(SS03) Uplift of the Himalaya and its impact on the climatic and biodiversity changes in East Asia

Date: August 29
Place: Room 5233 (oral)
Organizers: Zhekun Zhou & Arata Momohara
Contact email address: zhouzk@mail.kib.ac.cn, zhouzk@xtbg.ac.cn
Purpose: The uplift of the Himalayas is one of the most outstanding geological events in the Cenozoic. This event has dramatically changed the geological and physiognomic aspects of Asia, and in turn has greatly affected the atmospheric circulation pattern, thus caused the onset and evolution of the East Asian monsoon system. In turn, this monsoon system has deeply impacted the East Asian biodiversity and climates from continental to local scales. Researches into these aspects have remained so hot that a great number of papers and books have been published recently. However, some key issues are still highly in debate, those of which include the details of time and rate of the uplift of Himalayas, the onset and subsequent evolution of the East Asian monsoon, and the biodiversity change under this dramatic climate change along the Cenozoic. Exploring these questions keeps an enduring attraction to paleobotanists, botantists, palynologists and geologists worldwide. The research field is very active and new findings are reported with a remarkable speed. We anticipate a number of interesting contributions to this symposium which will focus on all aspects of Palynology, Paleobotany, geology ecology, and biogeography.

Oral Presentation

Aug. 29 [AM1] Room: 5233

Chair: Zhekun Zhou

9:20-10:00 **[Keynote] Tibet, Monsoons and the vegetation of Asia: When did the Plateau attain its present elevation?** SS03-O01 (491)

Robert Spicer

10:00-10:20 **Development of Asian monsoon in the Plio-Pleistocene and its impact on species diversity of flora in central Japan** SS03-O02 (343)

Arata Momohara, Takeyuki Ueki, Takeshi Saito

Aug. 29 [AM2] Room: 5233

Chair: Arata Momohara

10:50-11:10 **Miocene flora from Ninghai in eastern Zhejiang and palaeoclimatic implication** SS03-O03 (502)

Bai-Nian Sun, Su-Ting Ding, Hui Jia, Bao-Xia Du, Xiang-Chuan Li, Liang Xiao

11:10-11:30 **Uplift of the Himalaya and its impact on the climatic and vegetational changes in the sub Himalayan foothills (Siwalik basins) of India and Bhutan** SS03-O04 (19)

Manju Banerjee, Sudha Gupta

11:30-11:50 **Was East Asian summer monsoon intensified in ca. 3.6-3.0 Ma?: data from palynological study of the Tokai Group, central Japan** SS03-O05 (443)

Takeshi Saito

11:50-12:10 **Climatic distribution of Eocene China: planetary wind or monsoon-dominated?**

SS03-O06 (424)

Cheng Quan, Yu-Sheng (Chris) Liu, Torsten Utescher

Aug. 29 [PM2] Room: 5233

Chair: Zhekun Zhou

14:30-14:50 **Late Quaternary climate on the basis of pollen and diaspores from Kathmandu Basin, Nepal** SS03-O07 (398)

Khum Narayan Paudayal, Sudarshan Bhandari, Arata Momohara

14:50-15:10 **Palaeoclimatic implications of the late Quaternary plant macrofossils from the Kathmandu Valley, central Nepal** SS03-O08 (33)

Sudarshan Bhandari, Arata Momohara, Khum Narayan Paudayal

15:10-15:30 **Long climatic record during the last 700 kyr revealed by pollen and charcoal analyses on the lacustrine sediments of the Paleo-Kathmandu Lake, the central Himalaya** SS03-O09 (135)

Rie Fujii, Misa Sugimoto, Takeshi Maki, Harutaka Sakai

15:30-15:50 **The Neogene vegetation and climate of Central Yunnan, SW China** SS03-O10 (577)

Yaowu Xing, Tao Su, Frédéric MB Jacques, Yongjiang Huang, Zhekun Zhou, Hans-Peter Linder

Aug. 29 [PM3] Room: 5233

Chair: Arata Momohara

16:20-16:40 **A novel palaeoaltimetry proxy based on spore and pollen wall chemistry** SS03-O11 (295)

BH. Lomax, WT. Fraser, G Harrington, S Blackmore, MA. Sephton, NBW. Harris

16:40-17:00 **Palaeoelevation of Yunnan during the late Miocene** SS03-O12 (203)

Yongjiang Huang, Frédéric M B Jacques, Tao Su, Yaowu Xing, Jinjin Hu, Yu-Sheng (Christopher) Liu, Zhekun Zhou

17:00-17:20 **The Middle Eocene to Early Miocene integrated sedimentary record in the Qaidam Basin and its implications for paleoclimate and early Tibetan Plateau uplift** SS03-O13 (489)

Bowen Song, Kexin Zhang, Jingfang Lu, Chaowen Wang, Yuan-yuan Sun, Yadong Xu

17:20-17:40 **The relationship between atmospheric pCO_2 and stomatal frequency in *Quercus pannosa* and its application to paleoelevation reconstruction** SS03-O14 (201)

Jin-Jin Hu, Zhe-Kun Zhou

SS03-O01 (491)

Tibet, Monsoons and the vegetation of Asia: When did the Plateau attain its present elevation?

Robert Spicer

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Understanding the elevation history of the Tibetan Plateau is one of the 'Grand Challenges' of Earth system science. The plateau influences the characteristics of the Asian Monsoon and thus the water supply for half the world's population, and its geological history informs our knowledge of crustal processes. In recent years palaeobotany has played a significant role improving our knowledge of Tibetan Plateau uplift. 'First contact' between greater India and Eurasia is currently thought to be around 56 Ma, beginning in the west followed by anticlockwise rotation of India and contact progressing eastwards. This is associated with slowing of NE India's northward movement from 118 mm a^{-1} to 83 mm a^{-1}. New CLAMP analyses suggest in the early Eocene northwestern India (~10° N palaeolatitude) experienced only a weak monsoonal climate consistent with seasonally alternating pressure cells over Eurasia and an un-elevated Tibet. Eocene leaves from the southern part of the plateau are distinctly tropical/subtropical in character suggesting a low elevation, but modeling and pollen data suggest 'far-field' lithospheric deformation and uplift in the Xining Basin, northeastern plateau by 38 Ma. By the late Oligocene (~25 Ma) northeastern India experienced a climate almost identical to that of the Sunderbans today suggesting monsoon amplification by an elevated Tibet. Oligocene leaves from southern Tibet indicate cool (high) conditions while on-plateau pollen assemblages mark a transition from Eocene mixed evergreen and deciduous broadleaves 'subtropical' forest to a cooler more conifer-rich forest in the Oligocene. Pollen evidence also shows that at this time the East Asia Monsoon became established. By now India's northward movement had slowed to 57 mm a^{-1} suggesting the development of a strong resistor, most likely a thickened crust and deepening 'root' below an elevated plateau. However the regional extent of the uplift remains problematic. By Miocene times (15 Ma) CLAMP and oxygen isotope analyses show southern Tibet had achieved it's current elevation of ~ 4.5 Km. On-plateau vegetation was of a mixed coniferous and broadleaved cool montane type similar to that in the highlands of southern China today. Grasslands developed in the north. Further slowing of India to 44 mm a^{-1} at 11 Ma indicates additional resistance in the form of significant uplift of the Himalayas. The post-Miocene development of a marked rain shadow northwards of the Himalayas led to the mixed coniferous broadleaved deciduous woodland with the extensive grasslands that we see today.

Keywords: palaeobotany, palaeoelevation, Asian Cenozoic climate.

SS03-O02 (343)

Development of Asian monsoon in the Plio-Pleistocene and its impact on species diversity of flora in central Japan

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Development of monsoon caused by uplift of the Himalaya promoted floristic diversification in east Asia since the late Pliocene. Stepwise changes of composition of flora including taxa endemic to extant flora in southern China in the Pliocene to the modern flora in central Japan occurred in the late Pliocene (3.3-2.6 Ma), latest Early Pleistocene (1.3-0.9 Ma), and late middle Pleistocene (0.5-Ma). The correspondence of the stages and trends to the wind and precipitation variability recorded

in the eolian deposits on the Chinese Loess Plateau indicates that intensity changes of winter and summer monsoons ruled vegetation and floral changes in Japan. Strong winter monsoon supplied dry and cold climate in glacial stages as well as heavy snow to the areas along the Japan Sea in interglacial stages. Development of summer monsoon intensified heavy rain to promote disturbance. To clarify relationships between development of Asian monsoon and diversification of local flora, we studied stratigraphic changes of plant macrofossil flora during the early Pleistocene in south Niigata. The extant flora and vegetation of this area are unique from the effect of heavy snow supplied by strong winter monsoon and vapor from the Tsushima warm current in the Japan Sea. We studied 138 fruits and seeds assemblages between 2.4 and 0.7 Ma in fluvial sediments of the Uonuma Group. The assemblages from the continuous sections 1300 m thick were correlated to marine isotope stages based on widespread tephras, magnetostratigraphy and nannofossil stratigraphy. Coldest month mean temperature curve reconstructed from fossil assemblages was well correlated with grain size fluctuation of the eolian deposit in the Loess Plateau that represents change of winter monsoon intensity. Increasing annual range of temperature since 1.4 Ma was attributed to intensified winter and summer monsoon. Change of composition of macrofossil flora centered in and around 1.3 Ma. Plant taxa including *Metasequoia* with *Chamaecyparis obtusa* and *Stewartia* that are now limited in less snowfall areas disappeared and *Cryptomeria*, *Thujopsis*, and *Fagus crenata* dominant in heavy snow areas along the Japan Sea increased. Species richness of assemblages standardized by rarefaction increased significantly since 1.4 Ma. Increase of the species diversity of herbaceous taxa, annual herbs, and plants growing in open places was significant. Change of disturbance regime by heavier rain and snowfall accompanying with development of the Asian Monsoon possibly accelerated a turnover of vegetation succession to increase species diversity of the local flora.

Keywords: Asian monsoon, disturbance regime, plant macrofossil, plant extinction, Quaternary.

SS03-O03 (502)

Miocene flora from Ninghai in eastern Zhejiang and palaeoclimatic implication

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Plant fossils with good cuticles were collected from the Shengxian Formation in Ninghai, eastern Zhejiang, China. The fossils are mainly leaves, fruits and seeds and the age of bearing-fossil strata is thought as the late Miocene. The flora is composed of total 60 species which belong to 46 genera and 29 families based on the leaf architecture and cuticle features. Of them, 7 species of gymnosperms belong to 5 genera of 4 families; 2 species of monocot angiosperms belong to 2 genera of 2 families, and the else are dicotyledons. The flora shows a subtropical evergreen broad–leaved forest with some temperate trees. For example, the genera *Cinnamomum, Litsea, Machilus, Castanopsis, Lithocarpus, Caesalpinia* and *Mallotus* are generally distributed in the tropic or subtropic regions, but the genera *Betula, Acer, Carpinus, Amelanchier, Cercidiphyllum* and *Cornus* are the key elements in the northern hemisphere temperate forests. The hydrophyte *Trapa* lived in the lake; the evergreen broad–leaved forests and some single species forests of *Cunninghamia* and *Pinus premassoniana* distributed in the area of 300–600 m a.s.l. Some shrub trees growing under the evergreen arbors, and the vines of *Smilax* climbing on the arbors or shrubs. Paleoclimatic characteristics of Miocene Ninghai flora were reconstructed using the coexistence approach (CA), overlapping distribution analysis (ODA), leaf margin analysis (LMA) and climate–leaf multivariate analysis program (CLAMP). The results show that the climate of the late Miocene was similar to that of today. Relative to the modern climate, the mean annual temperature

(MAT) in the late Miocene of Ninghai was nearly unchanged or slightly lower. The cold month mean temperature (CMMT) of the late Miocene was similar to that of today, and the warm month mean temperature (WMMT) was lower for 1–2.5 °C. The difference in temperature between the coldest and warmest month (DT) was 1–4 °C, and the mean annual precipitation (MAP) was less to 176–272 mm. This study was supported by the National Natural Science Foundation of China (Grant No. 41172022) and the Specialized Research Fund for Doctoral Program of Higher Education of China (Grant No. 20100211110019).

Keywords: plant fossil, leaf architecture, cuticle, coexistence approach, climate–leaf multivariate analysis program.

SS03-O04 (19)

Uplift of the Himalaya and its impact on the climatic and vegetational changes in the sub Himalayan foothills (Siwalik basins) of India and Bhutan

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A large number of plant megafossils and microfossils are recorded from each of the sectors of Siwalik (Neogene) foreland basins of Indian subcontinent. Angiosperm floristic of Siwalik foreland basins revealed that the areas were in the lower latitude, tropical climate, and high rainfall zone. Vegetation of warm, humid, tropical-subtropical climate thrived almost in the entire succession of Neogene sedimentation of all the seven sectors of sub Himalayan foothills. The fresh water vegetation in the early part of deposition changed towards estuarine vegetation in the Upper part of Lower Siwalik and Lower part of Middle Siwalik in the Himachal Pradesh, Ganga valley of Uttar Pradesh sectors of western Himalaya and Bhutan, Darjeeling foothills sectors in the eastern Himalaya. The evidences are mega plant fossils of mangrove plant affinity namely *Avicennia*, *Aegiceras* recovering cuticles with salt glands *Heliospermopsis* (Nagy) Banerjee 1995, and pollen grains of *Palaeosantalaceaepites*, *Spinizonocolpites*, *Zonocostites*, *Swertia*. The records of microplanktons namely microforaminifera, dinoflagellates, acritarchs in the same assemblage indicate marine transgression in the areas at this phase of deposition. The occurrences of epiphyllous and isolated fungal fruit bodies *Callimothallus* and *Meliolinites* indicate high rate of precipitation during the depositional period. *Pinuspollenites* is first appeared in this assemblage and suggest appearance of higher topography around the basins due to Himalayan upheaval. The temperate climate plant pollen appeared earlier in the western sectors basins suggesting an early and more intense orogenic activities to form high mountain at western part of India. Orogenic movement or Himalayan upliftment changed the near shore palaeogeography towards high mountaneous topography since Late Middle Siwalik to Upper Siwalik. Gradual disappearance of estuarine plant assemblage and increase of temperate savanna type pollen indicate that the sea (Tethys) completely withdrew from the northern boundary of the Indian subcontinent. The record of megafossils of fertile spike, isolated leaves of Poaceae in the late Middle Siwalik of Darjeeling foothills and poaceous palynomorphs from both Darjeeling foothills and Bhutan suggest that dry climate prevailed in the areas at this phase of deposition. Temperate climate indicator high altitudinal plant pollen, *Pinuspollenites*, *Piceapollenites*, *Abiespollenites*, *Alnipollenites*, *Tsugaepollenites* gained higher frequency of occurrence in the Upper Siwalik indicating gradual uprise of Himalaya during Pliocene and Pleistocene.

Keywords: Neogene, Himalayan foreland basins, mega and micro fossils, microplankton, marine transgression.

SS03-O05 (443)

Was East Asian summer monsoon intensified in ca. 3.6-3.0 Ma?: data from palynological study of the Tokai Group, central Japan

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The Tokai Group in central Japan is a good archive of paleoclimatic evolution from latest Miocene to Early Pleistocene. Intercalated widespread tephras are excellent age markers and key beds. I here present pollen assemblage changes during ca. 6.5-1.8 Ma. In Zone 1 (6.5-5.5 Ma) *Fagus* predominates the assemblage and deciduous type *Quercus* (D. *Qurcus*) and *Tsuga* are common elements with few warm-temperate elements such as *Liquidambar* and evergreen type *Qurcus* (E. *Qurcus*). This assemblage represents a temperate deciduous forest, possibly indicating a cool-temperate paleoclimate. Pollen assemblage of Zone 2 (5.5-3.6 Ma) is also dominated by *Fagus* and D. *Quercus*, but *Liquidambar* becomes rich. *Liquidambar* high percentage suggests warmer condition than in Zone 1. In Zone 3 (3.6-3 Ma), E. *Quercus* becomes a major component together with D. *Quercus*, *Liquidambar* and *Fagus*. This assemblage suggests a mixed forest with evergreen and deciduous broad-leaved trees in warm-temperate region in southern China. Zone 4 (3-2.5 Ma) is similar to Zone 3 but characterized by intermittent Cupressaceae (former "Taxodiaceae") abundances. In Zone 5 (2.5-1.8 Ma), warm-temperate elements such as E. *Quercus*, *Cathaya* and *Pseudolarix* almost do not occur. On the other hand, cool-temperate or boreal elements such as *Picea* become rich. These pollen assemblage changes from Zone1 to Zone 5 can be explained by global paleoclimate fluctuations inferred from oxygen isotope curves. Zone 1 indicates a cooler climate in Messinian, Zones 2 and 3 represent a climatic amelioration in Pliocene, and Zones 4 and 5 indicate the onset of glacial-interglacial cycles and the their intensification. Of these assemblage changes, transition from Zone 3 to Zone 4 is clear and Zone 4 almost corresponds to the interval of the mid-Pliocene warmth (3.5-3.0 Ma). I suggest that this clear pollen assemblage change results from not only temperature increase by the global warming in the mid-Pliocene but also precipitation increase by intensification of East Asian summer monsoon related to Tibet-Himalaya uplift.

Keywords: paleoclimatic evolution, mid-Pliocene Warmth, glacial-interglacial cycles.

SS03-O06 (424)

Climatic distribution of Eocene China: planetary wind or monsoon-dominated?

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Proxy-based quantitative estimates of Eocene climate conditions are abundantly available from marine isotope records and floral data. However, the available terrestrial data are mainly from North America and Europe, and only a few are known from East Asia. Previous qualitative studies on Chinese Eocene floras briefly illustrated the zonation of the Eocene climates in China with a planetary wind-dominated arid zone in the central part, i.e., the subtropical highs. But such pattern of

climatic distribution is subjected to the quantitative study. Based on analyses on 66 plant assemblages, carefully selected from 37 fossil sites throughout China, we here report the first large-scale quantitative climatic results and discuss the Eocene climatic patterns in China. Our results demonstrate that the Eocene monsoonal climate must have been developed over China, judging from the presence of apparent seasonality of both temperature and precipitation revealed by our quantitative estimation, which appears not to support previously claimed Eocene planetary wind-dominated climate system that is supposed to be accounted for the then arid climate over central China. In addition, the paleoclimatic results from tropical sites in southern China show that the Eocene temperatures in the tropics of Southeast Asia appear cooler than the present, an interesting aspect quite different from the situation of Eocene tropical SST. This might be related to the possible weak Eocene Kuroshio Current in the southwestern Pacific, and/or the significantly enhanced paleo-winter monsoon from Siberia.

Keywords: Eocene climates, plant fossils, quantitative reconstruction, Eocene monsoon over China, cooler low latitudes.

SS03-O07 (398)

Late Quaternary climate on the basis of pollen and diaspores from Kathmandu Basin, Nepal

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A high resolution palynostratigraphy from Kathmandu Basin has been studied to understand the past climate changes in this region. 90 samples were collected in each 10 cm intervals from the 33 m thick surface exposure belonging to the Gokarna Formation at northern part of the Kathmandu Basin. The study revealed 45 species of pollen taxa belonging to 33 families. The gymnosperms consist of *Abies*, *Picea*, *Pinus*, and *Tsuga*. The major angiosperm taxa are *Quercus*, *Castanopsis*, *Betula*, *Myrica*, *Alnus, Juglans*, *Eleagnus* and Oleaceae. Other angiosperms such as Ericaceae, Sapotaceae, Rutaceae, Euphorbiaceae, Dipsacaceae, Caprifoliaceae, and Acanthaceae are present in fewer amounts. The herbaceous plants like Poaceae, Cyperaceae, Compositae, Caryophyllaceae, Chenopodiaceae, and Polygonaceae are present in high number. Plenty of aquatic plants *Polygonum, Trapa, Typha, Myriophyllum* and *Nymphoides* indicate the lake under eutrophic condition. This condition is also evidenced by an aquatic pteridophyte *Azolla* and algal remains *Botryococcus* and *Pediastrum*. Pteridophytes spores are represented by family Polypodiaceae, Lycopodiaceae and Pteridaceae. The Besigaon section experienced warm to cool temperate climate at the bottom part with high amount of plants such as *Abies, Picea, Pinus, Tsuga, Betula* and *Juglans*. There was warm temperate climate at the middle part of the section indicated by the presence of *Castanopsis* pollen and very few gymnosperms. At about 53,170±820 years BP the climate shifted again to cool temperate type with the dominance of *Abies*, *Picea*, *Pinus*, *Betula* and *Juglans* and some other steppe elements. The plant macrofossil investigation from the same section revealed 66 taxa belonging 38 families from five macrofossil bearing layers. The lower half of the exposed section is completely devoid of macrofossil horizons however the upper half yielded a significant amount of fruit and seeds. The angiosperms such as *Carpinus*, *Alnus*, *Pyracantha*, *Quercus* subgen. *Cyclobalanopsis*, *Eurya* and *Zizyphus* suggest the deposition of the middle part in warm climatic condition. The humid phase is documented in middle horizons with the findings of *Selaginella remotifolia* and wetland aquatic taxa such *Carex, Schoenoplectus, Nymphoides*. In contrast, the upper horizon dominated by gymnosperms such as *Abies*, *Pinus*, *Picea*, *Tsuga* and *Taxus* represent rather cold climate. Combining data from both pollen as well as diaspores suggest minor fluctuation in climate from cold

to warm and to cold again with increasing humidity during Late Quaternary in the Kathmandu Basin.

Keywords: palaeoecology, palynostratigraphy, plant macrofossils, Himalaya.

SS03-O08 (33)

Palaeoclimatic implications of the late Quaternary plant macrofossils from the Kathmandu Valley, central Nepal

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The Gokarna and Thimi Formations, constituting the middle and upper part of the sedimentary sequence of the Kathmandu basin contain rich plant macrofossil assemblages. The result obtained from plant macrofossils identified into lower rank of taxa provides information of the late Pleistocene palaeoenvironment in central Nepal that were influenced strongly by the SW Indian monsoon system and tectonic movements of the Himalayas. Three outcrops (Dhapasi, Besigaon, and Mulpani sections) belonging to the Gokarna Formation and one outcrop (Madhyapur Thimi section) belonging to the Thimi Formation were selected for macrofossil analysis. Most of 115 genera belonging to 53 families were identified to the genus and/or species level. Assemblages from the lower and middle part of the Gokarna Formation were characterized by dominance of taxa requiring a warm temperate climate such as *Eurya*, *Ficus*, *Morus*, *Zizyphus*, *Stephania*, *Quercus* subgen. *Cyclobalanopsis*, *Pyracantha* and *Carpinus*. The upper part of the formation consisted of assemblages dominated by taxa that are distributed in cool temperate zone such as *Abies*, *Pinus*, *Picea smithiana*, *Tsuga dumosa*, *Taxus wallichiana*, *Quercus* subgen. *Lepidobalanopsis* and *Betula* and indicated a climatic deterioration during the deposition of the Gokarna Formation. Two cold climate peaks were recognized during the stage between 53,170±820 and 49,300±2100/1700 yrs BP in the late Pleistocene. Assemblages from the lower and middle part of the the Madhyapur section of the Thimi formation was characterized by a common occurrence of conifers indicating a cold phase. Decrease in conifers in the upper horizons and dominance of warm climate taxa such as *Carpinus*, *Eurya*, *Rubus*, *Viburnum*, *Pyracantha* and *Sambucus* indicated an amelioration of climate during the deposition of the Thimi Formation. The higher diversity and common occurrence of aquatic plants indicated rich wetland vegetation in the Kathmandu Basin. The plant macrofossil analysis showed at least four cycles of climate fluctuation between warm and cool phases during the depositional stage of the Gokarna and Thimi Formations between 41,700±5600/3200 BP and 53,170±820 yrs BP.

Keywords: climatic fluctuation, Indian monsoon, Kathmandu Valley, Late Pleistocene, plant macrofossils.

SS03-O09 (135)

Long climatic record during the last 700 kyr revealed by pollen and charcoal analyses on the lacustrine sediments of the Paleo-Kathmandu Lake, the central Himalaya

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The Kathmandu Valley is located on the southern slope of the central Himalaya under strong influence of Indian monsoon. The basin-fill sediment of the valley is one of the best archive for the paleoclimatic and paleoenvironmental studies. We undertook the Paleo-Kathmandu Lake Project, in order to clarify changes in paleoenvironment and Indian monsoon during the Pleistocene. In this project, Fujii and Maki carried out pollen analysis of a 218-m-long core taken from the basin-fill sediments. As the results, an outline of the paleoclimatic changes in the valley during the last ca. 700 kyr was revealed and millennial-scale climatic changes from 130 kyr to 15 kyr were clarified. We here present the results, and compare the paleoclimate record with that from the charcoal analysis by Sugimoto on the same samples. Then, we try to reconstruct the paleoclimate changes in the valley from a view point of fire history. The pollen diagram is divided into fifteen fossil pollen zones from K-1 to K-15 in descending order, and they correspond to periods from MIS 2 to MIS 15. In the interglacial periods (MIS 5a, 5c, 5e, 7, 9, 11, 13 and 15), it was generally characterized by increase of warm climate index like as *Castanopsis* and *Mallotus*, and by increase of wet climate index like as *Alnus*, *Betula* and *Carpinus*. It means that the climate was hot and wet. It is noteworthy that frequency of *Alnus*, *Betula* and *Carpinus* in MIS 11 was similar to those in early MIS 3 and late MIS 2. In the glacial periods, *Pinus*, Gramineae, *Artemisia* and Chenopodiaceae were dominant, and *Abies* and *Picea* appeared though their percentages were low. It suggests that the climate in the glacial periods was cold and dry. As the results of charcoal analysis, it was revealed that number of charcoal grains increased in the glacial periods, especially in MIS 2, 4, 6 and 12. Those high peaks considerably correspond to peaks of the total amount of dry climate index (Gramineae, *Artemisia* and Chenopodiaceae) and high values of $d^{13}C$ (Mampuku et al., 2008). Therefore, it is inferred that in glacial periods, precipitation decreased due to weakening of Indian summer monsoon and caused frequent wild fire. This tendency is similar to that in core from the South China Sea (Luo et al., 2001).

Keywords: palynology, charcoal, Himalaya, Indian monsoon, Pleistocene.

SS03-O10 (577)

The Neogene vegetation and climate of Central Yunnan, SW China

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The Cenozoic vegetation and climate change of Himalayan and adjacent areas are crucial to understand the impact of the Neogene uplift of Himalaya. The vegetation and climates of three Neogene fossil sites from eastern Himalayan region were investigated. The paleoclimate were reconstructed using Coexistence Approach and CLAMP. During the early Miocene, the vegetation was subtropical seasonal evergreen forest with few tropical elements. The paleoclimate suggests a seasonal subtropical climate with a MAT of 17-19°C, and a MAP of 1200-1600mm which is similar to the present (MAT: 18°C, MAP: 1507mm). During the late Miocene, the vegetation was subtropical evergreen forest with few *Quercus* Sect. *Heterobalanus* species. The climate was a little warmer (MAT: 17.2-18.0°C (CA), 15.7±1.33°C) and more humid (MAP: 1206-1537.4mm (CA), GSP: 1297±184.7mm (CLAMP)) than the present. In the early Pliocene, the vegetation was warm

temperate evergreen and deciduous mixed forest with several *Quercus* Sect. *Heterobalanus* species in it. The temperature was cooler (MAT: 15.6-18.2°C (CA)) which is different from the present Dry-Hot Valley climate. The dry season precipitations from these three fossil sites are higher than the present values which suggest weaker precipitation seasonality during the Neogene.

Keywords: vegetation, palaeoclimate, Neogene, Yunanan, eastern Himalaya.

SS03-O11 (295)

A novel palaeoaltimetry proxy based on spore and pollen wall chemistry

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Understanding the uplift history and the evolution of high altitude plateaux is of major interest to a wide range of geoscientists with implications in many disparate fields. Currently the majority of palaeoaltimetry proxies are based on detecting a physical change in climate in response to uplift, making the relationship between uplift and climate difficult to decipher. Furthermore, current palaeoaltimetry proxies have a low degree of precision with errors typically greater than 1 km. This makes the quantification of uplift histories and the identification of the mechanisms responsible for uplift difficult to determine. Here we report on advances in both instrumentation and our understanding of the biogeochemical structure of sporopollenin that are leading to the establishment of a new proxy to track changes in the flux of UV-B radiation over geological time. The UV-B proxy is based on quantifying changes in the concentration of UV-B absorbing compounds (UACs) found in the spores and pollen grains of land plants, with the relative abundances of UACs increasing on exposure to elevated UV-B radiation. Given the physical relationship between altitude and UV-B radiation we suggest that the analysis of sporopollenin chemistry, specifically changes in the concentration of UACs, may offer the basis for the first climate independent palaeoaltimetry proxy. Owing to the ubiquity of spores and pollen in the fossil record our proposed proxy has the potential to enable the reconstruction of the uplift history of high altitude plateaux at unprecedented levels of fidelity, both spatially and temporally.

SS03-O12 (203)

Palaeoelevation of Yunnan during the late Miocene

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Yunnan Province has a complex geography with altitudes varying from almost sea-level to more than 6000 m. Its Neogene tectonic history is mainly the result of the collision of the Indian and Eurasian plates. This collision resulted in the uplift of the Qinghai-Tibet Plateau and the Himalayas, but also to the uplift of the Hengduan Mountains. Besides, these compressive forces had repercussions on South-East Asian geography. Even if Yunnan occupies an important position between the Qinghai-Tibet Plateau and the Indochina Peninsula, almost nothing is known about its palaeoelevation, in contrast to what have been done in Tibet. In this study, we use information from three fossil leaf assemblages to reconstruct the palaeoelevation of Yunnan during the late Miocene: Lincang, Xiaolongtan and Xianfeng. CLAMP (Climate Leaf Analysis Multivariate Program) links the leaf physiognomy with climatic parameters including the enthalpy at surface. Climate modeling gives the enthalpy at mean sea level. The difference between enthalpy at mean sea level and at surface is proportional to the altitude. During the late Miocene, Xianfeng is at about the same altitude as now (a little over 2000 m) whereas Lincang and Xiaolongtan are at lower altitudes (around 200 m and 500 m, respectively). Northern Yunnan to which Xianfeng belongs reached its present elevation; however, Southern Yunnan underwent an uplift since the late Miocene. These results correlate well with the floristic: Leguminosae are an important component of Lincang and Xiaolongtan assemblages whereas Fagaceae are clearly dominant in Xianfeng.

SS03-O13 (489)

The Middle Eocene to Early Miocene integrated sedimentary record in the Qaidam Basin and its implications for paleoclimate and early Tibetan Plateau uplift

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Tibetan Plateau uplift is the most prominent tectonic events of the Cenozoic and plays an important role in controlling regional and global climate, yet its uplift history has remained controversial.With a thick sequence of Eocene to Pliocene terrestrial records, the Qaidam Basin at the northern margin of the Tibetan Plateau provides an important sedimentary archive for understanding the surface uplift history of the northernTibetan plateau. Detailed analysis of whole rock geochemistry, clay minerals, sedimentary color and pollen in the Dahonggou section, northeast of the Qaidam Basin, are investigated and the results suggest a intense weathering in the source area during the Middle Eocene (Unit 1, 48.5- 40.5 Ma), indicating a warm and humid condition. The distinct decrease of chemical weathering degree in source regions began at ~40.5Ma, which is in accordance to the distinct decrease in redness of sedimentary sequences and the disappearance of thermophilic elements in pollen records. To the pollen record, vegetation changes in the Unit 2 are probably the most dramatic in the whole studied sedimentary sequences: the thermophilic elements, which with the highest average content in the Unit 1, disappeared in the sub-unit 2a ; At the same time, the broadleaved trees display a gradual decrease upwards from the Unit 1 to the Unit 2. All these above observations indicate an important decreasing trend for temperature and precipitation in the studied regions. So, we interpret the ~ 40.5 Ma cooling event could as evidence for intensification of central Asia aridification , which could be attributed to attainment of high elevations in the southern-central Tibet, which then, formed an orographic barrier, preventing moisture from the Neotethyan oceans into studied area at about 40.5Ma.

Keywords: chemical weathering, palynology, redness record, Central Asia aridification, Cenozoic global cooling.

SS03-O14 (201)

The relationship between atmospheric pCO_2 and stomatal frequency in *Quercus pannosa* and its application to paleoelevation reconstruction

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Research into the relationship between atmospheric CO_2 concentration and stomatal frequency (stomatal density, SD or stomatal index, SI) is becoming popular. This relationship can be used as a proxy for the reconstruction of paleo-CO_2 levels and paleoelevation. However, this relationship is species-specific. Most are negative, some positive and a few no response. Fossils of *Quercus* sect. *Heterobalanus* are common in Neogene of Hengduan Mountains. They could be suitable potential material for the reconstruction of paleo-CO_2 levels and paleoelevation. In order to achieve the aim, sun and shade leaf materials of 5 individuals each from 15 sites in different elevations of a range from 2493 m to 4497 m of *Quercus pannosa*, a dominant element of Sclerophyllous forests in the Himalayas and the nearest living relative of *Quercus* sect. *Heterobalanus* fossils, are collected to analyse leaf stomatal frequency. An inverse relationship between stomatal frequency and elevation is found in *Quercus pannosa*, in other word, a positive relationship between stomatal frequency and atmospheric CO_2 concentration. This correlation is different from most other plant species. Furthermore, the response of stomatal frequency of sun and shade leaves has the same tendency, though the SD and SI of shade leaves are lower than these of sun leaves. Therefore, sun and shade leaves in fossils should be distinguished to use stomatal method to estimate paleo-CO_2. Fossils of *Quercus* sect. *Heterobalanus* were collected from the late Miocene Xiangfeng flora in center Yunnan, and the Pliocene Yangyi flora in western Yunnan. The cuticle analysis from these fossils is carried out in order to test whether the new finding CO_2-SD/SI relationship can be used to estimate paleo-CO_2 and paleoelevation of Neogene.

Keywords: *Quercus pannosa*, SD/SI, sun and shade leaf, paleo-CO_2 levels, paleoaltitude.

(SS06) "Into the Icehouse" climate and vegetation change at the end of the Pliocene (a joint ROCEEH and NECLIME symposium)

Date: August 25
Place: Room 5236 (oral), Room 6302 (poster)
Organizers: Torsten Utescher & A. Angela Bruch
Contact email address: utescher@geo.uni-bonn.de
Purpose: The drastic global change from Neogene warm to Quaternary ice house climate took place to a large extent during the Pliocene. Marine records give evidence for a globally severe cooling and/or increasing aridity during Pliocene and towards the Pleistocene. There is evidence from various palaeobotanical records that this change involved a distinct loss in biodiversity, and for the first time, plant associations are recorded that are close to modern ecosystems. However not many details are known yet about the spatial and temporal distinctions in terrestrial climate evolution, influencing the vegetation cover differently in different parts of the continents.
Our symposium aims to discuss the late Pliocene to early Pleistocene terrestrial climate record, its spatial differentiation and influence on vegetation development. Contributions to quantitative vegetation and climate reconstructions based on all kinds of plant fossils, macro remains as well as pollen, and from all parts of the world are welcome to provide an overview of temporal and spatial changes at the Pliocene/Pleistocene transition.

Oral Presentation

Aug. 25 [AM2] Room: 5236

Chair: Torsten Utescher

10:50-11:30 **[Keynote] Late Pliocene vegetation and climate changes from the western Mediterranean area: the Camp dels Ninots maar record** SS06-O01 (220)

Gonzalo Jiménez-Moreno, Francesc Burjachs, Isabel Expósito, Oriol Oms, Angel Carrancho, Juan José Villalaín, Jan van der Made, Jordi Agustí, Gerard Campeny, Bruno Gómez de Soler, Eduardo Barrón

11:30-11:50 **A marine palynological study from off north-western Africa as a tool for land–sea correlation in the Late Pliocene** SS06-O02 (540)

Francesca Vallé, Suzanne A.G. Leroy, Chiori O.C. Agwu, Lydie M. Dupont

11:50-12:10 **Plio-Pleistocene vegetation response on orbitally forced climatic cycles in Southern Europe** SS06-O03 (54)

Angela A. Bruch, Adele Bertini

Aug. 25 [PM2] Room: 5236

Chair: Angela A. Bruch

14:50-15:10 **Early Pleistocene vegetation and climate changes in continental deposits of the Lesser Caucasus of Armenia** SS06-O04 (223)

Sébastien Joannin, Jean-Jacques Cornée,Philippe Münch, Michel Fornari, Iuliana Vasiliev, Wout Krijgsman, Samuel Nahapetyan, Ivan Gabrielyan,Vincent Ollivier, Paul Roiron, Christine Chataigner

15:10-15:30 **Pliocene climate cycles and vegetation variability in NW Germany prior to the onset of**

severe Pleistocene cooling SS06-O05 (538)

Torsten Utescher, Abdul R. Ashraf, Volker Mosbrugger, Andreas Schäfer

15:30-15:50 **Plio-Pleistocene climate, vegetation, and biogeography in southern Australia** SS06-O06 (487)

Kale Sniderman, Greg Jordan, Nick Porch

Aug. 25 [PM3] Room: 5236

Chair: Torsten Utescher

16:20-16:40 **Cenozoic vegetation and climate changes in the subtropical East Asia: a case study from Guangxi, south China** SS06-O07 (293)

Yusheng (Christopher) Liu, Cheng Quan

16:40-17:00 **Late Pliocene vegetation and climate change at Fudong, southwestern China** SS06-O08 (204)

Yong-Jiang Huang, Zhe-Kun Zhou, Frédéric M.B. Jacques, Yu-Sheng (Christopher) Liu, Tao Su, Yaowu Xing

Poster Presentation

Aug. 25 [PM1] Room: 6302

13:30-14:30 **Miocene-Pliocene vegetation changes of west southern Africa (Namibia)** SS06-P01 (192)

Sebastian Hoetzel, Francesca Vallé, Lydie Dupont

SS06-O01 (220)

Late Pliocene vegetation and climate changes from the western Mediterranean area: the Camp dels Ninots maar record

Gonzalo Jiménez-Moreno[1], Francesc Burjachs[2,3,4], Isabel Expósito[3,4], Oriol Oms[5], Angel Carrancho[6], Juan José Villalaín[6], Jan van der Made[7], Jordi Agustí[2,3,4], Gerard Campeny[3,4], Bruno Gómez de Soler[3,4], Eduardo Barrón[8]

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The Late Pliocene is a very interesting period as climate deteriorates from a warm optimum at ca. 3.3-3.0 Ma to a progressive climate cooling, an intensification of Northern Hemisphere glaciations. Around that time, the Mediterranean area also witnessed the establishment of the mediterranean-type seasonal precipitation rhythm (summer drought). These important climate changes produced significant vegetation changes such as the extinction of several thermophilous and hygrophilous

plant taxa from the European latitudes. Besides these long-term trends, climate was also characterized by cyclical variability (i.e., orbital changes) that forced vegetation changes (forested vs. open vegetation). In the Mediterranean area, cyclical changes in the vegetation are mostly forced by precession, even if during the 2.8 – 1.0 Ma period obliquity also played an important role on shaping the vegetation. In this study we analyzed pollen from a Late Pliocene maar lake core from NE Spain. An increase in aridity is observed throughout the studied sequence. Cyclical changes in the vegetation are also observed mostly forced by precession but also by obliquity and eccentricity. Precipitation seems to be the main factor controlling these cycles. Climate, paleobiogeographical and age implication are discussed within the context of the late Pliocene Northern Hemisphere glacial intensification.

Keywords: palynology, vegetation, climate variability, Late Pliocene, Mediterranean area.

SS06-O02 (540)

A marine palynological study from off north-western Africa as a tool for land–sea correlation in the Late Pliocene

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The distribution of pollen in marine sediments reflects vegetation changes on the continent. The combined study of pollen and dinoflagellate cysts from marine sediments gives the opportunity to establish land-sea correlations, trying to link climate and vegetation changes to oceanic changes. Here we present the preliminary results of a palynological study of well-dated marine sediments retrieved offshore north-western Africa at ODP Site 659 (18°05'N 21°02'W; 3071 m water depth). ODP Site 659 is located outside the upwelling area and lies directly under the main stream of the Saharan Air Layer, which carries dust, plant waxes, and pollen out of the African continent. The source areas of pollen at this location are mainly the savannah and the dry forest (woodlands) from the Sahel zone and the Sahara desert. We present the pollen and dinocysts records for an interval between ~3.6 and 2.7 Ma. The aridity/humidity cycles occurring during the Quaternary in the South Sahara and Sahel zone are supposed to be driven by the variability of the Atlantic meridional overturning circulation. We want to test this for the Pliocene. Modelling studies suggest that during the mid-Pliocene (3.6 – 3 Ma), the final closure of the Central American Seaway strengthened the Atlantic meridional overturning circulation enhancing heat advection to high northern latitudes and increasing the precipitation in north-western Africa. As a result of more humid conditions, mid-Pliocene woodlands and tropical savannahs extended northwards far into the today's arid regions. Additionally we ran XRF scanning of the sediment cores to compare our pollen record with element ratios (Ti/Ca and Fe/K). These data can be used as indication of terrestrial input and as climatic index.

SS06-O03 (54)

Plio-Pleistocene vegetation response on orbitally forced climatic cycles in Southern Europe

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The pace and causes of the early human colonization, in one or several migratory waves from Africa in new environments of the Eurasian continent during the Early Pleistocene, are still a matter of debate. However, climate change is considered a major driving factor of hominin evolution and dispersal patterns. In fact directly or indirectly by its severe influence on vegetation, physiography of landscape, and animal distribution, climate modulates the availability of resources. Plant fossils usually are rare or even absent at hominin sites. Thus, direct evidence on local vegetation and environment is generally missing. Independent from such localities, pollen profiles from the Mediterranean realm show the response of regional vegetation on global climate changes and cyclicity, with distinct spatial and temporal differences. Furthermore, plant fossils provide proxies for climate quantification that can be compared to the global signal, and add data to understanding the regional differentiation of Mediterranean environments. In this presentation we will discuss various palaeobotanical data from Southern Europe to assess Early Pleistocene climate and vegetation in time and space as part of the environment during the first expansions of early humans out of Africa.

Keywords: Southern Europe, Early Pleistocene, climate cycles, vegetation cycles.

SS06-O04 (223)

Early Pleistocene vegetation and climate changes in continental deposits of the Lesser Caucasus of Armenia

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The Lesser Caucasus is an active volcanic and tectonic belt which resulted from the collision of the Arabian and the Eurasian plates since Neogene times. During the Quaternary, the Lesser Caucasus was uplifted and large lakes developed in graben structures. In this active background, and, in the context of evolving climate states (i.e. climate cycles) during Pleistocene time, the Lesser Caucasus can provide crucial insight into exploring direct environment (i.e. vegetation landscape and climate) of first hominids in Eurasia. Thus, in this poorly investigated region, one must question whether the vegetation recorded the particular climate scheme of humid glacials and arid interglacials as suggested in Kazakhstan. In Southern Armenia, the diatomitic sequences of the Shamb paleo-lake offer a rare opportunity to give new insights of Western Asia vegetation-inferred paleo-climate. We investigate pollen-based climate changes of the most complete Shamb section (Joannin et al., 2010). $^{40}Ar/^{39}Ar$ dating of two volcaniclastic layers provided ages of 1.24 ± 0.03 and 1.16 ± 0.02 Ma (2σ).

Magnetostratigraphic data show that the entire Shamb section is of reversed polarity which correlates with part of the Matuyama period (1.785-1.070 Ma). Pollen- and macroremains-based glacial and interglacial phases are compared with climate changes inferred from the global (LR04) oxygen isotope record. The Shamb section ranges from approximately 1.30 to 1.08 Ma (marine isotopic stages 40 to 31). The vegetation of the Lesser Caucasus developed in a mosaic pattern in a Pleistocene continental, mostly arid climate, similar to the present-day. The vegetation changes record a dominant climate response to the obliquity orbital parameter and the influence of precession could not be established. Pollen and macroflora both indicate that glacial periods were cold and dry and that interglacials were warm with local humidity. The early Pleistocene Western Asia climatic model is thus similar to Mediterranean climatic model.

SS06-O05 (538)

Pliocene climate cycles and vegetation variability in NW Germany prior to the onset of severe Pleistocene cooling

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The application of quantitative techniques such as Coexistence Approach and interpretation of diversity of plant functional types (pfts) on the palaeobotanical record allows for detailed reconstructions of continental climate and its variability. For the NW European Cenozoic, recent studies based on macro- and microflora reveal a close correlation of continental temperature evolution and global signals known from marine archives. Prior to the Pleistocene comparatively warm climate conditions with MAT around 12.5 °C and CMT above freezing prevailed in NW Germany, significant cooling set on during the Gelasian. For the first time in the Neogene regional climate history, cooling strongly affected even summer temperature. In contrast to numerous other European continental areas, where drying is reported, the inferred Pliocene mean annual precipitation rates in NW Germany at first dropped below 1,000 mm at the beginning of the Zanclean, but then increased again along the later Pliocene. Presently two Zanclean to Piacencian palynomorph records from the Lower Rhine Basin comprising a total of 350 samples are analyzed in detail to study climate and vegetation change. Withal, restrictions caused by erosional surfaces and gaps in the record, the palynomorph spectra obtained from the the paludal to lacustrine sequences reveal orbital scale cyclicity of climate and vegetation change, suggesting a distinct coupling of the continental climate evolution with the marine environmental system. Phases of eustatic sea-level lowstand connected to glaciation events are mirrored in the continental curves and reflected by vegetation change. It is shown that climate variability is characterized by non-proportional changes of climate parameters. As was assumed from the general record variability primarily effects the cold season in the earlier part of the Pliocene, from the Piacencian on, summer temperatures show a high variability as well. Unlike the climate dynamics previously characteristic for the area cool phases tend to have higher rainfall in the Pliocene pattern. The climate cycles are also reflected in vegetational patterns, e.g. diversity proportions of broadleaved evergreen woody angiosperms vs. needleleaved cool temperate components. [Grant: DFG MI 926 / 8-1]

Keywords: Pliocene, Northwest Germany, palaeoclimate, vegetation, diversity.

SS06-O06 (487)

Plio-Pleistocene climate, vegetation, and biogeography in southern Australia

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The nature and timing of the shift from warmer Neogene climates to Quaternary ice house climates is poorly known in Australasia. However, we present evidence from Early Pleistocene fossil pollen, plant macrofossils, and beetles that in southern Australia the major transition from warm, moist, summer-wet Neogene climates into cooler, summer-dry climates did not coincide closely with the Pliocene-Pleistocene boundary near ~2.6 Ma, but occurred later, some time after ~1.5 Ma. We present data showing that mesic rainforest communities, dominated by conifers and angiosperms now extinct in Australia, coexisted alongside hyperdiverse, micro-sclerophyll plant communities, for which the closest analogues are the extraordinarily species rich sclerophyll shrublands of southwest Australia. It has previously been widely assumed, largely based on fossil pollen records only, that the Neogene-Quaternary transition heavily impacted rainforest biomes while promoting the radiation of the Australian sclerophyll flora. However, our data suggest that the novel development of a winter-dominated rainfall regime, or perhaps more generally of higher-amplitude climate variability in the Pleistocene, caused mass extinctions in both Australian vegetation types. Southeast Australian Early Pleistocene plant and insect taxa which are still extant in Australia tend now to be confined to refugia either to the south (Tasmania), to the east (montane New South Wales and Queensland) or in the far southwest (Southwest Australian Floristic Region). These regions may have functioned as refugia because of varying combinations of relictual climates and of low orbital-scale species range dynamics (ORD, of Jansson & Dynesius 2002, *Ann. Rev. Ecol. Syst.* 33:741) (perhaps, in southwest Australia).

Keywords: palynology, palaeobotany, sclerophyll, rainforest, beetle.

SS06-O07 (293)

Cenozoic vegetation and climate changes in the subtropical East Asia: a case study from Guangxi, south China

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A quantitative paleoclimate study was applied to a macroflora from the Changsheling Formation in Guangxi of SW China. The age of the flora with cuticle-preserved leaves is still on debate, but it is accepted that it cannot be older than the Pliocene. This is a rare late Neogene or early Pleistocene macroflora in the southern subtropical-northern tropical China. The dominant fossil plant families include Lauraceae, Anonaceae, and Fagaceae, which seems not to be much change in terms of vegetation type to the modern. Both the Coexistent Approach and Leaf Margin Analysis were employed to test the paleoclimate condition of this flora may represent. The reconstructed temperatures of MAT, CMMT, and WMMT appear to be close to those of the modern; while precipitations show some contrasting differences although the estimated MAP appears overlapped

with the modern. Both the ancient precipitations in wettest and driest months appear quite low, e.g. 160-370 mm (estimated) vs 580-600 mm (modern) for the wettest month and 7-64 mm (estimated) vs 58-66 mm (modern). In addition, the precipitation in warmest month appears almost twice wetter for the fossil flora than that of the modern. In other words, our work suggests that in the late Neogene or early Pleistocene of tropical southern China the temperature seems not to be changed much, but the precipitations in wettest and driest months were much drier than those of today, while that in the warmest month was much wetter in the past than today.

Keywords: paleoclimate, late Cenozoic, southern China, subtropical-tropical regions.

SS06-O08 (204)
Late Pliocene vegetation and climate change at Fudong, southwestern China

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The late Pliocene Fudong Flora from northwestern Yunnan, southwestern China, bears abundant fossil leaves, seeds and fruits. The leaves are recovered from the lower claystone and fine sandstone while the seeds and fruits are from the upper red claystone of the deposits of Sanying Formation. Leaf fossil taxa include *Pinus*, *Picea*, *Berberis*, *Populus*, *Salix*, *Acer*, *Cyclobalanopsis*, *Lithocarpus*, *Quercus* and *Desmodium*, etc., of which, *Quercus* sect. *Heterobalanus* is evidently the dominant element, suggesting evergreen broad-leaved forest vegetation. Seed and fruit fossil taxa include *Ranuculus*, *Chenopodium*, *Antenoron*, *Cucubalus*, *Salix*, *Rubus*, *Aralia*, *Verbena*, *Sambucus*, *Cyperus*, *Scirpus* and *Carex*, etc., of which *Chenopodium* is clearly the dominant component, suggesting grassland, mingled with shrubs such as *Rubus* and *Aralia*. Vegetation type might have been shifted from evergreen broad-leaved forest at the lower stage to grassland at the upper stage of the late Pliocene at Fudong. MAT and MAP based on leaf assemblage yield 12.6-17.4ºC and 529-1151 mm, respectively; MAT and MAP based on seed and fruit assemblage yield 12.2-16.8ºC and 617-1361 mm, respectively. This suggests the climate was getting a little cooler and wetter during the late Pliocene at this locality. Interestingly, the CMMT of the seed and fruit assemblage yields -1.4-6.1ºC, which is significantly lower than that of the leaf assemblage (4.3-8.3ºC). This climatic change might be largely because of the coming glacial period at the end of the late Pliocene.

Keywords: late Pliocene, vegetation, palaeoclimate, Fudong, Yunnan.

SS06-P01 (192)
Miocene-Pliocene vegetation changes of west southern Africa (Namibia)

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The Miocene-Pliocene is the period of the major savanna grassland expansion in Africa and is

followed or accompanied by the expansion of the so-called C_4 plants, which are adapted to dry warm conditions. The driving forces for this expansion are still unknown. Increased climatic seasonality, increasing general aridification, cloud cover, intense herbivory, and fire abundance are discussed to play important roles. It is mostly believed that strong upwelling attended with decreasing sea-surface temperatures played a major role in the desiccation and hydrology changes on the African continent. However, direct evidences for this link have been rarely reported so far and it is still poorly known how the tropical vegetation changed in southern Africa and, especially, how the tropical savannas developed. The main scientific objective of this study is to gain insights in the variability of the tropical vegetation with emphasis on the expansion of the grasslands and its driving forces. Therefore, the current study focuses on the continuous tropical marine sediment sequence of ODP Site 1081, offshore Namibia (19°37'S, 11°19'E, 794 m water depth). The period from 9.2 to 2.8 Ma has been studied for its pollen, spores, and charcoal content. The results suggest relative humid conditions with a rather strong signal of woodlands and mountain vegetation between 9.2 and 8.3 Ma. From 8.3 Ma on, there is a gradual change to drier conditions recorded by a strong increase of grass pollen indicating that savanna grasslands replaced woodlands. This increase represents the major savanna grassland expansion in west southern Africa during the studied period. At 7.2 Ma large amounts of charred particles indicate stronger fire activity. This increased fire activity is probably related to the establishment of the savanna grasslands providing large amounts of fuel for bushfires. At 5.1 Ma the sedimentation pattern indicates higher fluvial input represented by higher pollen influx rates and the presence of swamp and lake indicators, such as *Typha* and Nympheaceae pollen. This might be related to a change in the course of the Cunene River, which fed the Lake Cunene during Late Miocene and Pliocene times (today visible as Etosha pan). The Cunene River discharge to the Atlantic Ocean probably began during late Pliocene times when the inland Lake Cunene started to dry out.

Keywords: Savanna expansion, palaeoclimate, palaeofires, Cunene Lake.

(SS08) Climatically-forced vegetation changes short-termed (a NECLIME symposium)

Date: August 24
Place: Room 5234 (oral)
Organizers: Andrea K. Kern & Torsten Utescher
Contact email address: andrea.kern@nhm-wien.ac.at
Purpose: Cenozoic studies around the globe allow us to draw substantial conclusions about Earth's evolution related to climatic changes. At the very best, proxy data based spatial reconstructions considering palaeovegetation or palaeoclimatic parameters can be compared with results obtained from adequate modeling studies which are highly useful to create an overall image. However, vegetation change caused by short-term climate variability usually remain concealed due to the delimited time resolution such studies permit.
Our symposium aims to discuss climate-vegetation interactions from decadal- to millennial-scale. This information is in great extent only supplied by high-frequency palynological analyses. Focusing on local vegetation dynamics climatic events and transitions can be deciphered and, if possible, compared with other geological and environmental proxy estimations. Besides, thematic priority lies on finding a potential climate-vegetation-equilibrium of fossil plant communities as well as up to what temporal extent, changes within the studied assemblage can be resolved. Only due to a deeper understanding of past short-term events, recent and future climate change and biotic response can be conceived.
We invite all contributions referring to high-resolving, quantitative vegetation and climate reconstructions in the Cenozoic.

Oral Presentation

Aug. 24 [PM2] Room: 5234

Chair: Andrea K. Kern

14:30-15:10 **[Keynote] Short-termed vegetation dynamics in the tropics: climate-forced and system-driven** SS08-O01 (195)

Henry Hooghiemstra, Mirella Groot, Raul Giovanni Bogota-Angel, Lucas Lourens, Juan Carlos Berrio, Erik Tuenter, Zaire Maria González-Carranza, Maria Isabel Vélez, Erik de Boer, Kenneth Frank Rijsdijk

15:10-15:30 **The vegetation change and fire record in the past 4000 years in Far East of Russia** SS08-O02 (598)

ShaoHua Yu, Zhuo Zheng, KangYou Huang, M.I. Skrypnikova

15:30-15:50 **Short-term landscape and climatic oscillation in the Holocene of Southern Primorye, Russian Far East** SS08-O03 (337)

Yury Mikishin, Tatiana Petrenko, Aleksandr Popov

Aug. 24 [PM3] Room: 5234

Chair: Torsten Utescher

16:20-16:40 **Cyclic vegetation changes during the Mid-Pleistocene climate transition around Osaka Bay, southwest Japan** SS08-O04 (241)

Ikuko Kitaba, Masayuki Hyodo, Shigehiro Katoh, David. L. Dettman, Hiroshi Sato

16:40-17:00 **Can vegetation changes be recorded on a decadal to centennial scale in the Late Miocene?** SS08-O05 (235)

Andrea K. Kern, Mathias Harzhauser, Ali Soliman, Werner E. Piller

17:00-17:20 **[General discussion]** SS08-O06

SS08-O01 (195)
Short-termed vegetation dynamics in the tropics: climate-forced and system-driven

Henry Hooghiemstra[1], Mirella Groot[1], Raul Giovanni Bogota-Angel[1,2], Lucas Lourens[3], Juan Carlos Berrio[4], Erik Tuenter[3], Zaire Maria González-Carranza[1], Maria Isabel Vélez[5], Erik de Boer[1], Kenneth Frank Rijsdijk[1]

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New high-resolution pollen records from tropical latitudes show a wealth of short-termed vegetation change. In the northern Andes we show obliquity and pCO_2-driven climate change in a new 284-kyr long record from the intra-Andean site Lake Fúquene. Glacial rates of temperature change vary from 2-3°C/100 yr, at Terminations up to 10°C/100 yr. Model studies show such high responsiveness during a full glacial-interglacial cycle is only explained when impact of green house gasses is included. From the Andean flank facing Western Amazonia we show a new record of Holocene climate change driven by trans-Amazonian moisture supply. Quasi-stable conditions lasted for maximally 200 to 600 yr evidencing that the low climate variability in Holocene ice-core records is not representative for the tropics. Both site studies show a dramatic difference in rate of temperature change across the last Termination. Multiple events of loss of the subpáramo biome in the region suggest climate change-driven migration rates may surpass biome migration capacity. Pollen records have high potential to improve understanding of processes involved in regional and temporarely extirpation of biota, as well as extinction. Regeneration capacity of the Andean subpáramo biome is compared with the species turn-over in a montane forest in Mauritius (Indian Ocean) after perturbation by the last Termination. After a long lasting ecological steady state during the last glacial, a cascade of short-lived forest associations developed finally into a next long lasting steady state during the Holocene. Tropical montane biomes are more vulnerable to climate perturbations as realized before but also show remarkable flexibility. Montane (Andes) and oceanic (Indian Ocean) island archipelagos are compared. Observations from the new and rapidly developing domain of 'high-resolution-paleoecology' are relevant for paleodata-model comparisons, conservation practice, as well as IPCC-related projections of the AD 2100 climate and environment.

Keywords: Dansgaard-Oeschger cycles, paleodata-model comparison, biome migration rates, rates of change, ecological change.

SS08-O02 (598)
The vegetation change and fire record in the past 4000 years in Far East of Russia

ShaoHua Yu[1], Zhuo Zheng[1], KangYou Huang[1], M.I. Skrypnikova[2]

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The environment change in the Far East of Russia has enormous influenced the whole carbon cycle of the earth, as a high-latitude swamp in the world. In this paper, 64 samples had been selected in Amur 23 core to pollen analysis with the vegetation survey of the entire region, which were compared with 40 surface pollen samples in order to reconstruct the palaeoenvironment in the past 4000 years. In addition, the charcoal data had been quantitative analyzed and compared with pollen data to explore the material source of charcoals, the fire frequency and the extent of fire, and the human activities in this period could been deeply studied. The results showed that the palaeoenvironment in the Far East of Russia could be divided by four periods: the temperate broad –leaved forest indicating warm and wet climate during the 4000-3000 years ago, and most of charcoals came from the grass and less than 50μm, which showed most of the fire took placed in region. The fire frequency was not very high, nearly to 370 years/ time. In this period, the swamp has begun developing and the environment has been little effected by human beings. Dense, wet grass and broad- leaved trees dominated in the 3000-1500 years, which reflected the wet and warm climate, when the swamp had been developed fully. Especially, the human activities had been greatly intensified after 2000 years, showed by the increasing Gramineae pollen and reticular charcoals. Most of fire was locally of significantly higher frequency, achieved to 182 years/time, indicating the palaeoenvironment had been influenced by climate and human activities. During 1500-500 years, the increasing of Pinus demonstrated the climate became relatively cold and wet, and the fire frequency still increased, nearly to 165 years /time. At the same time, the swamp had been finished growth with intensifying human activities. Cold and dry conditions characterized the time after 500 years, when the swamp presented recession. The concentration of charcoal had been largely increased with the fire frequency reach to 125 years/time, which implied that the wet meadow began to degradation.

Keywords: Far East, pollen, charcoal, palaeoenvironment, human activities.

SS08-O03 (337)

Short-term landscape and climatic oscillation in the Holocene of Southern Primorye, Russian Far East

Yury Mikishin[1], Tatiana Petrenko[1], Aleksandr Popov[2]

[1] *Far East Geological Institute, Russia, yurimikishin@fegi.ru*
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Holocene vegetation and climate of Southern Primorye were reconstructed through integrated studies of sediments of accumulative terraces. We distinguished 29 pollen assemblages and corresponding them stages of vegetation and climate development. The warmest climate was registered in the end of Middle Atlantic Period (6600–7100 Cal. yr BP), middle of Late Atlantic (6000–6450 Cal. yr BP), Middle Subboreal Period (3650–4350 Cal. yr BP), middle of Late Subboreal Period (3100–3200 Cal. yr BP) and end of Early Subatlantic Period (1750–2200 Cal. yr BP). Pollen spectra are dominated by broad-leaved tree pollens with *Quercus* prevailing and a high content of *Juglans*, *Ulmus* and *Carpinus*. A high content of pollen of thermophilic hornbeam in pollen assemblages, exceeding the modern content by 7–10 times on average is indicative of development in Southern Primorye of vegetation similar to the currently existing vegetation in Korean Peninsula, 400–500 km south of Primorye. Mean yearly air temperatures were growing 5–7° on modern temperatures (10–12°C) and yearly precipitation rate was growing 1.5–2 times

(1100–1600 mm). A climate cooling down to a level, close to the present time, was registered in beginning of Preboreal Period, Middle Atlantic Period (7100–7350 Cal. yr BP), beginning of Late Atlantic Period (6450–6600 Cal. yr BP), end of Late Atlantic Period (5500–6000 Cal. yr BP), beginning of Middle Subboreal Period (4350–4750 Cal. yr BP), end of Middle Subboreal Period (3500–3700 Cal. yr BP), end of Late Subboreal Period (2650–2900 Cal. yr BP) and Middle Subatlantic Period (1400–1700 Cal. yr BP). The pollen assemblages of this age reflect a decreasing role of broad-leaved trees and spread of alder/birch trees and Korean pine. A more significant climate cooling was registered in the end of Preboreal Period, end of Boreal period (8900–9300 Cal. yr BP), Middle Atlantic Period (7350–7500 Cal. yr BP), Early Subboreal period (5000–5100 Cal. yr BP), beginning of Late Subboreal period (3200–3500 Cal. yr BP), beginning of Early Subatlantic Period (2500–2600 Cal. yr BP), beginning of Middle Subatlantic Period (1700–1750 Cal. yr BP) and Late Subatlantic Period (600–900 and 150–500 Cal. yr BP). In pollen assemblages, there is little pollen of broad-leaved trees, but much pollen of small-leaved and coniferous trees.

Keywords: pollen assemblage, broad-leaved forest, coniferous/broad-leaved forest, hornbeam, Korean pine.

SS08-O04 (241)

Cyclic vegetation changes during the Mid-Pleistocene climate transition around Osaka Bay, southwest Japan

Ikuko Kitaba[1], Masayuki Hyodo[1], Shigehiro Katoh[2], David. L. Dettman[3], Hiroshi Sato[4]

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[4] *University of Hyogo, Japan.*

During the Mid-Pleistocene climate transition (MPT) from 1.25 to 0.7 Ma, the Quaternary climate system underwent large changes. The dominant climate cyclicity changed from ca. 41-kyr obliquity cycle to ca. 100-kyr eccentricity cycle, and the amplitude of variation increased. This caused a major change in the flora, e.g. several Tertiary plants disappeared around Osaka Bay, southwest Japan. Osaka Bay was also strongly affected by glacio-eustatic sea-level changes since the first marine incursion during marine oxygen isotope stage (MIS) 37 (1.25 Ma). Its depositional environment repeated the cycle of marine/fluvio-lacustrine phases associated with the interglacial/glacial cycle. We carried out multiproxy analysis of a 1,700-m core from Osaka Bay, focusing on the interglacials in the MPT to reveal the centennial to millennial scale variation in climate and sea-level, and discuss its influence on the flora. Diatom, sulfur and carbon isotope analyses reveal that the short-term high sea-level periods correspond to the single peak of precession cycle in MIS 31 and 25. In MIS 21 and 19 the sea-level highstand occurred just after the rapid postglacial sea-level rise, followed by a gradual decline in sea level accompanied by precession-related oscillations; a typical feature of the post-MPT interglacials with 100-kyr cyclicity. Inferred sea-level variation is supported by palynological marine/coastal vegetation proxies like the ratio of arboreal to herbaceous pollen, percentages of marine resting spore cysts or *Alnus* (main component of marsh forest). These marked cyclic changes are accompanied by significant vegetation changes. Before MIS 24, Taxodiaceae (*Cryptomeria* and *Metasequoia*) are dominant in the glacial periods. After MIS 22, however, it was replaced by Pineceae including sub-boreal taxa such as *Picea* and *Abies*, which probably grew in the cold-dry glacial climate. In the later interval *Metasequoia* nearly completely disappeared. On the other hand, forest components are very similar in every interglacial period. The interglacial vegetation is primarily characterized by deciduous broad-leaved forest, including *Fagus* or *Quercus* (*Lepidobalanus*). In interglacial periods, the proportion of *Quercus* (*Cyclobalanopsis*) fluctuated

with the precession cycle. The thermal maximum, shown by the highest proportion of *Quercus* (*Cyclobalanopsis*), occurred in phase with the sea-level highstand, with two exceptions. Therefore, vegetation cycles occurred in response to climate variation closely correlated with Milankovitch forcing, and the disappearance of *Metasequoia* might have been caused by cold glacial climates around the termination of MPT.

Keywords: Milankovitch cycle, cooling, disappearance of Tertiary plants, multiproxy analysis, Osaka Bay sediment.

SS08-O05 (235)

Can vegetation changes be recorded on a decadal to centennial scale in the Late Miocene?

Andrea K. Kern[1,2], Mathias Harzhauser[1], Ali Soliman[3,4], Werner E. Piller[3]

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Resolving environmental changes on decadal to centennial scales is state-of-the-art within the Holocene. Outside the ^{14}C range it remains a challenge to provide a valid age control for deposits, which usually also lack signs of annual preservation. Nevertheless, new methods are needed to discuss short-termed environmental evolution and to detect their relation with paleoclimatic changes. Thus we studied two Austrian localities in a marginal position to a huge paleo-lake of slightly different Late Miocene age (~11.3 and ~10.5 Ma, respectively). Previous integrative stratigraphic studies revealed a good time frame, but a more precise age could be provided by astronomical tuning due to geophysical data. High resolution analyses were conducted on cores with sample resolution of 1 cm at both localities. To describe changes within and around the lake, a combination of different biotic and environmental proxies was applied, including pollen, dinoflagellates, ostracods, geophysics (gamma-radiation and magnetic susceptibility) and geochemistry (carbon and sulfur). The analyzed a 1-m-core sequence of the older locality covers a time span of less than 1400 years. Palynological data describe a high-frequently-changing marsh vegetation in a shallow embayment of the paleo-lake. Re-occurring algae blooms happened before a transgression, occurring within a few decades, disturbed the high nutrient surface waters. This deepening caused further a rapid dieback of the non-forested wetlands, followed by a re-establishment within less than 100 years. All these data can be linked to variations of the mean annual precipitation, while temperature remained stable. For the second example a longer core (6 m) was investigated in respect to geophysical properties and ostracod distribution. Statistical data processing suggested a link to solar cycles, which could enhance the former age-model. In the course of this study, palynological and geochemical samples were analyzed for a shorter core segment (1 m) representing a time span of app. 2000 years. These revealed synchronous alternations within the indicators for vegetation, surface water and bottom water conditions assume a common trigger. This may have rather controlled input into the lake than causing major changes within the lake environments or even climate. Presumably, these minor oscillations were caused by solar cycles, which in fact seem rather to control local weather patterns such as wind or rainfall and not climate. Thus, due to our Late Miocene high-resolution analyses we can show different forcing mechanism on climate even on a decadal scale.

Keywords: high-resolution-analysis, climate-vegetation-interaction, dinoflagellates, pollen, solar cycles.

(SS09) Quantifying Cenozoic vegetation – new developments in standardized approaches (a joint ROCEEH and NECLIME symposium)

Date: August 30
Place: Room 5235 (oral)
Organizers: Angela A. Bruch, Elena Vassio & Johanna Kovar-Eder
Contact email address: abruch@senckenberg.de
Purpose: Standardized methods for vegetation reconstructions are crucial tools to obtain comparable results for fossil floras from different regions and independent from the scientist using the method. Regional or global vegetation reconstructions are a base for as different objectives as landscape reconstructions or climate modeling. Depending on the scale of the objected vegetation unit to be reconstructed, a method has to meet special preconditions and therefore can vary considerably in its theoretical setting.
Several methods were developed during the last years which are based on different philosophies (taxonomic or physiognomic) and approaches (semi-quantitative to statistical), cover different spatial scales of the reconstructed vegetation units (local, regional, or global), or rely on different fossil plant remains (macro or micro floras). Each of those has specific advantages for specific scientific applications.
Our symposium aims to give an overview to the state of the art of methods available and their latest developments. It is NOT meant to be a competition to find "the best method" but to stress the necessity of standardized vegetation reconstructions, to promote their application, and to provide a tool box for various crucial scientific questions.

Oral Presentation

Aug. 30 [AM1] Room: 5235

Chair: Angela A. Bruch

9:00-9:20 **[Introduction] Quantifying Cenozoic vegetation – new developments in standardized approaches** SS09-O01

Angela A. Bruch

9:20-9:40 **Further steps towards a management of the bias between vegetation and sedimentary fruit and seed assemblages** SS09-O02 (542)

Elena Vassio, Edoardo Martinetto

9:40-10:00 **Integrated Plant Record (PR) vegetation analysis validated by application to modern vegetation types in China and Japan** SS09-O03 (252)

Johanna Kovar-Eder, Vasilis Teodoridis

10:00-10:20 **Palaeovegetation reconstruction in monsoonal regions** SS09-O04 (209)

Frédéric MB Jacques, Tao Su, Jianwei Zhang, Li Wang, Yongjiang Huang, Jinjin Hu, Shufeng Li, Mei Sun, Zhekun Zhou

Aug. 30 [AM2] Room: 5235

Chair: Elena Vassio

10:50-11:10 **Anomalies in Cenozoic vegetational gradients on both sides of the North Atlantic - induced by Gulf Stream intensity?** SS09-O05 (539)

Torsten Utescher, Madelaine Böhme, Boglárka Erdei, Thomas Hickler, Yusheng (Christopher) Liu, Volker Mosbrugger

11:10-11:30 **Quantifying openness of palaeovegetation with modern LAI data – an attempt towards a new approach** SS09-O06 (53)

Angela A. Bruch

SS09-O02 (542)

Further steps towards a management of the bias between vegetation and sedimentary fruit and seed assemblages

Elena Vassio, Edoardo Martinetto

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In order to improve the reconstruction of local terrestrial palaeovegetation by means of quantitative and qualitative data from European Cenozoic carpological (fruit and seed) assemblages, actuopalaeobotanical investigations have been carried out in some small fluvial catchment basins (NW Italy), characterised by different vegetation and topographic contexts. The aim of these observations consisted in evaluating and quantifying the mismatch between fruit and seed assemblages and their source plant communities. The comparison of qualitative and quantitative floral data, obtained from vegetation relevés and deposit analysis has been carried out by means of the standardised and synthesised graphical approach of "*Plant Community Scenarios*" (*PCS*s). Modern diaspore contents allowed to distinguish assemblages originated in different basins, moreover, those sampled in the same basin provided homogeneous and peculiar signal. Comparison across all samples indicated a certain agreement between modern vegetation and the *PCS* reconstruction based on the analysis of fruit and seed assemblages. The last ones seem to better summarise – at least qualitatively - the whole basin area vegetation instead of that of the areas next to the sampling point. The fluvial accumulations of diaspores show similar frequency values for several taxa, which seem to indicate that bedload transport can produce some "homogenisation" of the fruit and seed mass. On the other hand, some samples taken in the same zone, display how much the frequency of taxa can change, within a uniform vegetation context, for the sole effect of sedimentary processes. The bias between each taxon's proportion in standing vegetation and in the related sedimentary assemblages has been evaluated and some common patterns of over-/underrepresentation have been pointed out, as an indication of generalised determining factors. These include environmental processes and diaspore features that affect plant material from the production (diaspore size, shape, woodiness, abundance), through the transport, until the final deposition and incorporation in clastic sediments (environmental energy, grain size, slope morphology). Small dimensions, consistent woodiness and rounded shape appear to be connected to overrepresentation. In addition, the dispersal mode seems to be very important: a clear overrepresentation of anemochorous, endozoochorous and myrmecochorous diaspores has been detected. Moreover, the bias for some taxa has been quantified, thus allowing to propose some preliminary correction factors (*Bias-index*). These have been taken into account, and applied as a key to the interpretation of analogous fossil assemblages, thus obtaining corrected *PCS*s which should provide a less biased picture of ancient vegetation.

Keywords: diaspores, fluvial deposits, representation bias, actuopalaeobotany, quantitative vegetation reconstruction.

SS09-O03 (252)

Integrated Plant Record (PR) vegetation analysis validated by application to modern vegetation types in China and Japan

Johanna Kovar-Eder[1], Vasilis Teodoridis[2]

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[2] *Charles University Prague, Czech Republic*

The Integrated Plant Record (IPR)-vegetation analysis is a semi-quantitative tool developed as a proxy to assess zonal vegetation classification. It is based on fossil plant taxa catagorized into zonal taxonomic-physiognomic components reflecting key autecological characteristics. The proportions of these components in the fossil assemblages define main vegetation types. Modern vegetation studies in SE China (Emei Mt., Longqi Mt., Meili Snow Mt.) and Japan (Shirakami Sanchi, Mt. Fuji, Nara, Yokohama, Yakushima Island) are performed here to test this fossil-based technique and achieve fine-tuning and corroboration. Thirty-five different units of different vegetation formations generally defined as broad-leaved evergreen forests, mixed mesophytic forests, broad-leaved deciduous forests, and subhumid sclerophyllous forests have been investigated. The IPR-vegetation analysis results obtained from this modern vegetation largely support the originally defined proportions of the important zonal woody angiosperm groups, i.e., broad-leaved deciduous, broad-leaved evergreen, sclerophyllous and legume-type components, in the defined main vegetation types, and cluster analysis confirms these results as well. Nonetheless, it appears appropriate to define ecotones and to adapt the threshold value of the broad-leaved evergreen component for the definition of broad-leaved evergreen forests. The results reflect a distinct underrepresentation of zonal herbs in the fossil record, regardless whether leaf, pollen, or fruit assemblages. The vegetation scheme based on the IPR-vegetation analysis is therefore extended to properly reflect zonal herb diversity in modern vegetation. The results also confirm a higher diversity of zonal herbs in broad-leaved deciduous forests versus broad-leaved evergreen forests, as observed in the Neogene European record.

Keywords: Paleogene, Neogene, recent, methodology, Asia.

SS09-O04 (209)

Palaeovegetation reconstruction in monsoonal regions

Frédéric MB Jacques[1], Tao Su[1], Jianwei Zhang[1], Li Wang[1], Yongjiang Huang[2], Jinjin Hu[2], Shufeng Li[1], Mei Sun[1], Zhekun Zhou[1,2]

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Recently, several methods have been developed to reconstruct palaeovegetation. Among them the Integrated Plant Record (IPR) and the biome reconstruction has been used at the regional scale both in Europe and in Asia. Because European Cenozoic floras show affinities with modern floras of South-East Asia, we think if worth to test these two methods in a monsoonal context. We focus our study on the Neogene of the Hengduan Mountains and the adjacent sites in Yunnan. This region is very important because it is one of hotspot of biodiversity around the world. This high biodiversity is

the consequence of the topography: high mountains separated by deep valleys. This topography is the result of the uplift of the Tibetan plateau and Himalayan Mountains. Therefore, it is very important to understand when the modern vegetation appeared in this region. At present day, this region also exhibits a broad range of vegetation types, from tropical forests to alpine meadows. We work on 14 fossil sites including leaf, pollen and fruit assemblages. The climate at that time as temperatures similar to the modern one, and the monsoon is already established, even if potentially weaker than now. The IPR vegetation analysis can reconstruct six vegetation types based on 15 phenological and autecological components. In China, 19 biomes can be reconstructed based on 76 Plant Functional Types (PFTs). This region was mostly forested at that time and the climate was warm; therefore, the contrast or the resolution of the IPR vegetation analysis is not high enough to discriminate between the different vegetation types. The reconstructed biomes show more differences and contrast. On the other hand, because the IPR has only a few components, it is easier to reconstruct a gradient in evergreen taxa or sclerophyllous taxa in a region. The PFTs on which the biomes are based are too detailed to study the gradual change in the vegetation between sites. We conclude that these two methods are complementary: the biome reconstruction gives a detailed and precise view of the past vegetation whereas the IPR vegetation analysis allows to study the gradual changes in vegetation between sites.

Keywords: biome reconstruction, integrated plant record, Hengduan mountains, Yunnan, Neogene.

SS09-O05 (539)

Anomalies in Cenozoic vegetational gradients on both sides of the North Atlantic - induced by Gulf Stream intensity?

Torsten Utescher[1,2], Madelaine Böhme[3], Boglárka Erdei[4], Thomas Hickler[1], Yusheng (Christopher) Liu[5], Volker Mosbrugger[1]

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Today an effective Gulf Stream accounts for mild, maritime climate in Western Europe and causes significant longitudinal, climatic anomalies when comparing both sides of the North Atlantic, expressed in differentiated biome patterns. E.g. at ca. 40° northern latitude, evergreen broadleaved sclerophyllous woodland of the Northern Mediterranean corresponds to cold deciduous forest at the American East Coast, at ca. 55° cold deciduous forest to subarctic needleleaved woodland. Actually, the Gulf Stream topic is very active and a slowing-down or cessation of the thermohaline circulation in the North Atlantic and its consequences for Western Europe are discussed within the context of future climate change. To improve our knowledge on interactions between climate and biosphere we study finger prints of the North Atlantic circulation and its changing intensity on past vegetation patterns in the adjoining continental areas along the Cenozoic. Due to the unfavorable data cover in the eastern North America this is achieved not only by direct comparison of both regions, but also by detailed study of related gradient changes in Western Eurasia. Presently we analyze diversity gradients derived from the palaeobotanical record in a series of time slices using a system of 26 different herbaceous to arboreal plant functional types (pfts). First results indicate that Palaeogene to earlier Neogene vegetation of the mid- and higher latitudes of Western Europe do not have a

comparatively cool aspect as could be expected from a weaker Gulf Stream prior to the closure of the CAS. In contrast, thermophilous pfts such as broadleaved evergreen woody plants even tend to have a diversity centre in the latter region when compared to the American East Coast and other Eurasian mid-latitudinal areas. Being most striking in the Eocene, this persisting pattern is still visible in the late Miocene and might mirror the impact of warm and wet climate on the vegetation existing in the Tethyan Archipelago. Miocene biomes existing at about the same latitude on both sides of the Atlantic appear less diversified when compared to present, a fact that can be related to the shallower climatic gradients resulting for both continental areas. The analysis of diversity patterns of drought-tolerant pfts allow for assessing relations of Gulf Stream intensity, the spread of open environments in the late Neogene of Southwestern Europe, and potentially drier than present conditions along the East Coast of Northern America. [Grant: DFG MI 926 / 8-1]

Keywords: palaeobotany, Neogene, plant functional types, Gulf Stream, diversity.

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Quantifying openness of palaeovegetation with modern LAI data – an attempt towards a new approach

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Although widely used in palaeontological literature to describe fossil habitats of animals and early humans, terms like "open woodland", “savannah”, or “open environment” are poorly defined in botanical and ecological sense. They tend to comprise all kinds of habitats that cannot be clearly assigned to closed forest (no open spaces) or open steppe (no trees). In an attempt to better distinguish the different types of open habitats quantitatively, a new quantitative method based on the principles of the Coexistence Approach is developed to exploit remotely sensed data as independent proxies of vegetation density for correlation and will use such numerical data as leaf area index (LAI), vegetation cover and greenness as provided by Masson et al. (2003). These parameters are so far widely used for vegetation modelling of open environments. However, their exploitation for palaeoenvironmental questions is not yet fully elaborated. To test this approach we apply the GIS-based Coexistence Approach (CA_{GIS}) on fossil plant material from an archaeological site in South Africa. Previous qualitative environmental interpretations of the fossil fauna and flora from the Middle Stone Age site Sibudu, KwaZulu-Natal, remain ambiguous. Because much of the material is anthropogenically introduced, it is difficult to distinguish between the effects of natural changes in the local vegetation and behavioral changes of the people that inhabited the shelter. CA_{GIS} can be applied to such biased assemblages and seems to be an adequate method to directly quantify not only palaeoclimate but also vegetation parameters at an archaeological site. Obtained data show a distinct increase of winter temperatures, summer precipitation, and vegetation density from 60 to 50 ka.

Keywords: palaeovegetation density, methodology, leaf area index, Coexistence Approach.