxygen isotope measurements ( $\delta^{18}\text{O}$ ) of bulk biomineral have been conducted in parallel, and showed comparatively lower heavy oxygen values in the same fossil tissues with stronger visible alteration, such as Grey Hoek Fm. Our results suggest that certain lithostratigraphic units of the Andrée Land Group have to be regarded as contemporaneous lithofacies subjected to different sedimentary environment, rather than separate stratigraphic members.

**Keywords:** Vertebrates, Microfossils, Biostratigraphy, Chemostratigraphy, Devonian, Spitsbergen.