

EUG XI



Theme OS

Open Symposia

EUG XI



Symposium OS01

Palaeontology, Stratigraphy and Sedimentology

Convenor

Duncan McIlroy

OS01

Palaeontology, Stratigraphy and Sedimentology

Wednesday PM Session

OS01 : WEpm25 : G8 Late Pleistocene and Holocene Megamammals of the European North-East

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Six stages of megamammals faunal history, which differ from each other in species composition and faunal structure are revealed. During Late Pleistocene there were three stages of: Byzovaya interglacial, initial period of Late Valdai ice sheet degradation and late glacial. During post-glacial there were stages of early, middle and late Holocene. These stages are closely connected to environmental changes in the region. For second part of Holocene regional distinctions in species composition and faunal structure are shown. Late Subboreal cooling nearly has not influence fauna inhabited modern forest zone, but megamammalian assemblage of the Polar Urals has changed more considerably. It has lost forest elements and became modern-like tundra fauna. Thus, in the north of the region, where climatic changes were more distinct, fauna went through more essential transformation. On the basis of studying not numerous findings of bones it is suggested that Late Pleistocene brown bears were larger than modern ones and wolves had shorter metapodia. Early Holocene polar fox is closer to Late Pleistocene *Alopex lagopus rossicus* by proportions of M/1. Late Holocene martens were smaller than Holocene animals of Baltic region. Morphometric study of series of bones has allowed to reveal geographical variability of Late Holocene hares. The largest hares occupied the Polar Urals. Late Holocene reindeer of the Polar Urals is not different from modern tundra subspecies in measurements of postcranial bones.

OS01 : WEpm26 : G8 Vegetation, Climate, and Fire: A Post-Glacial Landscape History from Western Canada

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Palaeoecological analyses (pollen and charcoal) from seven sediment cores were used to reconstruct the post-glacial vegetation, climate, and fire disturbance history on southern Vancouver Island, British Columbia, Canada. A non-arboreal pollen and spore zone is recorded in the basal clays at one site and possibly represents a tundra or tundra-steppe glacial refugium. An open *Pinus contorta* (lodgepole pine) woodland characterised the landscape in the late glacial interval. Fires were rare or absent and a cool and dry climate dominated. Closed forests consisting of *Picea* (spruce), *Abies* (fir), *Tsuga heterophylla* (western hemlock), and *Tsuga mertensiana* (mountain hemlock) with *P. contorta* and *Alnus* (alder) replaced the *P. contorta* biogeochron in the late Pleistocene. The incidence of fire increased at this time even though climate was cool and moist. Evidence for a Younger Dryas-like event at this time includes *Alnus* peaks and colluvial deposits in wetlands. Open *Pseudotsuga menziesii* (Douglas-fir) forests with *Preridium* (bracken fern) and *Alnus* expanded westward during the warm dry early Holocene. At this time closed *Picea* and *T. heterophylla* forests grew in a moist region on southwestern Vancouver Island. At high elevations, forests consisting of *T. heterophylla* and *P. menziesii* expanded during the early Holocene. Fires occurred frequently in lowland forested ecosystems during this interval. At high elevations, charcoal increased somewhat from the late Pleistocene, indicating slightly more fires and reflecting continued moist conditions at high elevations. The mid and late Holocene was characterized by increasing precipitation and decreasing temperature respectively. Mid Holocene lowland forests were dominated by *P. menziesii* with *T. heterophylla* and *Alnus* in southeastern regions, *T. heterophylla* and *Thuja plicata* (western red cedar) in southern regions, and *T. heterophylla* and *Picea* in southwestern regions. An overall decrease in charcoal influx suggests a decrease in lowland fires. At high elevation, mid Holocene forests consisted of *T. heterophylla*, *Picea*, and *Abies* with *Alnus*. An overall increase in charcoal influx at high elevations likely reflects an increase in the number of charcoal fragments entering the basins by overland flow as opposed to an increase in fire incidence because climate was

moister. In the late Holocene extant closed *T. heterophylla* and *T. plicata* forests became established in wetter western regions, *P. menziesii* forests occupied drier eastern portions, and *T. mertensiana* and *Cupressaceae*, likely *Chamaecyparis nootkatensis* (Alaska yellow cedar), forests were established in sub-alpine regions. Lowland fires were infrequent in wet western regions but frequent in drier eastern regions. A slight reduction in charcoal influx generally occurs at high elevations, implying fewer fires.

OS01 : WEpm27 : G8 Recent Endolithic Microfossils in Early Archaean Fossiliferous Rocks

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The 3.3- 3.5 b.y.-old Early Archaean cherts from the Barberton greenstone belt, South Africa, are well known for their indigenous microfossils, whereas the 3.7->3.8 b.y.-old cherts and banded iron formations (BIFs) of the Akilia Province and Isua greenstone belt, Greenland, are better known for their isotopic evidence for life. In both locations, however, we have found the fossilised remains of recent endolithic microorganisms including fungi and bacteria. This is the first time that chasmo-endolithic fossils have been described. Given the attention to Antarctic/Arctic environments as potential analogues of the Martian environment during certain stages of its history, the discovery of the fossilised microbes in from the Arctic environment of Greenland is particularly relevant. Moreover, the presence of microfossils of different ages in the same rock sample urges caution in the interpretation, especially, of bulk biochemical and isotope analyses.

The fossiliferous cherts from Barberton represent bacterial mats which formed on sediment surfaces in shallow water to intertidal environments in a predominantly volcanic regime. The mats were formed primarily of filamentous bacteria and also rod-shaped and coccoidal bacteria. These microfossils are clearly embedded in the microcrystalline quartz matrix, with a clear relationship to the carbonaceous material making up the mats and are therefore of the same age as the chert. However, two angled fracture surfaces in one of the carbonaceous chert samples were covered by a densely interwoven network of >100 μ long, 3-4 μ wide, septate filaments, occurring in association with approximately 5 μ spherical to oval, carbonaceous structures with decorated surfaces. The filaments were identified as fungal hyphae (phylum *Basidiomycota*, M.Blackwell, pers. comm.) by their branching nature and by the presence of clamp features at regular intervals along their lengths. The spiny to striated oval structures are fungal spores. Many of the microbial structures had collapsed and were partially degraded by the time they were fossilised (silicified).

$\delta^{13}\text{C}$ data document evidence for the presence of microbial life at the time that the BIFs of the Akilia and Isua provinces in SW Greenland were deposited. Fracture surfaces within the BIFs are coated with anatomising networks of 2-10 μ wide, >100 μ long, branching, organic filaments. In cracks between the magnetite and the quartz grains there are filaments formed by chains of coccoidal cells up to 5 μ in diameter, as well as colonies of coccoids embedded in extracellular polymeric substances. These microbial structures have all been silicified. Both the Barberton and Isua/Akilia greenstone belts have been relatively recently exhumed and thus the endolithic intrusions must be of relatively recent date.

OS01 : WEpm28 : G8 Diagenetic Alteration of Biogenic Phosphate – Constraints on Oxygen Isotope Analysis of Vertebrate Fossils from Neogene Marine Deposits

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The oxygen isotope composition of phosphate in bones and tooth enamel ($\delta^{18}\text{O}_\text{p}$) is extensively used as a proxy for palaeoclimate and vertebrate physiology. This proxy relies on original oxygen isotope compositions of the PO_4 group, which is generally assumed to be resistant to diagenetic exchange.

Preservation of the difference in $\delta^{18}\text{O}_\text{p}$ value of homeothermic mammals versus heterothermic reptiles and fish can be used as a proxy for diagenetic alteration of biogenic phosphates. Oxygen isotope composition in bones from homeothermic mammals reflects that of body water, hence the ingested meteoric water, because the (body-)temperature ($37\pm 2^\circ\text{C}$) and consequently the $\text{PO}_4\text{-H}_2\text{O}$ fractionation is constant during phosphate formation. In contrast, heterothermic animals, due to their low metabolic rates, are not able to maintain a constant body temperature, which covaries with ambient temperatures. Because the $\text{PO}_4\text{-H}_2\text{O}$ fractionation increases with decreasing temperature, $\delta^{18}\text{O}_\text{p}$ values of homeothermic animals are lower than for heterothermic animals ingesting water with the same oxygen isotope composition.

Similarly, the $\delta^{18}\text{O}_\text{p}$ values from marine and co-occurring terrestrial mammals fossilized in the same marine environment can be used to monitor diagenetic changes of fossil phosphate as their ingested water sources (sea water and meteoric water) differ in $\delta^{18}\text{O}$. $\delta^{18}\text{O}_\text{p}$ values of marine mammals are thus higher than those of terrestrial mammals. Diagenetic alteration of original biogenic phosphate in the same sediments and pore waters can be expected to homogenize these primary differences in $\delta^{18}\text{O}_\text{p}$ values by inorganic precipitation of phosphate and/or isotopic exchange with ambient sea water.

Using this approach, the effects of phosphate diagenesis are being investigated for bones and teeth from different taxa co-occurring in the same horizon for Oligocene to Pleistocene marine localities in Europe and USA (Florida). Initial results of $\delta^{18}\text{O}_\text{p}$ measurements with TC-EA CF-IRMS from Miocene deposits close to Antwerp give a range of $\delta^{18}\text{O}_\text{p}$ values for shark teeth from 21.8 to 22.8‰ which is identical to that for whale and sea cow bones (21.7 to 22.2‰). This clearly indicates alteration of original bone phosphate, which is also supported by destruction of bone histology and phosphate crystallinity. However, in another Miocene fossil site of Austria a homeothermic-heterothermic difference in $\delta^{18}\text{O}_\text{p}$ values of ca. 2‰ has been well preserved: sea cow bone (19.2‰) and shark tooth (21.0‰). Clearly, the diagenetic history in these sites has been significantly different. Reasons for this difference in phosphate diagenesis are part of the ongoing research.

OS01 : WEpm29 : G8 Tethys-Paratethys Relationship in the Gulf of Saros: Northwestern Turkey

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Relationships between the Tethys and Paratethys can be inferred from the Neogene stratigraphy of the Gulf of Saros, NW Turkey. In this area Neogene sediments fill a half graben, the Enez graben, and are represented by three formations resting unconformably on the Oligocene and older rocks. At the base of the Neogene succession is Gazhanedere formation which is represented by meandering river clastics and lacustrine sediments. This Late Oligocene-Astaracian formation is overlain transitionally by braided river and beach clastics of Kirazli formation. It starts at the base with braided river clastics comprising of Astaracian-Early Vallesian mammal fauna. 0.5-7 meters of

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gypsum lenses are also seen within this part. Up the section are beach clastics with different ostra zones reaching up 1.5-2 meters. A Sarmatian-Serravalian marine fauna have been yielded from this upper part of the Kirazli formation. This fauna indicate a Mediterranean (Tethyan) origin. The uppermost unit, the Alçitepe formation is represented by Macra-bearing clastics with some gypsum interbeds at the base and sandstones, and sandy limestones with bivalv fossils at the top. Fossil associations from the Alçitepe formation indicate that during the deposition of this formation Mediterranean and Paratethyan conditions alternated with each other. In this paper the Neogene stratigraphy, paleogeography and fauna will be described.

OS01 : WEpm30 : G8 Proposal for Redefinition and New Chronology of the Skade and Utsira Formations, Norwegian North Sea

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The Upper Tertiary sands of the Utsira and Skade Formations have become increasingly important the last few years both as a potential storage of CO₂ and also in the reconstruction of the geohistory of the late Tertiary of the central and northern North Sea. Detailed knowledge about their age and distribution is therefore of the highest importance.

We present an improved chronology of the Utsira and Skade Formations in type wells from blocks 15/9, 16/1 and 24/12 in the Norwegian North Sea. We have also recognised an error in the definition of the boundaries between Skade and Utsira Formation, which unfortunately has caused much confusion to workers in the northern North Sea. To overcome this problem, a redefinition of the base of the Utsira Formation is proposed.

The Skade Formation, which previously has been assigned an Oligocene age has, in this work, been redated in its type and reference wells to encompass the Early Miocene only. Analyses carried out in other wells in the area support such an age. In addition, detailed log correlation coupled with seismic stratigraphic subdivision clearly support our interpretations in blocks 15/9, 16/1 and 24/12. Seismically, the top of the Skade Formation corresponds to a seismic reflector which eastwards is recognised as a distinct conformity. Its base is less distinct on seismic sections, but can readily be identified on wireline logs. The sands are turbiditic in origin and were shed from the East Shetland Platform, pinching out to the east of the Viking Graben.

The overlying Utsira Formation has previously been dated to Middle and Late Miocene age in its type well 16/1-1. Our work in the area, however, documents that the lower half of the Utsira Formation in this well corresponds to intervals which have been defined as Skade Formation in its key and reference wells. The age of this lower part is consequently Early Miocene. A redefinition and also a new type section for the Utsira Formation is therefore required, and we propose wells 16/1-2 or 24/12-1 as candidates.

In these and other wells in the area, sands of the Utsira Formation comprise the upper part of a distinct coarsening upward sequence. The shales from the lower part of this sequence contain the diagnostic *Bolboforma badenensis*/*B. reticulata* assemblage, also known from ODP Sites on the Vøring Plateau, which suggests an age of approximately 14-12 Ma. The overlying sands of the Utsira Formation yield latest Middle Miocene to Early Pliocene ages. Our work suggests that these sands were also shed from western source areas in this part of the basin.

OS01 : WEpm33 : G8 Details of Aptian Sea Level Fall Record and High Resolution Cyclostratigraphy in Carbonate Peritidal Deposits (Seydisehir and Fele Areas, Western Taurides, SW Turkey)

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Study areas, Seydisehir and Fele, are located in the south western part of Turkey, in the western Taurides. 2 stratigraphic sections in the Seydisehir area and one stratigraphic section in the Fele area are measured in detail. Study interval covers the Aptian stage and biostratigraphic framework is constructed by using benthic foraminifera and dasycladacean algae.

Globally widespread Aptian sea level fall is recorded as Insitu Karstic Breccia deposits. In both areas, this important karst breccia level is composed of successive 3 main intervals following each other and can be traced for short and long distances. This indicates that Aptian sea level fall is not only a record of sudden and sharp retreat of the sea. The presence of peritidal deposits between successive karst breccia levels indicates that short term sea level rises on long term fall trend are also recorded.

The measured sections including breccia levels are totally composed of shallowing-upward meter-scale cycles. The cyclicity is constructed by vertical facies associations. From bottom to top of each cycle, generally subtidal, intertidal, and supratidal facies are present respectively.

Within the chronostratigraphic framework, this cyclicity is interpreted as Milankovitch cyclicity and corresponds to E2 eccentricity signal and termed as 4th order cycles in this study. However, the nature is not simple, smaller scale cycles are also present within the meter-scale shallowing-upward cycles (4th order cycles). Generally smaller scale cycles are observed by the alternation of two different genetically related facies within 4th order cycles, and one 4th order cycles early includes 2-5 number of smaller scale cycles. They are termed as 5th order cycles hierarchy. Even at some individual beds, fining-upward structures are recorded within this 5th order cycles and interpreted as 6th order cycles. However, they show a relatively random distribution compared with 5th and 4th order cycles.

It is concluded that Aptian peritidal carbonates in the Tauride region are completely composed of cyclic deposits and recorded the important Aptian sea level fall.

OS01 : WEpm34 : G8 Sequence Stratigraphy of the Upper Jurassic Kimmeridge Clay: Evidence from Quartz Grain-Size Analysis

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A quantitative method of quartz grain-size analysis for mudstones that employs Backscatter SEM, X-ray and image analysis is applied to the Kimmeridge Clay (Late Jurassic, Wessex Basin). The analysis is simple: Backscatter SEM images are taken at 800X magnification, the quartz identified using X-ray and CL analysis and the image exported into an image analysis package. The silt sized quartz particles are then highlighted, and the area of the image they represent calculated as a percentage. Results for the Kimmeridge Clay show decametre-scale upwards-fining and upwards-coarsening packages. A high-resolution correlation with a basin-margin section in the Boulonnais, northern France, indicates that increased grain-size in basin facies corresponds to sand deposition on the margins. Conversely, fine-grained basin facies corresponds to mudstone or condensed section on the basin margin. The grain-size variation in the Kimmeridge Clay therefore appears to be a record of relative sea-level or climate change of at least regional extent.

OS01 : WEpm35 : G8 Reconciling Molecular Phylogeny of Planktonic Foraminifera with the Fossil Record

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The fossil record of pelagic protists, especially planktonic foraminifera, has become the focus of studies of fine-scale evolutionary patterns and speciation processes. Long, well-dated, and continuous sequences recovered from the ocean floor provide a unique archive of morphological evolution of these organisms. The unique nature of the marine microfossil record allows direct stratophenetic tracing of ancestor-descendant lineages, a powerful means for reconstructing the phylogenetic history of the group. Not only does this approach avoid phylogenetic inferences based on hypothetical common ancestors, it also provides valuable, well-constrained data on divergence times of individual lineages. In recent years, the first DNA sequences (SSU rRNA gene) have been successfully extracted from modern planktonic foraminifera, allowing the construction of a genetically based phylogeny for the group. Thus, planktonic foraminifera provide an exceptional opportunity to compare fossil evidence for relationships between species with genetic data.

The evidence available to date indicates that planktonic foraminiferal phylogeny based on palaeontological data shares many general patterns with phylogenies derived from SSU rRNA sequences. The agreement includes the existence of major clades on generic and suprageneric levels and to a large degree also the relationships among these clades. Nevertheless, the genetic data has brought about several new discoveries. The foraminifera are shown to be a monophyletic group within the SSU rRNA 'tree of life' and are unrelated to other protist groups. The genetic data also show that modern planktonic foraminifera have evolved from several different certain ancestors and question the relationships between certain clades as well as the nature of foraminiferal morphospecies.

I will discuss these issues concentrating on one example - the latest SSU rRNA phylogeny of the neogloboquadrinid clade. The relationship of this clade to the other planktonic foraminiferal clades has remained obscure for many decades. Although the SSU phylogeny cannot resolve the ancestry of the neogloboquadrinids it does show that they have an independent benthic ancestor from those of the spinose and microperforate planktonic groups. The genetic data clearly indicate that morphospecies of the neogloboquadrinid clade consist of a plethora of distinct genetic types. In particular, the two 'coiling varieties' of *Neogloboquadrina pachyderma* show considerable genetic difference in their SSU sequences and in combination with the large ecological differences associated with their geographic ranges this fact is strongly suggestive of species level difference. This conclusion supports numerous earlier suggestions and I will present data, which provide further evidence to this end. To sum up, it appears that genetic and palaeontological phylogenies of planktonic foraminifera can be reconciled. Genetic data provide a powerful, independent testing ground for phylogenetic reconstructions based on fossil evidence as well as guidance in assessing and interpreting the fossil data.

OS01 : WEpm36 : G8 Palaeontological 'Estimates', Molecular 'Clocks' and the Evolutionary History of Lower Chordates and Early Vertebrates

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Recent years have witnessed a renaissance in the study of early chordate and vertebrate evolution. This has been stimulated, at least in part, by the hypothesis that vertebrates and jawed vertebrates evolved through polyploidy. Research has revealed that the extant groups of invertebrate chordates and jawless vertebrates constitute only a vestige of the diversity and disparity attained in the geological past. The fossil record has also revealed a diverse array of

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anatomies that have no counterpart at the present day. This has forced a paradigm shift in the way in which the various nested clades of chordates are thought to have evolved, and in our understanding of the sequence in which key anatomical characters were acquired. Critically, an understanding of the timing and tempo of chordate evolution is lacking, largely as a result of the patchy nature of the fossil record of early chordates and the failure of molecular clock estimates to corroborate one another or palaeontological estimates. Both palaeontological and molecular estimates have been produced for the timing of the most significant chordate evolutionary events; although these lie within the same order of magnitude, they do exhibit considerable discordance. Reconciling which estimates are the best approximations for the divergence of chordates from their successive sister-groups, exploring the implications of differing approaches to calibrating molecular 'clocks'. In summary, we will attempt to reconcile palaeontological and molecular approaches to the dating major diversification events in early chordate evolution, taking into consideration the different hypotheses of relationships implied by morphological and molecular datasets, and the differences between cladograms and phylogenetic trees.

OS01 : WEpo01 : PO Foraminiferal Zonation of the Two Facies Types of Middle Carboniferous in the Western Part of South Tien-Shan (Uzbekistan and Adjacent Countries)

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The Western part of South Tien-Shan (Central Asia) expands over 1200 km and underwent a complicated geological and tectonic evolution. The study of the distribution of foraminifers from the Middle Carboniferous deposits provides clues for tectonic and paleogeographical reconstruction. Two types of sequences in the Middle Carboniferous are observed in South Tien-Shan. They differ in both lithological composition and stratigraphical range, geographically defining two latitudinal bands. The southern band in compasses Bashkirian and Lower Moskovian strata consisting of sequence: a lower - carbonatic (200-300 m) and an upper - terrigenous (150 - 600 m). The lower limestone was developed as a carbonatic platform since the Devonian (Central Kusilkum, Malguzar Mountain, North Nuratau and high foothills of Turkestan-Alay Ranges). The foraminiferal zones: *Varvariella varvariensis* with two subzones, *Pseudostaffella antiqua*, *Pseudostaffella praegorskyi*, *Profusulina parva*, *Ozawatnella pararhomboidalis*, *Verella spicata* (Bashkirian) and *Aljutovella aljutovica*, *Aljutovella priscoidea* and *Pulchrella subpulchra* (Lower Moskovian) are represented in a sections of North Nuratau (Shokhtau) and Turkestan-Alay (Turkala and Akhantau). The upper terrigenous strata are considered according to foraminifers to be Lower Moskovian (Murantau, North Nuratau and high foothills of Turkestan-Alay Ranges). The northern band consists of sections in Central Kusilkum, North Slope of North Nuratau and low foothills of Turkestan-Alay. Two terrigenous cycles are distinct distinguished. (1) Upper Bashkirian and Lower Moskovian terrigenous deposits represent one big sequence - 1500- 2500 m (North Nuratau, Katrantau and Karachatur). Sandstone, siltstone and conglomerate with locally limestone (sandy and organic) predominate, beginning from Upper Bashkirian. The composition of the foraminifers is poorer than in its time equivalent deposits in the southern band. The foraminiferal zones are non-closed from behind of the barren beds in sections. (2) A cycle of the terrigenous rocks with conglomerate on base (2000 - 3500 m) Upper Moskovian age unconformable cover deposits of different-ages. Two foraminiferal zones of Upper Moskovian: a lower - *Kamaina kamensis* is established and an upper - *Fusulinella schwagerinoides* is proposed in Central Kusilkum. Both foraminiferal zones are present in Guzan, Katrantau and Karachatur. Eleven foraminiferal zones are established in the deposits of Middle Carboniferous in South Tien-Shan.

OS01 : WEpo02 : PO Planktonic Foraminifera Biostratigraphy of the Middle Eocene-Lower Miocene Epiligurian Succession (Northern Apennines, Italy)

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A quantitative biostratigraphical study was performed on planktonic foraminiferal assemblages from 15 detailed sections of the Paleogene Epiligurian Succession. The sections crop out in five areas of the Northern Apennines (Italy), between the south-eastern Piedmont and central Emilia regions.

This study enable us to confirm that the standard oceanic and Mediterranean schemes are not valid, as a whole, in this area. Some marker is, in fact, absent or shows a different chronostratigraphical range. In particular, among the most important, is reported the absence of *Truncorotaloides rohri*, *Globoquadrina praedehiscens*, *Globigerinatella insueta* and

Globigerinoides altiaperturae, *Cassigerinella chipolensis* and *Pseudohastigerina micra* don't show a co-occurrence; *P. micra* often disappears before the Eocene/Oligocene boundary.

Some substitutive bioevents have been however identified: the massive extinction of muricate species at the Bartonian/Priabonian boundary; the increasing abundance of *Pararotalia opima opima* at the subzone P21a/P21b boundary (= Rupelian/Chatian boundary), and the FO of *Globoquadrina dehiscens* at the N4a/N4b boundary. The changes in assemblage composition and/or taxa distribution have also required emending some of the zone definitions.

The proposed zones are: - *Acarinina* spp., *Globigerinatella* spp., *Turborotalia cerroazulensis* assemblage Zone - *Globigerina semiinvoluta* interval Zone - *Turborotalia cerroazulensis* s.l. interval Zone - *Pseudohastigerina* spp., interval Zone - *Globigerina ampliapertura* interval Zone - *Paragloborotalia opima opima* interval Zone - *Globigerina ciperoensis* interval Zone - *Paragloborotalia kugleri* total range Zone - *Globoquadrina dehiscens/Catapsydrax dissimilis* co-occurrence range Zone.

The biostratigraphical results are also fundamental to improving the identification of some stage boundaries, in this area:

- the Eocene/Oligocene boundary is here identified by the LO of *T. cerroazulensis* group, but not necessarily by the LO of the youngest species (*T. cerroazulensis cuiensis*) only, and by the marked reduction in size of the pseudohastigerids (< 125µm), with the FO of *Pseudohastigerina naguevichiensis*.
- The Rupelian/Chatian boundary is identified by the LO of *Chiloguembelina cubensis* and by the FCO of *P. opima opima*, which occurs slightly before.
- The Aquitanian/Burdigalian boundary is identified by the LO of *P. kugleri*.

The value of the proposed scheme consists in its complete applicability to five different parts of the quite complex 'Epiligurian basin', over a distance of about 250 km. We think this scheme could represent an important tool to improve the stratigraphic and evolutionary knowledge of the Epiligurian succession, and a useful base to produce biostratigraphic schemes extended to still larger areas.

OS01 : WEpo03 : PO Paleobathymetric Reconstructions Based on Foraminifera: The Example of the Eocene to Miocene Epiligurian Succession (Northern Apennines, Italy)

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Benthic and planktonic foraminiferal assemblages, from several detailed stratigraphic sections of the western and central parts of the Northern Apennines (Italy), have been carefully analysed for their paleobathymetric meaning.

The study has been conducted on the Epiligurian Succession, from the base (i.e. basal Monte Piano Marl Fm., Middle Eocene) to the upper part of the Antognola Marl Fm. (Early Miocene).

Test morphology and composition of benthic and planktonic foraminifera, as it well known, are indicative of many aspects of their life environment. Therefore, the occurrence of peculiar assemblages in modern areas can provide useful information to characterise fossil environments.

In our study paleobathymetric data have been obtained from i) the subdivision of the benthic assemblages (calcareous and agglutinated taxa) into morphogroups, both infaunal and epifaunal and ii) the identification, in the planktonic assemblages, of 'paleobathymetric indexes'.

In the whole studied area the bathymetric data record an overall shallowing trend. In particular a greater bathyal depth (over 2000 m to about 1000 m) has been determined for the Bartonian 'varicoloured facies' of the Monte Piano Marl Fm.. Lower to middle bathyal depth (about 1000 m to 600 m) have been obtained for the Priabonian-Upper Rupelian grey marls of the Monte Piano Fm. and for the sandstones of the Ranzano Fm.. Finally, the Upper Rupelian-Lower Burdigalian Antognola Marl Fm. (and its lateral equivalent units) contains foraminiferal assemblages indicating an upper bathyal paleodepth (about 600 m to 200 m).

These results are particularly relevant due to the lacking, in the studied area, of information of this type valid both on a regional scale and for the whole time interval. Moreover, it is worth of note that paleobathymetric information, from deep-water depositional systems, is particularly difficult to obtain only through facies analysis.

OS01 : WEpo04 : PO
Radiolarian Biostratigraphy of a Pelagic Succession at Monte Inici (Upper Jurassic, Sicily, Italy)

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This study is devoted to the biostratigraphic analysis of Upper Jurassic radiolarian assemblages and their calibration with Ammonites Zones.

The formation under scrutiny is located at Monte Inici, in the northwestern part of Sicily (Italy).

During the Late Jurassic, Sicily area showed a series of structural highs and basins (Catalano & D'Argenio, 1982): Monte Inici was part of a submerged plateau characterized by the deposition of condensed facies like Ammonitico Rosso, even though more basinal facies, such as radiolarites, also occurred.

The studied succession consists of pelagic siliceous limestone comprised between the ammonite-bearing, red nodular limestone of the lower and upper members of Ammonitico Rosso. The siliceous member, of which three stratigraphic sections have been studied, is constituted by an alternation of thinly and evenly bedded red siliceous limestone and calcareous marlstones with chert layers and nodules. In the lower half of the succession, marlstones are more widespread than in the upper one. In the latter siliceous limestone and chert layers prevail and a nodular structure begins to develop.

Only half of the samples show a moderate faunal content. The preservation is approximately the same for all the samples and is not very good. The radiolarian assemblages have identified three possible time intervals for the succession. The base should be dated middle Callovian to early Kimmeridgian because of the presence of *Archaeodictyonitra aptarium*, *Acanthocircus trizonalis angustus* and *Emiluvia orea orea*. The age of the central part spans from Upper Oxfordian to early Kimmeridgian due to the existence of *Acanthocircus trizonalis angustus* and *Emiluvia orea ultima*. Finally, the top part has been dated between Upper Kimmeridgian and early Tithonian given the presence of *Acaeniolite umbilicata* and *Emiluvia orea ultima*.

The ammonites assemblages refer the top of the lower member of Ammonitico Rosso to Middle Oxfordian, because of the presence of species belonging to the *transversarium* Zone, and the top of studied succession to Upper Kimmeridgian, by ammonites belonging to *beckeri* Zone.

In sum, the integration of data referring to radiolarians with that corresponding to ammonites allows dating the pelagic siliceous formation in the period from Middle Oxfordian to Upper Kimmeridgian.

Overall, the calibration with Ammonites seems fundamental for the improvement of the biostratigraphical information provided by radiolarians. However, the validity of this analysis -still under completion- is restricted to the Mediterranean Jurassic Tethys.

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OS01 : WEpo05 : PO
The Ternate Formation (Northern Italy): Planktonic Foraminiferal Biostratigraphy, Calcareous Algae Assemblages and Sedimentary Petrography

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The calcareous Ternate Formation crops out in the Varese province (Northern Italy) and has been drilled in the southern Alps subsurface by the Agip Oil Company (Lisanza well). It covers a chronostratigraphical interval from the late Bartonian to the late Priabonian and represents the lowermost clastic unit of the Eocene-Miocene South-Alpine foredeep clastic wedge. In spite of its scarce outcrops, it is of particular interest because mainly formed by reworked shallow marine grains supplied by a coeval carbonate shelf, which developed on the Southern Alps margin and now completely eroded. In order to better define the kind of shelf, its age and the paleogeographic setting, an integrated study on two sections (Travedona and Ternate) was performed to define: i) planktonic foraminiferal biostratigraphy, ii) calcareous algae assemblages, and iii) sedimentary petrography. In particular, calcareous algae assemblages studies have never been reported in the previous literature. The main results can be summarised as follow: i) the marly base of the studied succession (Travedona section), shows a late Bartonian age (*Acarinina* spp., *Globigerinatheka* spp. and *Turborotalia cerroazulensis* Zone). A Priabonian-early Rupelian age (*Globigerinatheka seminivoluta* - *Pseudohastigerina* spp. Zones) is recorded for the middle-upper part of the Travedona section and for the Ternate section. Calcareous Nannofossil assemblages (Cobianchi, personal communication) confirm an early Oligocene age for the top of the Ternate section (MNP21a Zone); ii) the calcareous algae assemblages show an Eocene-Oligocene (*Lithothamnium moreti*, *Lithothamnium roveretoi*, *Lithophyllum ligusticum*, *Lithophyllum sjmetricum*, or exclusively Oligocene (*Lithothamnium ladronicum*, *Lithophyllum embergeri*, *Lithophyllum kampneri*, *Lithophyllum perrandoi*), chronostratigraphical range. Three species (*Palaeothamnium archaethypum*, *Lithothamnium saxorum* and *Corallina marshallensis*) have been reported as entirely belonging to the Miocene. Therefore, it is necessary to propose a wider chronostratigraphical interval, including Late Eocene and Oligocene. This represents the first occurrence for these species in Italy, and for *Corallina marshallensis*, in Europe. The studied assemblages, composed by dominant encrusting or nodular specimens are indicative of tropical shallow-waters (0 to 60-70 m depth); iii) the dominant lithologies consist of bioclastic limestones, including calcareous algae, larger Foraminifera, bryozoans, echinoderms, other shallow water biota, and minor carbonate terrigenous grains, interbedded with hemipelagic marls containing very abundant planktonic Foraminifera assemblages; iv) the petrographic data show that the intrabacinal bioclastic constituents range from 73 to 87% of total rock, with minor amount of carbonate terrigenous grains mostly fed Southern Alps Jurassic-Paleogene cover units. Sparry calcite (11-33% of the total rock composition) fills the interstices among the bio-grains.

The resulting paleogeographic picture suggests a Middle-Late Eocene Southern Alps, eroded by a poorly developed drainage pattern and bordered by an active tropical carbonate shelf.

OS01 : WEpo06 : PO
Early Jurassic Age of Ferrar Group Volcanism in North Victoria Land, Antarctica: Constraints from Interbedded Fossiliferous Black Shales

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In North Victoria Land (Antarctica), the Mesozoic magmatism is represented by the Ferrar Group, which consists of tholeiitic dolerite sills (Ferrar dolerite) and basaltic lava (Kirkpatrick basalt). This magmatism, dated at the early Middle Jurassic, developed with the emplacement of dolerite sills at 178 Ma, followed by erosion and sedimen-

tation before the main flood basalts at 176.6 Ma. This short duration of Ferrar magmatism indicate a very high rate of volcanic processes at regional scale (Fleming, 1997). In the northern side of the Shafer Peak along the Priestley Glacier (162° 35' 36"E; 74° 00' 13"S, Mount Melbourne Quadrangle), the succession of Ferrar Group starts with massive volcanoclastic breccias with plant debris at the base, intruded by doleritic sills. The upper portion of volcanoclastic breccias is characterised by a silty matrix. Over the volcanoclastic levels a thin black shales horizon macroscopically rich in Conchostracan tests and higher plant debris is present. This fossiliferous horizon is followed by marly siltstones and fine-grained sandstones with crossed stratification. Lava flows with pillows structures and volcanic breccia conclude the sequence. Some samples collected in the black shales have been studied for palynological analyses. The organic residue yielded a rich and well preserved microflora seemingly only composed by spores, pollens, cuticles and others organic debris, indicative of a non-marine environment. Previous palynological works in the Ferrar Group of North Victoria Land (Section Peak), assigned a questionable Early Jurassic age at the recorded microflora on the basis of similarities with other assemblages from Early Jurassic of Australia and Europe (Norris, 1965). The Shafer Peak samples show an assemblage more diversified than the one described by Norris. This assemblage shares several species with the Perth Basin Jurassic microflora (Filatoff, 1975). The abundance of *Classopollis*-type pollens (35%) and the absence of *Dictyosporites complex* allow us to assign the Shafer Peak microflora to the *D. harrisii* Zone (Filatoff, 1975). The *D. harrisii* Zone has been compared (Helby et al., 1987) to the upper part of *Callialasporites turbatus* Zone, which base is defined by a consistent increase of *C. turbatus* and decrease of the *Classopollis* abundance. In the Shafer Peak samples the absence of any reliable *Callialasporites* specimens, allow us to consider the recognized assemblage not younger than the base of the Toarcian, which represents the lower boundary of the *Callialasporites turbatus* Zone. The Early Toarcian age attributed to these lacustrine interbeds within basaltic lava flow, mainly implies that in the North Victoria Land the Ferrar magmatism started before 187 Ma (late Early Jurassic) and indicates that this volcanism do not represents a short-time event.

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OS01 : WEpo07 : PO
Stratigraphy of Cretaceous Radiolarian Cherts of Cuba: Preliminary Results

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We present the preliminary results of a stratigraphic survey that we are conducting of radiolarian cherts of the orogenic belts of central and western Cuba. The radiolarian cherts of Cuba occur in both deep-water continental-margins, and in ophiolite units. In the continental margin sequence of Rosario (Guaniguanico Terrane, western Cuba), the radiolarian cherts of the Santa Teresa Formation overlies Lower Cretaceous basinal sediments which are either composed of limestones (Artemisa Formation), or sandstones (Polier Formation). Four sections of this formation were studied. Biostratigraphic data indicate that radiolarians deposition occurred between the Aptian and the Cenomanian. The allochthonous ophiolite nappe that in western Cuba overlies the Guaniguanico Terrane (Northern Ophiolitic melange) also contains radiolarian cherts, which in some of the exposures occur interbedded with basalts and dark limestones. The radiolarian chert beds are usually red, and they occur alternated with thick claystone interlayers. In all the three studied sections their age ranges between the Aptian and the Cenomanian. Thus these ophiolite cherts are coeval with the continental margin cherts of the Santa Teresa Formation. Finally, the biostratigraphic analysis of an outcrop of red radiolarian cherts that occur within a folded ophiolite unit near Santa Clara (central Cuba), indicates that radiolarians deposition occurred during the Lower Cretaceous, and, in particular, that is not younger than the Aptian.

OS01 Palaeontology, Stratigraphy and Sedimentology

OS01 : WEpo08 : PO Lake Baikal Plio-Pleistocene Diatom Biostratigraphy from Deep Drilling Cores

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Eleven biostratigraphic diatom zones are distinguished in the interval from 5 Ma to 0.8 Ma BP in the Plio-Pleistocene sedimentary record from Lake Baikal. The zone boundaries are defined by FAD (first appearance) and LAD (last appearance) datums of the diatom species in Lake Baikal sediments. Based on the age determinations from magnetostratigraphic data, the Baikal diatom climatostratigraphic zones correlate remarkably with European climatostratigraphic records. The distinct *Teritarius* zone in the Baikal record that corresponds to the first glacial interval of Siberia appears to correlate with the cold Praetiglian period in northwestern Europe. The diatom *Cyclotella comtaeformica* zone corresponds to the cold Eburonian period in the pollen record from Netherlands (Zagwijn, 1997).

Two major biostratigraphic boundaries in the Baikal record are found at 2.6-2.5 Ma BP and at 1.8-1.5 Ma BP. These correspond to both the proposed 2.5 Ma (Sac et al., 1997) and the adopted 1.79 Ma (Berggren et al., 1995) Plio-Pleistocene boundaries. The 2.5 Ma boundary in Lake Baikal is the most dramatic and marked by a complete disappearance of two diatom genera. At the 1.8 Ma boundary species of the same genus replace each other. The changes on high taxonomic level in the Baikal diatom record at ca. 2.5 Ma support the argument for lowering the base of the Quaternary to the Matuyama/Gauss paleomagnetic reversal boundary.

During the Brunhes chron, 31 local diatom assemblage zones are distinguished in Lake Baikal sediments. The zone boundaries are sharply defined by FAD and LAD datums of the dominant diatom species. The age determinations of the diatom zone boundaries are based on correlation with marine isotopic and insolation records (Williams et al., 1997; Prokopenko et al., 2001). The large number of diatom zones during the Brunhes chron reflect the dramatic glacial/interglacial fluctuations of climate, driven by Milankovitch orbital forcing. Almost all diatom zones during the Brunhes chron correspond to individual marine isotopic stages or even substages. During glacial times Lake Baikal was colder and unfavorable for planktonic diatoms. Glaciers surrounding the lake were the source of icebergs and cold nutrient-poor water with fine glacial detritus affecting the transparency of surface water. The planktonic diatom community was completely depressed and almost all glacial periods are marked by extinctions of dominant species of pelagic diatoms. In total 21 diatom species appeared and 17 species went extinct during the Brunhes chron alone. The extinction and appearance of diatom species during glacial-interglacial changes in Lake Baikal are important evidence of climatic control on diatom species evolution (Karabanov et al., 2000).

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OS01 : WEpo09 : PO Carbon Isotope Event Markers Near the Permian-Triassic Boundary in the Idrjica Valley (W. Slovenia)

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The aim of this study was to determine more precisely the variability of $\delta^{18}\text{O}$, $\delta^{13}\text{C}$ carb., $\delta^{13}\text{C}$ org. and $\Delta\delta^{13}\text{C}$ carb.-org. as well as their anomalies in the P/Tr boundary carbonate sequence in the Idrjica Valley and together with the magnetic susceptibility data more precisely determine the duration of the global events, which caused the isotopic anomalies in the investigated section. For this purpose the 55 cm thick P/Tr boundary profile was systematically sampled at 1 cm intervals.

Petrographic observations show that the P/Tr boundary in the investigated area lies within the Tesero Horizon, which is only some tenth of centimetres thick. It contains up to 0.8 cm thick clayey marl (PTB layer) showing characteristic magnetic susceptibility pulse and magnetite spherules. PTB layer represents the P/Tr boundary.

Isotopic data based on $\delta^{13}\text{C}$ carb., $\delta^{13}\text{C}$ org. and $\Delta\delta^{13}\text{C}$ carb.-org. values indicate several carbonate and organic carbon isotopic anomalies as well as perturbations in primary productivity, which may be the results of well known global changes in the carbon cycle at the P/Tr transition. The first perturbations in $\delta^{13}\text{C}$ records of the investigated section begun approximately 400 kyr before the end of the Permian Stage and could be attributed to the different driving mechanisms such as the terminal phase of the end Permian marine regression, oceanic anoxia, volcanic activity and climatic changes. For the P/Tr transition in the Idrjica Valley the gradual increase in $\Delta\delta^{13}\text{C}$ carb.-org. in the topmost 26 cm of the Upper Permian is most probably related to the decrease of primary production during the last 380 kyr. It coincides with the gradual impoverishment of Upper Permian fauna moving towards the boundary and its abrupt disappearance at the boundary as well as by an abrupt decrease of the accumulation rate from 32 cm / 100 kyr to 5 cm / 100 kyr.

The surprising shift of $\Delta\delta^{13}\text{C}$ carb.-org. toward higher values just above the boundary (in the interval from 0 to 3 cm representing 10 kyr) seems to be linked with the hiperproduction of plankton blooms which could be the consequence of a subsequent recovery period in the biological system after the terminal Permian productivity crash.

OS01 : WEpo10 : PO Turbidite Depositions of the Central- Carpathian Paleogene Basin: Submarine Fans, Facies Tracts and paleogeography

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The Central-Carpathian Paleogene Basin (CCPB) represents a large accommodation space of the submarine fan deposits. The lowermost formations of the CCPB contains alluvial and delta-fan sediments and transgressive facies of shoreface sandstones and nummulitic banks. The nummulitic strata are overlain by hemipelagic drapes (Globigerina Marls) or by mud blankets. Next formation of the Sambron-Pucov-Szaflary beds comprises of submarine fan deposits, which show a radial organization and marginality to multiple point-source canyons and related shelf-margin deltas. These sediments are indicative of debris flow deposition, muddy hypopycnal plumes and delta-toe turbidites, which are intercalated by conglomeratic and breccia accumulations driven by en masse movement and submarine landsliding. The Sambron Beds are overlain by claystone lithofacies, which indicate enormous amounts of mud entrained into the CCPB and low efficiency of feeder channel systems. Stratification of turbidite beds reveals a flow-stripping processes (base-missing divisions), formation of dune phase (cross-stratified bedforms), hydroplastic deformation (convolute beds) and traction-carpet deposition (megabeds with multiple Tb intervals). Mud-rich fans represent a simple depositional system with open-fan facies, basinal mudstones, pulsating lobes, Zebra-type

turbidites, large leveed channels, interchannel deposits and megaturbidites. The deposition tended to main flux of turbidite systems during the Upper Oligocene. The basin became to fill up by sand-rich fans, developed in longitudinal systems with counter-directional paleocurrent orientation. Depositional systems exhibit a downfan distribution of facies tracts from markedly channelized, leveed and slump-folded deposits in slope fan, through lobe-and-levee and channel-and-levee deposits in middle fan to lobe-fringe and distal facies in lower fan. Channels are filled by conglomeratic and chaotic accumulations, nivellated by thinning-upward sandstone beds. Lobe units show a progradational stacking and tabularity of turbidite beds. Levee crest and interchannel deposits are characterized by slumps and various wave-current structures (e.g. starved-ripple and climbing-ripple lamination, cross-ripple stratification, flaser-type bedding). Uppermost formation of the CCPB is formed by sandstone lithosomes (sheet sands), which correspond to suprafan-lobe and suprafan-toe deposits. The lithosomes are tabular bodies of massive amalgamated sandstones (S1 flow type), deposited from high-density turbidites or sandy debris flows. Sandstone lithosomes are characterized by sharp contacts, typical for the freezing of high-density currents, by buoyancy of coarser grains (floating granules), by rafted clasts of claystone chips and by transition to laminar intervals (S2 flow type). Erosional and mould structures in sandstone lithosomes (e.g. bulbous moulds, deltooid marks) indicate a high flow regime and load capacity. Their deposition requires a specific hydrodynamic conditions, probably via hydraulic jump, when the flows slowed down and lost efficiency, resulting in accumulation of a high volume of sands. Sandstone lithosomes represent the final stage of the submarine fan deposition in the CCPB.

OS01 : WEpo11 : PO A Zircon SHRIMP+TIMS and Sm-Nd Isotope Study of High-Grade Paragneisses from the Mid-German Crystalline Rise: Evidence for Northern Gondwanan and Grenvillian Provenance and Early Carboniferous High-Grade Metamorphism

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SHRIMP analyses of detrital zircon cores from high-grade metasediments from the Mid-German Crystalline Rise, which forms the suture zone between the Eastern Avalonian and the Saxothuringian terranes, yield mostly ages of ~550 Ma and ~2.06 Ga, with minor ~1.0 and 2.4-2.9 Ga components. U-rich, Th-poor overgrowths record high-grade metamorphism at 356.7 ± 4.7 Ma. TIMS analyses of single zircon grains and small multi-grain populations can be explained by mixing of these components without invoking later loss of radiogenic Pb. The protolith metasediments were deposited during the Late Proterozoic to Early Cambrian, prior to the break up of the northern Gondwana margin at 460-500 Ma. These data are consistent with the sediments' high eNd values (0.9 to -3.0), which are comparable to those of well documented Late Proterozoic sediments from other parts of Europe. The combined isotope data suggest derivation of the sediments from at least three distinct crustal source regions. Dominant sources were the Avalonian-Cadomian orogenic belt (~45%), situated at the northern margin of Gondwana during the Neoproterozoic, and the West-African and/or eastern Amazonian cratons (~45%). The Grenvillian belt was a minor source (~10%).

OS01

Palaeontology, Stratigraphy and Sedimentology

OS01 : WEpo12 : PO

The Relation between Foreland Basin Development and Unroofing History of the Patagonian Andes; Part I: Magnetostatigraphy of the Miocene Santa Cruz Formation

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In the southern Patagonian Andes, the complex subduction history of the Pacific plate appears to have caused significant in the mid-Miocene. Related effect on erosion and sediment flux are recorded in syn-orogenic deposits of the Miocene Santa Cruz Formation in the eastern foreland. However, because of the generally poor exposure of this unit there have been few detailed stratigraphic studies; a better understanding of the chronostratigraphy of this foreland deposit is necessary for an improvement of chronological constraints on biostratigraphy of the Santa Cruz Formation and an assessment of the tectonically driven exhumation of the Cordillera. Here, we report a preliminary magnetostratigraphy for the lower part 280 m of the Santa Cruz Formation in the proximal part of the foreland basin (47.6° S, 71.5° W), where the total thickness of the formation is ~800 m.

Based on stepwise demagnetization of ca. 300 samples from 96 sites, a polarity record with seven well documented reversals was established. A reliable correlation of the local polarity stratigraphy to the geomagnetic polarity time scale is presently not possible, but will be established through ongoing Ar-Ar dating of 3 volcanic tuffs contained in the section.

Thermal demagnetizations revealed two components of magnetization, with a viscous overprint by the present-day magnetic field direction superimposed on the characteristic remanent magnetisation direction.

Rock magnetic analyses indicate magnetite as the dominant remanence carrier. Hysteresis data cluster predominantly in the pseudo-single domain grain size range of the Day diagram. These results are supported by the isothermal remanent magnetization (IRM) acquisition curves. In the bottom 80 m of the section, S-ratios are relatively low and show significant scatter. In combination with IRM curves and hysteresis data this indicates the presence of hematite as an additional remanence carrier. In contrast, S-ratios in the upper 200 m of the section are generally higher and less scattered, characteristic for low coercive mineral phases and indicating a dominance of magnetite as remanence carrier. The generally high concentration of magnetic minerals in the sediments can be explained by the high content of andesitic volcanic clasts in the sediments, documented by sandstone petrography.

OS01 : WEpo13 : PO

About Perspectives of the Triassic Deposits in the Komi Republic

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Triassic deposits in the southern parts of the Komi Republic and in the Vologodskaya, Arkhangelskaya, Kirovskaya, Permskaya regions are presented only by lower section. Lithologically it is composed by red terrigenous formation: red stratum of clay with lenses of aleurolites and sandstone's. At the boundary of the Permian and Triassic deposits there is a horizon of the basal conglomerates. The typical feature of the internal structure of the lower Triassic is rhythm. This formation lies subhorizontally, forming rather shallow depression, which is located at the axial part of the Moscow - Mezen syncline. Structural plan of the lower Triassic is inherited from the upper Permian period, and differs by smaller amplitude, larger isometric's and smoothness of the structures. Mineralogical researchers show that the clay mineral practically in all specimens is sodium smectite mineral with the alumina and ferrous varieties - montmorillonite and nontronite. In the section dominates montmorillonite. There are two varieties of it - regulated and not regulated montmorillonite. Peak of the basal reflection of the first type is clear, of the second type - more wide. At the diffractograms of the first type basal reflection of the second sequence is fixed more often than at the diffractograms of the second type. Differences at

the dissemination of the chlorite and mica allowed to define the Permian - Triassic boundary. In the result of our researchers normal stratigraphic section of the Trias, in the basin of the Vychegda River, was built. Discovered Triassic montmorillonite clays are very important in the national economy. It is important to say that the Triassic conglomerates contain diamonds, what gives a base for their further studying. Also there is an information about barytes concretions in them. All wells near Syktyvkar gave mineral water. So further studying of the Triassic deposits is required.

OS01 : WEpo14 : PO

Paleoflow Directions and Emplacement Mechanisms of Miocene Lahar Deposits in the Cantal Stratovolcano (Massif Central, France) as Inferred from a Photo-Statistical Method

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The main problem of the paleovolcanological studies on ancient volcanoclastic deposits are confronted with is the determination of emplacement mechanisms. Most often, emplacement mechanisms and paleoflow directions are inferred from field observations and compared with data acquired from present-day volcanoclastic deposits. Ancient volcanoclastic deposits, however, may be so weathered and hardened than applications of standard sedimentological methods are practically impossible. The photo-statistical method (e.g., Karátson et al. 1999) allows a quantitative description especially of coarse-grained volcanoclastic deposits including detailed data on clast orientation. This method was applied for lahar deposits in the Miocene Cantal stratovolcano (Massif Central, France). Results are compared with Late Tertiary lahar deposits from New-Zealand, USA, Japan, Turkey and Hungary. Clast alignment (R) values are obtained for individual flow units of the studied lahar sequences and are represented on rose diagrams. Preliminary results on Cantalian lahar deposits indicate that (i) clast alignment values range between 0.37 and 0.60 in accordance with results from studied lahar deposits worldwide, (ii) clast alignment value, particle shape and transport distance are not necessarily correlated and (iii) a number of rose diagrams can display a bi-orientation of clasts (with relatively poor clast alignment value). To explain these results, we propose that clast alignment does not necessarily depend on transport distance. The observed bi-orientation can be accounted for by the remobilisation of the deposit that may disorganise previously emplaced beds by producing sequences containing differently distributed imbricated clusters of clasts with various alignments.

Karátson D & al, *IUGG 22nd General Assembly*, B, p.168, (1999).

OS01 : WEpo15 : PO

Early Palaeozoic Accretion of Perigondwanan-Derived Terranes to Baltica: Data from Provenance Analysis of Sedimentary Sequences Cored by Deep Drillings in Denmark, N. Germany, and N. Poland

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Multidisciplinary investigations, including provenance analysis, isotope datings, and palynology of Lower Palaeozoic clastic sections in the subsurface of Denmark, N. Germany and N. Poland facilitate: a) identification of structural domains with different crustal origins (exotic terranes), b) study of the palaeo(bio)geographic evolution of the northern part of the TESZ, c) timing of terrane amalgamation.

Cambrian clastic sediments from boreholes G-14 (southern Baltic Shield), Leba-8, Bialogora-6, and Zarnowiec-6 (Leba-high area, northern Poland) show clear evidence of provenance from a high grade crystalline source. Detrital composition is dominated by K-feldspar, phengitic muscovite and polycyclic zircons, and the heavy mineral spectra denote a mature Z-R-T configuration, with both euhedral, prismatic zircons of deep magmatic source, and recycled, well rounded polycyclic zircons represented. The zircons show U/Pb radiometric ages of 1500 to 1760 Ma (Laser Ablation - PIMMS single grain dating). ⁴⁰Ar/³⁹Ar single-grain datings of detrital muscovites yield ages of 850 to 1100 Ma. Accordingly, the source area of the Cambrian clastics can be identified with the Baltic Shield.

Llandoverly clastic sediments from the boreholes G-14 and Slagelse-1 (Western Sealand, Denmark) show evidence of mixed Perigondwanan-Baltica provenance. Petrographical evidence of clastic input of Perigondwanan derivation includes occurrence of detrital plagioclase, chromite, organic fragments, and cleaved slate fragments in fine-grained sandstones of Llandoverly age. Single-grain dating (⁴⁰Ar/³⁹Ar fusion analysis) of detrital muscovites from Llandoverly clastic sediments of G-14 and Slagelse-1 boreholes, yielded mixed age patterns with clear Sveconorwegian and Cadomian signatures. Reworked acritarchs of clear Perigondwanan affinity occur in both the G-14 and Slagelse-1 boreholes since uppermost Ordovician times.

The start of detrital input from Perigondwanan source area is interpreted as a response to the initial developing of foreland-type flexure of the Baltic shield in front of the Caledonian orogen in uppermost Ordovician times. On the basis of micropaleontological data, the detrital source of Perigondwanan affinity can be identified with the Avalonia terrane. The occurrence of reworked acritarchs of Llanvirn age and Perigondwanan palaeobiogeographical affinity in Ashgillian sediments (precisely dated as early to middle, pre-Hirnantian Ashgill by chitinozoans) of the G-14 borehole, demonstrates that sediment input from an uplifted Perigondwanan source-area (Avalonia) was active during this time, and the Tornquist Ocean was probably closed.

Accordingly, closure of the Tornquist Ocean occurred during pre-Hirnantian Ashgill (lower part of Dicellograptus anceps Graptolite Zone), between 450 and 440 Ma in terms of absolute geological time.

OS01 : WEpo16 : PO

Sedimentological and Palaeontological Features of the Holocene Deposits Capping Volcanic Banks of the Gulf of Naples, Eastern Tyrrhenian Sea

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In the northwestern sector of Gulf of Naples, Eastern Tyrrhenian Sea, a belt of submerged volcanic banks ('Miseno' and 'Penta Palummo') develops on the continental shelf as the offshore continuation of the Phlegrean Fields, a large Late Quaternary volcanic district of Southern Italy. These banks develop at depths of 28 -72 m and are formed by relicts of Upper Pleistocene volcanic edifices covered by a relatively thin Late Quaternary marine sequence. A study conducted on sediments collected from the sea floor indicates that the deposits capping the volcanic banks are characterised by bioclasts, pumices, volcanic fragments and dark minerals (pyroxenes). Most of bioclasts are represented by fragments of coralline algae, bryozoans and molluscs. The benthic foraminiferal assemblage is prevalently characterized by epiphytic species. Based on the reconstructed thanatocoenoses (macro and microfossil assemblages) it can be concluded that the bioclastic sand is mostly autochthonous and derived from the break-up of algal buildups. The unconsolidated bioclastic fraction is colonized, in turn, by encrusting coralline algae and bryozoans. Most of the finest carbonatic grains are formed in situ by bioerosion; the resulting product is a Rhodalgall lithofacies, characterized by encrusting coralline algae, which is typical of open continental shelf developing within the temperate climatic zone.

OS01

Palaeontology, Stratigraphy and Sedimentology

OS01 : WEpo17 : PO High-Resolution Log-Sequence Stratigraphy of the Upper Paleocene Deposits in the Eastern North Sea Basin

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High-resolution stratigraphic analyses of the Upper Paleocene succession in the Danish North Sea sector and the adjacent parts of the basin have been performed on the basis of well logs from more than 50 wells. The succession comprises hemi-pelagic marls and muds of the North Sea Marl and Lista Formation. The lower and upper boundaries of the succession correspond to the boundaries for Sequence 1.1 of Michelsen et al. (1998) and are proposed to coincide with lows on the eustatic sea level curve of Haq et al. (1988).

Eight lithological units within the North Sea Marl and Lista Formations has been recognized by distinct log-patterns. Especially the sonic and resistivity logs have proved to have a high correlation potential. The unit boundaries are located at marked changes in log readings without regarding genetic stratigraphic relationships. However, ten internal surfaces marked by high gamma ray peaks, followed by upward decreasing gamma ray trends, are considered to reflect flooding surfaces. At least four of these surfaces are biostratigraphically documented and correlated with flooding surfaces described by O'Connor & Walker (1993) from the UK Moray-Firth area.

The North Sea Marl and Lista Formations consists mainly of hemipelagic marls and muds intercalated by gravity derived coarser materials. The lithology of the hemipelagic sediments shows significant vertical variations which can be traced laterally within the main part of the area, and partly also in the Danish onshore area. The eight lithological units are, therefore, regarded as isochronous within the study area, which is supported by the biostratigraphically documented correlation of flooding surfaces to the UK Moray-Firth area. This gives rise to propose a detailed cyclicity within the hemi-pelagic deposits.

It is generally acknowledged that the main transport direction during the Late Paleocene was from the British Isles to the northwest. Mapping of the thickness distribution of selected parts of the analysed succession indicates that the eastern North Sea and southern Central Graben was dominantly fed by sediments transported from the eastern margin of the basin in the early Late Paleocene. The greater thicknesses of the upper Upper Paleocene in the northern part of the Danish Central Graben compared to the more condensed succession near the eastern basin margin suggest sediment transport from the northwest, the British Isles.

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