8th NECLIME Annual Meeting 2007

25th to 28th of October, Bratislava, Slovakia

We were pleased to welcome colleagues from different countries at the annual NECLIME meeting from 25th to 28th October 2007 at the Faculty of Science in Comenius University in Bratislava, Slovakia. There were discussed two main scientific topics.

- **Mio/Pliocene climate in Eastern and Western Eurasia: comparing data from Europe and China**

  Today the eastern and western coasts of Eurasia are under very different climatic conditions influenced by the predominant atmospheric and oceanic circulation. During the Neogene these conditions changed severely. The patterns and changes of the European climate have been studied intensively by NECLIME during the last years. In parallel, a lot of work has been done by Chinese NECLIME members to reconstruct the climate development in China. One session of our meeting was devoted to the combination and comparison of these results.

- **The influence of vegetation on climate: evidence from plant and vertebrate proxy-data and modelling**

  There was presented integration of the results from different sources concerning the development of climate and vegetation. There are still a lot of open questions concerning the timing and progress of the expansion of grasslands on the one hand, and the influence of this development on climate change on the other. Independent sources of information like vertebrates, plants, climate and vegetation modelling can help to unravel the various interferences between climate and vegetation.

  It was pleasure for organizers to welcome all “NECLIME people” in Bratislava and we are looking forward to meet in Izmir at NECLIME 2009.

Acknowledgements

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Marianna Kováčová, Angela A. Bruch

Abstracts

Palynological record from the Late Oligocene and Miocene of BİGA Peninsula (NW Turkey), with emphasis on mangrove

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NNE–WSW trending coaly Tertiary basins crop out from north to south as Lapseki–Biga, Çan–Etili and Yenice–Kalkım–Çırpılar located to the Biga Penninsula. First palynological data indicate that lignite deposits between Lapseki and Biga are different from lignite deposits outcropping Çan and Etili district with respect to temporal and environment.

The sequence outcropping in a restricted area of eastern part of Şevketiye village located to Lapseki–Biga road generally consists of tuff, sandstone, bituminous shale, lignite–bearing claystone, lignites and their alternation. A well preserved diverse palynological assemblage indicates a Late Oligocene. The palynomorph content of the samples obtained from the lower part of the sequence determines a back mangrove environment including *Longapertites* (Arecaceae, Lepidocaryoideae), *Arecipites* (Arecaceae), *Monocolpopollenites tranquillus* (Palmae) and *Leiotriletes adriennis* (*Acrostichum*). Back mangrove environment was replaced by mangrove environment through to upper part of sequence because of abundance of P*silatricolporites crassus* (*Pelliciera*) and presence of *Spinizonocolpites*

(*Nypa*), foraminifer test linings and dinoflagellate cysts. Both palynomorph assemblages signal an environment reflecting transport by streams backround during entire sedimentation.

The lignite basin surrounding Çan–Etili consists of lacustrine and fluviatile sediments interfingering by volcano–sedimentary rocks. The palynomorph assemblage generally consists of Cupressaceae, Sparganiaceae, *Alnus*, *Quercus*, *Castanea* and *Liquidambar*, indicates a Middle Miocene age. Lowland-Riparian and montane elements are characterized by the dominance of *Engelhardia*, *Liquidambar*, *Quercus*, *Podocarpus*, *Alnus*, *Ulmus*/*Zelkova*, Cyrillaceae, *Pinus*, *Cedrus* and *Castanea*. Swamp-Freshwater elements are represented by Sparganiaceae, Taxodiaceae, Cupressaceae and *Nyssa* as well as fern spores such as Osmundaceae and Polypodiaceae.

In this study, terrestrial palaeoclimatic conditions of Çanakkale area are first discussed based on the coexistence approach method.

Paleoenvironmental Interpretations on the Floral Assemblage from Cemitery Paleolake, Catalão, Goiás, Brazil

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The lacustrine deposits from Cemitery Paleolake are composed of diatomites, argilites and spongilites, and are superimposed on carbonates and magmatic rocks of Late Cretaceous age. The microspongilite is composed of freshwater sponges indicating a lentic freshwater environment. The abundant plant macrofossils have been recovered from the thick diatomites and thin layered argillites. The plant remains characterize a local palaeoflora that existed in the Mid-Western Brazil, during the late Neogene/early Quaternary, where today the vegetation corresponds to the Cerrado Biome. Fruits, seeds and leaves are preserved as impressions, compressions and adpressions, showing a floral assemblage composed of elements belonging to different dicotyledonous families, such as Myrtaceae, Lauraceae, Tiliaceae, Cecropiaceae, Myrsinaceae, Bixaceae, Leguminoseae and others. Besides, there is the presence of remains of fungi, algae and pteridophytes, the last related to the families Dennstaedtiaceae and Blechnaceae. The main goal of this study is the reconstruction of the paleocommunities to understand the local environmental and climatic conditions which have

predominated in that time through the region. This could help in better knowledge on the origin and evolution of the Cerrado Biome. Distinct techniques have been used, such as fluorescent microscopy for pollen and cuticle analyses, geochemistry for organic matter studies, drawing and photographic techniques for taxonomy, and climate quantifications with the Coexistence Approach (CA) and the Leaf Margin Analysis (LMA) for paleoclimatic characterization. Partial results show: (a) the occurrence of ancient wildfires in this region at that time indicated by fusenite recovered from the organic matter of some specimens; (b) the presence of a riparian forest similar to the wet forest found in the Cerrado today, which has been confirmed by taxonomic analysis; (c) average temperatures around 4°C higher than today according to both methods used (CA & LMA). The taxonomic analysis also confirms the existence of a unique paleoflora composed of some taxa that are not co-occurring in any modern flora.

Neogene paleoclimate in Carpathian area. An evaluation based on a synthesis of the Neogene paleofloras from Romania and Moldova Republic.

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The Neogene Flora from the eastern part of Europe is not well understood if the Romanian local Floras from inside and from around the curvature of Carpathians is not known. Unfortunately a recent synthesis on this subject is absent. Only the extensive book of Givulescu (1997), as a critical synthesis of all the paleobotanical studies of the Tertiary of North-western part of Romania partially fulfils this condition. It presents a paratropical to subtropical type of flora till temperate, mainly arboreal, with many typical thermophilic taxa. Another partial synthesis is represented by an unpublished paper of Stefârta (1997) made as a report in order to obtain the tile of “doctor habilitate”, and comprehend the Neogene Flora from Moldova Rep. The unpublished Ph.D. theses of some of the authors of the present critical “synthesis of syntheses” also had a similar character and have been used here. Few not important small floras described in the area remained out of this synthesis. Unfortunately, all these papers were redacted in Romanian, so they remained unknown for the scientific community.

The scientific evaluation of the Romanian Neogene Flora, made by us, allows a better reconstruction of the Neogene Paleoclimate and the resulted curve of paleotemperatures is compared with some already constructed curves by some Romanian authors.

The Rise and Fall of Pikermian Chronofauna

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We build on previous research (e.g. Bernor et al., 1979; Bernor, 1983; Fortelius et al., 2002; Eronen, 2006) to integrate the evolution of Pikermian-type mammal faunas to their ecologic, climatic and paleogeographic contexts. We use similarity index comparisons to map out the spatial extent of Pikermian fauna, and how it developed over time. We then use recently developed late Miocene palaeoclimatic and palaeogeographical reconstructions to assist in our interpretations.

According to our results, the Pikermian fauna started to develop in the middle Miocene of central-western Asia and then expanded east and west during the late Miocene. Its distribution was from China to the Balkans during the latest Miocene, and it was followed by an almost complete collapse during the early Pliocene. We also compare this development to that of the Clarendonian Chronofauna of North America which was similar in its faunal composition. Importantly, it was not simultaneous but associated with similar climatic context and development as the Pikermian chronofauna. We hypothesize that the driving factor for the rise and fall of the Pikermian fauna was a regional climatic development that allowed the Pikermian fauna to flourish under certain climatic conditions.

Early Miocene (Ottnangian) coastal upwelling along the Bohemian Massif revealed by stable isotope data ($\delta^{18}O$, $\delta^{13}C$) of planktonic foraminifera

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Measuring stable isotopes of oxygen and carbon is a common tool in paleobiology for estimating paleoenvironmental parameters like temperature, productivity and salinity. In the present study, this tool is applied to planktonic foraminifera of the Lower Miocene (Ottnangian) Zellerndorf Formation. The silty clays of the Zellerndorf Formation and intercalated diatomites of the Limberg Member are reported from several localities in the North Alpine Foreland Basin of Lower Austria. Faunal and sedimentological data of earlier studies on these deposits (e.g. Roetzel et al., 2006) suggest coastal upwelling of cold and nutrient-rich water masses along the steep south-eastern scarp of the Bohemian Massif. Whereas the diatomites of the Limberg Member are dominiated by silicious microfossils, there are several small planktonic species of microperforate tenuitellinids and globigerinids known from the overlying Zellerndorf Formation with blooms of *Tenuitellinata selleyi* and *Turborotalita quinqueloba*, both indicative of cooler water masses.

For this study, samples from the Zellerndorf Formation above the diatomite were collected at the sections Parisdorf and Limberg. The species *Globigerina lentiana*, *Globigerina praebulloides* and *Tenuitella clemenciae* were chosen for isotope measurements. Additionally, bulk samples of all collected samples were measured.

All the species of the Parisdorf section display slightly negative $\delta^{18}O$ values between -1.5‰ and -0.7‰ indicating rather cool water temperatures ranging from 10–14°C (based on the equation of Bemis et al., 1998 and suggesting a SMOW of -1 according to Lear et al., 2000). The $\delta^{13}C$ values are low and vary between -1.5‰ and -0.8‰. In the Limberg sample only Globigerina praebulloides was measured. The δ18O data suggest slightly warmer surface temperatures compared to Parisdorf and the $\delta^{13}C$ ratio is more negative.

Both data sets correspond well with published isotope signatures of *Globigerina bullloides* reported for Pleistocene and recent upwelling settings (Faul et al., 2000; Peeters et al., 2002). This species is the direct descendant of the herein measured G. praebulloides and is thus considered to be a reliable base for this actualistic comparison. Furthermore, the results differ clearly from Miocene *G. praebulloides*-signatures of non-upwelling areas. Bulk samples of both sections display $\delta^{18}O$ ratios between -3.7‰ and -2.1‰ and $\delta^{13}C$ variations between -1.2‰ and +0.4‰ without recognisable trends. The observed variation of 1.2‰ in $\delta^{18}O$ may be related to seasonal temperature fluctuations. The offset in isotopic composition of foraminifera and bulk samples (mean: 1.9‰) is probably related to the contribution of nannoplankton carbonate in the bulk samples.
The $\delta^{18}O$ ratios can also be used to separate different species according to their depth habitats. *T. clemenciae* shows the highest $\delta^{18}O$ values (-0.8‰) indicating that this species lived in a deeper part of the water column than the globigerinids. When possible, globigerinid specimens were separated according to their size (fractions 0.063µm and 0.15 µm). Generally, the large tests of *G. lentiana* and *G. praebulloides* yield heavier $\delta^{13}C$ values than in the smaller ones. In extant globiginerids this offset is linked to ontogenetic effects (Peeters et al., 2002).

The distribution of equivalent diatomitic deposits along the western and eastern margin of the Bohemian Massif and in the Polish Carpathians (Kotlarczyk, 1988) suggests that the recorded upwelling is not only a local phenomenon. Hence, this hydrodynamic regime has to be integrated in future reconstructions of the Central Paratethyan oceanography during Ottnangian times.

Buried Late Miocene forest at Bükkábrány, Hungary

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A unique fossil assemblage – fifteen 'in situ' trunks standing at their original position – was explored at the open cast lignite mine of Bükkábrány, N Hungary. The trunks occupying an area of 50 x 100 m have been preserved in Upper Miocene deposits, in grey sands overlying the lignite seam. The height of the trunks ranges from 2 to 5.2 m, their perimeter at the base reaches even 8.8 m. Their macromorphology, type of base and surface character, resembles modern *Taxodium*. Especially the

broadening base recalls the buttressed trunks of *Taxodium* trees growing in flood-prone sites. Their age according to the regional stratigraphy is estimated to 7.5 million years (Magyar I. personal communication).

The fossil forest is presumably the remnant of a swamp forest which is also corroborated by the paleogeographic position of the fossil site at the area of the former Pannonian Lake. Fossil leaf and fruit assemblages indicating the typical swamp vegetation associated to the Pannonian Lake have already been reported from the site. The systematic study of the trunks (M. Dolezych), the associated macro- and microflora provides proxy data for local flora and vegetation reconstructions, 3D reconstruction of the swamp forest, palaeoecological and climate analyses.

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High-resolution palynology and sub-Milankovitch cycles in Lake Pannon – coupled or decoupled?

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The influence of the Milankovitch cycles on Lake Pannon sediments has been proven during the last years by well-log analyses in the Vienna Basin (e.g. Harzhauser et al., 2004). Eccentricity signals (100-kyr, 400-kyr) can be detected throughout the lower Upper Miocene and through the upper Middle Miocene (Sarmatian) with high accuracy. Cyclic changes of habitability and oxygenation of the lake bottom was also inferred from rhythmic occurrences of within-habitat bivalve-pavements, formed by near-monospecific opportunistic dreissenids (Harzhauser and Mandic, 2004). That study was conducted within an outcrop at Hennersdorf close to Vienna, where basinal clay is exposed. To achieve an even finer paleoecological record a series of cores have been taken along the Hennersdorf section within an ostracod-project under the leadership of Dan Danielopol (Institute for Limnology, Mondsee). Each core was cut into samples of 5 mm thickness and analysed for the ostracod fauna.

First results suggest a high-frequency cyclicity of environmental parameters, expressed by iterative variations of the taxonomic composition and the oscillating number of specimens counted per sample. The forcing mechanism is not understood yet but considering the established correlation of the deposits with the Milankovitch frequency bands, the observed high-frequency oscillations have to be correlated with higher frequency cycles such as the sub-Milankovitch cycles.

All samples are now also analysed for dinoflagellates and for terrestrial palynomorphs. The aim of these studies is to understand if the cycles observed within the benthic fauna are also expressed by the dinoflagellate record. This would implicate that the observed cycles are also affecting the surface waters of Lake Pannon and are not only an expression of bottom-water oxygenation. The comparison with the palynological signal will allow to recognise if the forces that had influenced Lake Pannon hydrology are expressed also in the terrestrial ecosystem. Our working hypothesis is that a rhythmic signature of the pollen record coinciding with the aquatic signature will point to a general sub-Milankovitch climate forcing in the Alpine-Carpathian realm during the Late Miocene.

Astronomical forcing of depositional systems and mollusc radiations in the Miocene Dinaride Lake System

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The Dinaride Lake System (DLS) was a long-lived, lacustrine-continental environment which became established during the early Miocene along the Dinaric Land on a paleogeographic barrier between the Paratethys and the proto-Mediterranean seas. Two main lacustrine phases occurred in the DLS. The first phase may coincide with a global mid-Burdigalian sea level lowstand which resulted in the restriction of the Paratethys during the Late Ottnangian. At that time, endemic lake-molluscs can be traced as far as the Bakony Hills in Central Hungary. The second phase, occurred around the Early/Middle Miocene boundary and was restricted to the Dinarides. The Dinaride land mass had at that time become smaller, because its former northern shore was already flooded by the Paratethys

Sea. The molluscs of both phases are nearly completely fully endemic, originating from autochthonous speciation and radiation events. In total, about 190 species level taxa, grouped into 36 genera, are described from the DLS. Among these, the most diverse genera are prososthenid (*Prososthenia*) and melanopsid (*Melanopsis*) gastropods, followed by dreissenid bivalves (*Mytilopsis*). Each of these groups comprises more than 30 species and subspecies.

First fieldtrips concentrated on the Sutina section in the Sinj Basin (SE Croatia) with a 140-m-thick marl/lignite succession. The Sinj Basin belongs to the southernmost basins of the Miocene Dinaride Lake System, positioned on the paleogeographical high between the Central Paratethys and the proto-Mediterranean Sea. Its sedimentary infill is composed by more than 300 m thick lacustrine sediments comprising carbonates, marls and important lignite deposits. The sediments are highly fossiliferous bearing in part a rich mollusc fauna. Its taxonomic inventory represents one of the best known for the whole Dinaride Lake System. The studied section represents the topmost part of the basin's sedimentary infill and comprises two main transgressive-regressive cycles starting with light carbonates and ending with massive lignitic beds. Based on the sedimentological field research, the deposits are tentatively grouped into six facies. Limestones strongly predominate. Biogenic deposits are represented by lignite intercalations and mollusc coquinas, but the occurrence of calcarenites and marls is very rear. Additionally, pyroclastics are represented by at least one intercalation. The poor content of siliciclastics is explained by very low rate of river supply and the predominantly carbonatic basement formed by Cretaceaous and Eocene limestones. The high percentage of endemism impedes straightforward biostratigraphic correlation with regions. As absolute datings (magnetostratigraphic and radiometric) are still in progress, a first approach is a cyclostratigraphic interpretation to allow an estimation of the relative time which is represented in the section. For this, geophysical data (gamma-logging) have been obtained in the field from the highly rhythmic marl/lignite successions and subjected to spectral analysis. The spectral analysis of gamma-log data proved the significance of 17-m-thick sedimentary cycles which have been correspondingly interpreted as being forced by the 100 kyr eccentricity periods. Hence, the succession could represent the deposition of about 800 kyr resulting in a mean sedimentation rate of about 0.2 mm/yr. Based on this time frame the evolutionary pulses of the mollusc faunas can be evaluated. As the most eye-catching feature, the melanopsids and prososthenid gastropods display low disparity and low diversity close to the main phases of lignite-formation, which are interpreted to be expressions of the 400 kyr eccentricity band. In the intervening interval, diversification starts and the morphologic disparity increases considerably. A climatic trigger, resulting from astronomical forcing,

is therefore a very likely component which influenced the evolution of the lake molluscs.
The investigation is part of the Austrian FWF Project P18519-B17: "Mollusc evolution of the Miocene Dinaride Lake System" and "Neogene terrestrial environments of the Pannonian Basin and carst region" supported by Ministry of Science, Education and Sports of the Republic of Croatia.

Associations of calcareous dinoflagellates from the Sarmatian sequences of the Vienna Basin, the example from the Jakubov section

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Low diverse associations of calcareous dinoflagellate cysts consisting mainly of taxa with an oblique ultrastructure are reported from Sarmatian (late Middle Miocene) coastal marine sediments. Samples were derived from the Skalica Formation of the Jakubov locality. Three boreholes J64 A2, J 29 a JZ 46 were sampling. 13 samples were studied in detail in order to bring information about their content of calcareous dinoflagellates.

The Skalica Formation is rich in fossil remnants: nannoplankton, planktonic and benthic foraminifers, mollusks, ostracods, fish skeletons and otholites, and also flora fragments and pollens. The age of sequence was determined by foraminiferal assemblages belonging to Porosonion granosum Zone and nannofossil local Zones (Kováč et al., 2006).

The study shown the dominance of morphotypes with an oblique ultrastructure of two types of needle-like crystallites and very thick layers of the cyst wall belonging to *Pirumella* genus. The following taxa are newly introduced: *Pirumella gigantea* n. sp., a *Pirumella gigantea granulate* n. sp. which are dominated over *Pirumella edgari* and not so frequent forms of *Cylindratus*, *Bicarinellum*, *Calcicarpinum* genus.

Lithology, microfaunal and microfloral spectra determine the sedimentation in instable warm-water shallow marine (lagunal) environment (with maximum depth 15 m), with fluctuation of salinity and oxygen content. The results obtained and paleoecological interpretation based on calcareous

dinoflagellate cysts distribution coincide very well not only with those shown by planktonic and benthic foraminifera, nannoplankton.

Modelling the interactions between past vegetation and climate changes

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The Neogene period is characterized by a progressive opening of the vegetation, with replacement of the forest cover by grasslands or deserts in many areas of the world, a change which is parallel to the overall cooling of the global climate. This trend culminated during the cold periods of the Pleistocene. For instance, at the last glacial maximum, forested areas were strongly reduced compared to the present, while deserts and grasslands expanded on all continents. In general, vegetation cover was less dense. Such a change is expected to lead to an increase of surface albedos and a decrease of roughness lengths. Both effects may impinge on surface temperatures. Here, we use the CARAIB vegetation model (Otto et al., 2002, Global Planet. Change, vol. 33:117–138) together with the Planet Simulator, an earth system model of intermediate complexity (http://www.mi.uni-hamburg.de/Planet-Simulator.216.0.html) to analyse the impacts of surface cover changes on global climate, as well the feedbacks involved in the vegetation-climate system. The results of these coupled simulations are used to discuss the observed changes between the last glacial maximum and the present, and between the Miocene and the present.

Reconstruction of vegetation and climate history from Late Miocene to Pleistocene based on palynological evidences from Zada Basin (Tibet), Preliminary Results

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Zada Basin (SW-Tibet, present elevation about 4.000 m a.s.l.) is a basin with fluvio-lacustrine to lacustrine sediments ranging in age from Late Miocene to Pleistocene. In the years 2005 and 2006 more than 100 samples were taken for palaeomagnetic, sedimentary and palynological investigation. A first analysis of the samples with palynological methods has following results: About 86 taxa of different plants were recognised in 49 samples yet analysed. This means 12 taxa of gymnosperms, 32 taxa of pteridophyta/bryophyta, 34 taxa of angiosperms as well as 8 taxa of algae could be differenciated. The main taxa of gymnosperms are (in botanical names) *Picea*, *Abies* and *Pinus*. The main taxa of pteridophyta/bryophyta are Polypodiaceae, Lycopodiaceae and Pteridaceae. For angiosperms the most frequent taxa are Compositae, Poaceae, Chenopodiaceae and *Juglans.* Also high amounts of charcoal particles are preserved in the samples. A strong fluctuation in the absolute number of taxa in the samples is visible. The number of taxa ranges from 3 to 38 in some samples. Most prominent gymnosperms are *Picea*, *Abies* and *Pinus*. All other taxa are rare comparing to their abundance. These results are representative for a mountain forest builded up from *Picea*, *Abies* and *Pinus* and additional trees like *Juglans*, *Betula* and *Cedrus*. The undergrowth vegetation was consisting of Polypodiaceae, Pteridaceae and Lycopodiaceae as well as Poaceae, Compositae and Chenopodiaceae at dryer places. The climate conditions were temperate and humid. The fluctuations in number of taxa might be due to variations in water supply. The more dryer the conditions have been the less number of taxa survived. An alternating monsoonal system with more stronger and weaker precipitations could be responsible for that. A monsoonal system is indicated because of some palynomorphs with long distance transport origin. Pollen of *Alnus*, *Corylus*, *Quercus*, *Carpinus*, *Symplocos*, Euphorbiaceen and Oleaceae. These have been detected in some samples. This taxa do not grow in forests on a high elevation. They must have been transported out of the lowlands at the southern side of Himalaya mountains (e.g. Siwalik Basin).

A synthesis of the Neogene palynofloras from Carpathian area, Romania. Climatic significances.

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In the Romanian Carpathians a lot of palynological studies have been made, based on a material coming from Neogene terranes. Spread in numerous small papers, most of them in Romanian, these studies show new lists of Neogene plants, that will be good to be compared with those obtained by

the study of other fossil vegetative plant parts. A book of Petrescu (2003) tried to cover the necessity of a synthesis.

Evaluating the paleoclimatic significances of the lists of equivalent taxa it's also good to observe the similitude of the resulted curves of temperatures with those obtained evaluating other fossil identified plant parts.

Vegetation characteristic and dynamic in three late Miocene lacustrine basins derived from pollen data: differences and agreements

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The Neogene basins in Bulgaria are widely distributed, comprising the sediments aged from the latest Oligocene up to the latest Pliocene. Being part of the Balkan Peninsula, the territory of the country is key area in studying the evolution of the Neogene flora, fauna, palaeoecology, and palaeogeography, as well as in tracing the migration ways of plants and animals between West and Central Europe and Asia Minor. On the other hand the region is important in understanding the evolution and origin of the Mediterranean flora and vegetation due to the presence of a lot of ancestor plant species of the recent Mediterranean ones.

The present report focuses on palynological studies in three freshwater basins situated in the West Bulgaria, aged as Upper Miocene and Pliocene: Kanina opencast mine in Gotse-Delchev Basin, Beli Breb Basin, and Staniantsi Basin. The Neogene floras have been analyzed from taxonomic and palaeoecological point of view. As regard the geology of the basins, some of them are relatively well known from different points of view of the geological science, i.e. lithology, palaeogeography, fossil content, etc. The age of flora bearing sediments covers the time span late Maeotian – Pliocene as it is

proved by faunistic data and floristic analysis (Angelova et al. 1991, Palamarev et al. 1999). The main vegetation communities were distinguished. The ratio between main floristic elements and changes in the composition of fossil floras have been analyzed and discussed. Floristic differences between three basins in time and space and patterns of vegetation evolution were traced out. On the base of the floristic analysis and vegetation peculiarities the main climatic values were supposed.

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Stratigraphy and microfaunal data of the Oligocene and Miocene ages in the Alakilise and Kultak regions (Gökova region)

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In this study, Kulak and Alakilise regions located on the Gökova Gulf and five stratigraphical sections measured in these regions. The basement rocks of study areas are represented by Mesozoic limestones and sandstones and shales alternations. These rocks are unconformably lies on the Oligocene sequence which is consisted of marl whit poor leaf fossils and coal. This terrestrial sequence is unconformably overlied by the Oligo-Miocene sequence which included marine limestones with abundantly bivalvias (Pecten and *Turitella sp.*), corals and foraminiferas. According to foraminiferal data (*Miogypsina sp.*,*Miogypsinoides sp.*, *Operculina sp.*, *Lepidocyclina sp.*, *Lepidocyclina cf. dilatata*, *Lepidocyclina* (*Eulepidina*) *sp.*, *Amphistegina sp.*, *Ditrupa sp.*, *Mississippina sp.*, *Quinqueloculina sp.*, Haurenidae, Rotaliidae, Textulariidae and Acervuliniidae), this sequence is Aquitanian age and foraminiferal fauna of the Aquitanian age is suggested shallow shelf environment. This sequence uncormably overlied by the Middle Miocene sequence that is includes conglomerates, sandstones, claystones and marine sandstones, limestones and marls with abundantlys corals, bivalvias and foraminiferas (*Anomalina sp.*, *Amphistegina sp.*, *Heterostegina sp.*, *Quinqueloculina sp.*, Acervuliniidae, Anomaliniidae, Discorbiidae, Rotaliidae, Hauerinidae, Textulariidae, Valvulinidae, Annelida, Soritidae, Gastropoda and Bryozoa). Foraminiferal fauna of the

Middle Miocene characterizes Langhian age which is suggested the marine shallow water environment. Moreover, mudstone and conglomerates of this sequence includes palynomorphs and mamalian fossils that is indicated Orleanian-Early Astaracian (MN5-MN6 boundary) (Kayseri et al., 2006).

This study supported by the TUBITAK project (104Y297) and DAAD. Palynoflora

Palynological results of the Middle Miocene deposits in the Milas-Ören region (western Anatolia)

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Middle Miocene sediments are widespread in surface sections of the Muğla region (Milas-Ören and Muğla-Yatağan) which are formed by the marl and coal seams. The present palynological investigations aimed at gaining new evidence on the age, palaeoclimate and palaeoenvironmental setting of the Middle Miocene sediments.
The Middle Miocene subtropical flora is characterized by the Cyrillaceae, Polypodiaceae, Osmundaceae, Taxodiaceae, *Pinus*, *Pinus-silvestris* type, *Cathaya*, *Quercus*, Castaneae, *Ulmus*, *Zelkova*, Cycadaceae, *Engelhardtia*, *Carya*, *Salix*, *Platanus*, *Alnus*, Nymphaceae, Chenopodiaceae, Pterocarya, Asteraceae and Poaceae. Palaeovegetation is represented by the swamp forest and upland flora during the deposition of the Middle Miocene coals. Upland flora makes up of *Pinus*, Castaneae, *Cathaya* and *Quercus.* Swamp forest comprises Myricaceae, Cyrillaceae and Taxodiaceae. Riparian and freshwater aquatic members that are *Pterocarya*, *Carya*, *Alnus*, Nymphaceae and *Pediastrum* are represented by an abundant species.

In this study, palaeoclimatic conditions of Milas-Ören region are discussed based on the coexistence approach method and palaeoclimatic conditions of the other Middle Miocene region in the western Anatolia are correlated with the coexistence approach results of this region.

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Vegetation and Climate of Ören region (western Anatolia) in the Oligocene and Early Miocene

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The Oligocene and Miocene from the Muğla-Ören region are represented from below to the top, by the Oligocene lacustrine sequence and Early Miocene terrestrial and marine sequences. In Kultak region (Ören) the Oligocene lacustrine sequence outcrops. The sequence deposits is a marl and coal, rich in spores and pollen, that overlays by disconformity the Early Miocene marine limestones, sandstones and coals.

Eleven samples of coals in the Oligocene sequence and eighteen samples of coals and mudstones in the Oligo-Miocene sequence were collected for palynological studies. Sporomorph of the Oligocene sequence is characterized by the *Verrucatosporites favus favus*, *V. alenius*, *Leiotriletes maxoides maxoides*, *L. maxoides maximus*, *Pityosporites microalatus*, *Piceapollis planoides*, *Triatriopollenites coryphaeus*, *T. exelsus*, *Plicapollis pseudoexelsus*, *Plicatopollis plicatus*, *Slowakipollis hipophäeoides*, *Bohlensipollis hohli*, *Dicolpopollis kockelii*, *Subtriporopollenites facilis*, *S. anulatus nanus*, *S. constans*, *Compositoipollenites minitus*, *Longapertites triangulatus*, species of Liliaceae, *Pentapollenites pentangulus*, *Olaxipollis matthesii*, *Momipites punctatus*, *M. quietus*, *Psilatricolporites crassus* and this sporomorph assemblage is suggested Early-Middle Oligocene age. These results show that the climatic condition through Early-Middle Oligocene age is the subtropical climatic condition and the coexistence approach (CA) results of the Oligocene sequence for the MAT range from 17.2–17.4°C, for the CMT range from 7.7–8.3°C, for the WMT 27.3–27.7°C and for the MAP 1217–1322 mm. Palynomorph of the Oligo-Miocene sequence include rich spores and pollen and the presence of *Verrucatosporites favus favus*, *Leiotriletes maxoides maxoides*, *L. maxoides maximus*, *Trilites corruvallatus*, *T. multivallatus*, *Pityosporites microalatus*, *Tsugapollenites sp.*, *Cathayapollis sp.*, *Piceapollis sp.*, *Dicolpopollis kockelii*, *Plicapollis pseudoexelsus*, *Interpollis sp.*, *Subtriporopollenites facilis*, *S. anulatus nanus*, *S. constans*, *Revesiapollis triangulatus*, *Momipites punctatus*, *M. quietus*, *Tricolpopollenites henrici*, *T. microhenrici*, *Aceripollenites striatus*, *Tetracolporopollenites folliformis* collectively indicates that the age of these sequence is from the latest Late Oligocene to the earliest Early Miocene period. Quantitative results of this period show that the values for the MAT are

between 17.3 and 21.3°C, 6.2–13.3 C for the CMT, 27.3–28.1 for the WMT, 1187–1322 mm for the MAP.

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Early Middle Miocene (Langhian) period in north of the Gökova Gulf (western Anatolia)

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This study is a biostratigraphic and palaeoclimatologic synthesis of palynological results on the Langhian sediments in Ören-Kultak region (western Anatolia). Lower part of these sediments consists of the coarse conglomerate, mudstone, sandstone with mammalian fossils and these sediments are formed terrestrial condition. The upper part of these sediments includes marl and limestone with foraminifers, bivalvias and corals, which is characterized marine environment. The mammalian data of this region suggested the early Middle Miocene age (MN5-6 boundary). Moreover foraminiferas of limestones in the Ören-Kultak region characterize the Langhian age. Palynological results obtained from the claystones and mudstones of these sediments and sporomorph assemblage is consisted of *Verrucatosporites favus favus*, *Leiotriletes maxoides minoris*, *L. maxoides maxoides* (Schizaceae), *Sterisporites sp.* (Sterculiaceae), *Baculatisporites primarius primaries* (Osmundaceae), *Pityosporites microalatus* (*Pinus*), *P. labdacus*, *Cycadopites sp.* (Cycadaceae), *Inaperturopollenites hiatus* (Taxodiaceae), *I. polyformosus* (*Sequoia*), *Cupressacites cuspidateaformis* (Cupressaceae), *Subtriporopollenites simplex* (*Carya*), *Triatriopollenites exelsus* (Myricaceae), *Momipites punctatus* (*Engelhardtia*), *M. quietus*, *Dicolpopollis kalewensis* (*Calamus*), *Tricolpopollenites henrici* (*Quercus*), *Tricolpopollenites librarensis* (Fagaceae), *Tricolporopollenites cingulum* (Castaneae), *Tricolporopollenites megaexactus* (Cyrillaceae), *Tricolporopollenites microreticulatus* (*Sambucus*) and *Tetracolporopollenites obscurus* (Sapotaceae) and these spores and pollen are indicative of the Langhian age.

The palynological results show that the sedimentation of the Langhian period developed under the subtropical climatic condition and coexistence approach analysis results of this period, the values are

from 16.5 to 21.3°C for the MAT, from 5.5 to 13.3°C for the CMT, from 27.3 to 28.1°C for the WMT and between 887 and 1520 mm for the MAP.

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Miocene Vegetation and their climatic implication from the Siwalik succession (Karnali River section) of the Nepal Himalaya

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Mudstones and Siltstones collected from the Siwalik molasse sequence (~16 to 5 Ma) of the Karnali River section, west Nepal are being studied for palynological assemblages. It is expected to present the preliminary results obtained from these sediments in NECLIME meeting. This will reveal important information about the Miocene vegetation and climate during the upliftment of the Himalayan mountain belt.

Floristic investigations on the Miocene flora of Badaogou, Changbai Shan, Jilin Province, NE China. - First comparisons to the modern flora of NE China and Europe

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Badaogou, Changbai region of Jilin province, China, is situated near the border to the DPR Korea (41°34'15" N 127°17'45" E). There, plant-bearing diatomites of the Ma´anshancun Formation are intercalated between basalt flows. In the 80-ies of the last century, radiometric dating of olivine-basalts indicated ca.13.4 Ma for one of the basalts.

Most prominent in the diatom assemblage is the oligotrophic centric freshwater genus *Pliocaenicus* sp. (Stephanodiscaceae). According to the current knowledge, *Pliocaenicus* is known from the late Miocene, mainly from the Pliocene, and by 1–2 recent species. The radiometric date and the occurrence of *Pliocaenicus* therefore raise questions regarding the age of these deposits. During the field campaign in June 2007 basalt samples have been taken by the authors who hopefully will contribute to a more precise age determination.

The diatomites yield foliage with excellent cuticle preservation. The flora is a mixture of deciduous and evergreen angiosperm taxa and conifers. Deciduous taxa prevail both in number of specimens and taxa. The following taxa have already been identified: Cupressaceae (2), *Pinus*, *Acer subpictum*, *Acer trifoliata*, Betulaceae, Juglandaceae (2), *Sassafras*, *Quercus* (2), *Castanea* vel. *Quercus*, *Tilia*, *Ulmus*, *Zelkova*, and a high number of taxa that yet await determination.

In gross morphology some taxa strongly remind of modern woody angiosperms in (N)E China (e.g., *Acer subpictum* reminding of *Acer pictum*, *Acer trifoliatum* reminding of *Acer triflorum*, *Quercus* reminding of *Quercus mongolica*). Further investigations will be carried out to compare also the cuticular structures of the fossil and modern species. Some taxa present in the fossil record are absent nowadays in this region (e.g., Cupressaceae, Lauraceae).

Also the pollen flora is very well preserved and is dominated by conifers (mainly *Picea* and *Tsuga*), Ulmaceae (*Ulmus*, *Zelkova*), and Fagaceae (*Fagus*, *Quercus*). *Tilia*, Betulaceae, Juglandaceae. Herbaceous plants occur in low abundances.

Comparing flora and climate of the Northeast part of China with Europe the differences in geographic latitude (Jilin province about 4–6° further south than central parts of Europe) have to be kept in mind. In this part of China, the MAT is about 3–4°C lower and the growing season is shorter than in Central Europe. The MAP is between 510–700 mm, and therefore also lower than in Central Europe. These climatic differences are caused by the strong influence of Central Asian air masses on NE China during the cold season and, by the influence of the Gulf Stream on the European climate. The climatic differences today are reflected in the flora of both regions.

The fossil flora of Badaogou may be a key to the understanding whether and to which degree similar differences already existed during the time of the diatomite deposition. However, to solve these questions, a sound dating is a prerequisite.

Large mammals and flora of the Swiss Molasse Basin: a proxy for the climate evolution during Oligocene and Early Miocene, preliminary results

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After the Terminal Eocene Event (the Eocene/Oligocene cooling event) a warm and wet climate took place in Europe. In the Late Oligocene the temperature and the humidity rate decreased quickly, leading to a global climatic crisis described by Berger (1990, 1992), which was followed by a warmer recovery period in the Early Miocene. Becker (2003) observed, during the Paleogene and the Neogene, changes in the diversity of the Rhinocerotidæ (*Perissodactyla*, Mammalia) of the Swiss Molasse Basin. In fact, the whole Ungulata (Mammalia) communities seem to be affected by this global climatic crisis by showing differences in their palæoecological parameters, such as body mass and size or dietary regimes, which are probably linked to the available food.

The aim of this project, financed by the Swiss National Fundation (SNF 115995) and the University of Fribourg (Switzerland), is to better understand the climatic and environmental changes during the Oligocene to Early Miocene period in the Swiss Molasse Basin by studying localities correlated by the small mammal biostratigraphical data of Engesser (1990) and Engesser & Mödden (1997).

A special focus is set on decisive Artiodactyla and Perissodactyla (Ungulata, Mammalia) genera of the Oligocene and Early Miocene and also on lineages present throughout the Oligocene/Miocene boundary: Rhinocerotidae and Tapiridae (Perissodactyla, Mammalia), Anthracotheriidae, Tayassuidae, Cainotheriidae and Moschidae (Artiodactyla, Mammalia). The comparison with the Late Oligocene and Early Miocene flora will also be discussed.

At this stage of the study, which started in January 2007, preliminary results from the most important outcrops such as Bumbach (MP25), Rickenbach (MP29) and Engehalde (MN1-2) will be discussed.

Quantitative climatic evaluation of a rich Pliocene leaf, fruit and pollen assemblage from Fossano, NW Italy

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The north-western part of Italy is very rich in outcrops of Pliocene sediments, which yielded abundant and diversified floral assemblages. In the year 1999 a flora-bearing deposit, comprising every kind of plant fossils (mummified leaves, carpoids, wood, pollen) was discovered in the neighbourhood of Fossano, a small town in southern Piedmont. Multidisciplinary palaeobotanical studies were started since the year 2000 with an extensive sampling of mummified leaves and carpoids. The leaf assemblage is dominated by laurophyllic (evergreen) leaves with excellent preservation, while leaves of deciduous trees are less common (*Acer integerrimum*, A*lnus gaudinii*, *Cornus sp.*, *Platanus leucophylla*). Cuticle of many laurophyllic leaves have been prepared in the Turin laboratories and identified at the Charles University of Prague. The material proved to belong to a few lauraceouos species (*Daphnogene sp.*, *Laurus abchasica*, *Laurophyllum pseudoprinceps*, *Ocotea heeri*) and one specimen was assigned to *Viscum morlotii*. The carpological assemblage of two distinct layers provided a much diversified assemblage. The uppermost layer was the leaf-bearing one (FO3), and was also sampled for pollen analysis, carried out in the Florence laboratories, in order to get a complete floral and vegetational picture.

The flora-bearing layers display an interesting stratigraphic position, because they are at the top of a sandy succession which represent a prograding deltaic system, laying over a thick succession of outer-shelf pelitic sediments of the late Early Pliocene (around 4.0–3.8 Myr). After the deposition of the Fossano succession, progradation continued to the NE, thus producing the deltaic and fluvial

sediments of the “type-Villafranchian” succession, reliably dated to the Mammoth to Kaena subchrons of the Middle Pliocene (around 3.3–3.1 Myr). Therefore, the Fossano floral assemblage is chronologically well framed between 3.8 and 3.3 Myr, and sequence stratigraphic data would suggest that the age precedes the Zanclean/Piacenzian transition (3.6 Myr). This relatively precise age constraints, in combination with the richness of the flora, encouraged us to start from this site the quantitative evaluation of Pliocene climate, which we plan to extend to all the important sites of north and central Italy. The Zanclean-Piacenzian climate has been quantitatively evaluated in recent papers on the basis of long pollen records from Italy and discontinuous macrofossil records from NW Germany. On the other hand, the even richer and less discontinuous Italian plant macrofossil record, which can also be integrated with microfloras in a composite frame, has not yet been used for quantitative climate reconstruction. The first quantitative evaluation of Fossano’s Pliocene climate has been obtained by applying the Coexistence Approach to an integrated leaf and carpological flora, comprising around 60 species. The occurrence of several thermophilous East Asiatic elements (*Eurya*, *Sinomenium*, *Symplocos subgen*., *Hopea*, *Rehederodendron*, *Toddalia*), in combination to “cooler” Eurasian genera (*Frangula* and *Taxus*), allow us to constrain the mean annual palaeotemperature between 14 and 18°C; this range can be restricted between 17 and 18°C, if *Ocotea* is considered as a reliable indicator. Mean annual precipitation higher than 1000 mm is definitely indicated by *Eurya* and *Rehderodendron*. The reconstructed climatic conditions are in agreement with previous evaluations of temperature and precipitation obtained with “the nearest living relative method” for several Italian floras (“Ca’ Viettone Floristic Complex”), which have almost the same composition as the Fossano one.

Late Miocene Climate Model Experiments

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We perform climate modelling sensitivity experiments to analyse how vegetation changes from the Late Miocene to present contributed to the late Cenozoic climate cooling. The reference experiment is a Late Miocene (Tortonian) run with a full set of palaeo-boundary conditions including, for instance, the Tortonian palaeovegetation. Based on the Tortonian run, we setup three sensitivity experiments which use the same set of boundary conditions except that the regional vegetation of North Africa, Central Asia, and in the high latitudes now refers to modern conditions. Preliminary results of our experiments suggest that these vegetation changes generally lead to regionally cooler and more arid conditions with an increased seasonality. In addition to the regional response, the desertification of North Africa and the "deforestation" of high-latitude forests significantly also contribute to a cooling of polar regions. Vegetation changes (Miocene vs. present) in Central Asia also lead to cooler conditions in the northern high latitudes, but less pronounced than in the other runs. As a summary, we find that vegetation changes from the Miocene until today contribute to reduce the northward heat transport in the atmosphere and, hence, to the cooling of the high-latitudes.

Vegetation of a Warmer World: A new Global Biome Reconstruction and Data-Model Comparison for the Middle Pliocene

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The Middle Pliocene, ca. 3.6 to 2.6 million years ago, represents a time in which Earth experienced greater global warmth with climate conditions similar to those predicted for the end of the 21st century. During that period, atmospheric CO_2 values are estimated to have reached 360-440 ppmv and global mean annual temperatures increased by ca 3°C. For a better understanding of the role of vegetation and vegetation-climate feedbacks on climate change, we produced a new global biome reconstruction for the Middle Pliocene. Our results are based on vegetation reconstructions from 202 palaeobotanical data sets, which were translated into an internally consistent classification scheme using 28 biomes. The data were combined with the predictions from a coupled state-of-the-art climate-vegetation model (HadAM3-TRIFFID-BIOME4) to fill the remaining data gaps. The data-model comparison approach allows, for the first time, a detailed and robust global biome reconstruction for the Middle Pliocene and provides a new boundary condition for future General Circulation Models. For the Middle Pliocene, both the vegetation reconstruction and model simulation indicate a general warmer and moister climate than today. The model results compare favourably with available palaeo-data and highlight the importance of employing vegetation climate feedbacks and the anomaly method in biome models. Discrepancies, which occurred between data and model reconstructions, will be discussed. Large-scale patterns identified by our Middle Pliocene biome reconstruction include a northward shift of evergreen taiga, temperate forest and grasslands with much reduced tundra vegetation, suggesting by more than 10°C higher mean annual temperatures than today. Warm-temperate forests (with subtropical taxa) spread in Middle and Eastern Europe and tropical savannas and woodland expanded in Africa and Australia at the expense of deserts. Our new biome reconstruction enhances our knowledge about the Middle Pliocene and how vegetation and climate may change in the future.

Vegetation Changes in Armenia in the Plio-/Pleistocene – Preliminary results

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This project aims to reconstruct the Plio-/Pleistocene environment of the Lower Caucasus in order to understand the prerequisites for the first appearance of Humans in this area. In the Vorotan Basin in Armenia a lake existed from about 2.5 Ma until at least 800 ky BP. Today there are several outcrops with lake sediments, mainly diatomites with well-preserved fossil plants, insects, and vertebrates, intercalated frequently with volcanoclastics and covered by thick basaltic flows at several levels of the sequence. Dating and correlation of the profiles are under progress, including radiometric dating of tuffites intercalated in the lake sediments and palaeomagnetic analysis of the profiles.

Four of these profiles have been studied in detail for palaeobotanical and palynological analyses. They show a good preservation of pollen with more than 60 pollen taxa determined so far. In addition, there are almost 200 taxa described from macrofossils of that area, from which about 80% are still occurring in Armenia today.

The pollen profiles show several types of vegetation from humid forests to dry steppes. These vegetation types provide first estimates for their relation to climate periods. Partly the profiles show obvious orbitally forced cycles with remarkable shifts from herb dominated vegetation to a clear dominance of trees. Detailed sampling has been done this year to analyze these cycles in more detail in order to understand the relation of vegetation changes and climate cyclicity.

Cyclic climate and vegetation change in the Pontian of Western Bulgaria

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Late Miocene lacustrine sequences from two carbonate basins in NW Bulgaria (Beli Breg Graben; Staniantsi Basin) display up to 25 rhythmically bedded sedimentary cycles. In the lower part of the

sequences, the cycles are composed of alternating lignite and marl beds containing freshwater fauna, in the upper part, alternations of dark and light grey marls occur. The thickness of the sedimentary cycles varies between 1.5 and 3 m. For each sequence, a palynomorph record is studied, sampled at 0.5 m intervals. In addition, four single cycles are analyzed in high resolution, sampled at 0.05 m intervals.

For the sequences and the four selected cycles, quantitative palaeoclimate records are calculated for a variety of variables using the Coexistence Approach (CA). The observed climate variations reveal hierarchical cycles of three different orders, corresponding to about 8–10 m, 1.6–2.5 m, and 0.2–0.5 m of sediment. The 1st order cycles show the most prominent climate change, within the range of several degrees Celsius and up to 200 mm in mean annual precipitation, the 2nd and 3rd order cycles display minor climate change, close to the resolution of the CA. Therefore, we use a calibration technique newly developed in order to refine the results obtained. It is shown that temperatures and precipitation rates tend to be higher in phases of the deposition of marls / light grey marls, while for the sapropelites dryer and cooler conditions result in most of the cases, combined with a lower seasonality of temperature. The observed climate cycles are mirrored by distinct changes in autochthonous plant associations (*Thelypteris* - Taxodiaceae / *Osmunda* - Pinaceae). Assuming low sedimentation rates near 0.1 m / kyr for both small Cenozoic basins, the 1st and 2nd order cycles fall within the range of orbital forcing (eccentricity and precession), in the small scale cycles of 0.2–0.5 m thickness, a millennial scale cyclicity could be expressed.

To verify the causal relation of the cyclicity observed in the sequences to astronomical variations magneto-stratigraphic studies are in progress.

Miocene macroflora from the localities Kalonda and Mučín (Southern Slovakia)

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Presented are results of paleobotanical research of two localities situated in Southern Slovakia near Lučenec. The main goal of the research was fossil macroflora determination, floristic evaluation, palaeoecology and palaeoclimatic interpretation The studied plant assemblage of Early Miocene age occurs in the Bukovinka Formation which is Eggenburgian in age and it is preserved in a layer of

rhyodacite tuff. Morphological character of impressions enabled identification of 26 angiosperms. The composition of the vegetation and leaf morphology correspond to evergreen broad-leaved forest suggesting humid tropical conditions.

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