(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

Centre for Earth, Planetary, Space and Astronomical Research, The Open University, Milton Keynes, MK7 6AA, UK, and Key State Laboratory for Systematic and Evolutionary Botany, Institute of Botany, Chinese Academy of Sciences, Beijing 100093, P.R. China, r.a.spicer@open.ac.uk

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

Arata Momohara[1], Takeyuki Ueki[2], Takeshi Saito[3]

[1] *Graduate School of Horticulture, Chiba University, Japan, arata@faculty.chiba-u.jp*
[2] *Geological Survey of Japan, Japan*
[3] *MeijoUniversity, Japan*

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

Bai-Nian Sun[1], Su-Ting Ding[1], Hui Jia[1], Bao-Xia Du[1], Xiang-Chuan Li[1, 2], Liang Xiao[1, 2]

[1] *Lanzhou University, China, bnsun@lzu.edu.cn*
[2] *Chang'an University, China*

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

Manju Banerjee[1], Sudha Gupta[2]

[1] *Former Professor of University of Calcutta, India, manjubanerjee@rediffmail.com*
[2] *University of Kalyani, India*

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

Takeshi Saito

Meijo University, Japan, tsaito@meijo-u.ac.jp

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?

Cheng Quan[1], Yu-Sheng (Chris) Liu[2], Torsten Utescher[3]

[1] *Research Center of Paleontology & Stratigraphy, Jilin University, China, quan@jlu.edu.cn*
[2] *Department of Biological Sciences, East Tennessee State University, USA*
[3] *Steinmann Institute of Bonn University, and Senckenberg Research Institute, Germany*

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

Khum Narayan Paudayal[1], Sudarshan Bhandari[1], Arata Momohara[2]

[1] *Central Department of Geology, Tribhuvan University, Kirtipur, Kathmandu, Nepal, khum99@gmail.com*
[2] *Graduate School of Horticulture, Chiba University, 648 Matsudo, Chiba 271-8510, Japan*

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

Sudarshan Bhandari[1,2], Arata Momohara[3], Khum Narayan Paudayal[1]

[1] *Central Department of Geology, Tribhuvan University, Nepal, bhandarisudarshan@gmail.com*
[2] *Paleo Labo Co. Ltd., Japan*
[3] *Faculty of Horticulture, Chiba University, Japan*

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

Rie Fujii[1], Misa Sugimoto[1], Takeshi Maki[2], Harutaka Sakai[1]

[1] *Kyoto University, Japan, rfujii@kueps.kyoto-u.ac.jp*

[2] *Japan Agency for Marine-Earth Science and Technology, Japan*

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

Yaowu Xing[1,2], Tao Su[2], Frédéric MB Jacques[2], Yongjiang Huang[3], Zhekun Zhou[2,3], Hans-Peter Linder[1]

[1] *Institute of Systematic Botany, University of Zürich, Switzerland, yaow.xing@systbot.uzh.ch*
[2] *Key Laboratory of Tropical Forest Ecology, Xishuangbanna Tropical Botanical Garden, Chinese Academy of Sciences, China*
[3] *Key Laboratory of Biogeography and Biodiversity, Kunming Institute of Botany, Chinese Academy of Sciences, China*

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

BH. Lomax[1], WT. Fraser[2], G Harrington[3], S Blackmore[4], MA. Sephton[5], NBW. Harris[2]

[1] *University of Nottingham, UK, barry.lomax@nottingham.ac.uk*
[2] *Open University, UK*
[3] *Birmingham University, UK*
[4] *Royal Botanic Gardens Edinburgh, UK*
[5] *Imperial College London, UK*

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

Yongjiang Huang[1,3], Frédéric M B Jacques[2], Tao Su[2], Yaowu Xing[2], Jinjin Hu[1,3], Yu-Sheng (Christopher) Liu[4], Zhekun Zhou[1,2]

[1] *Kunming Institute of Botany, Chinese Academy of Sciences, China, huangyongjiang@mail.kib.ac.cn*
[2] *Xishuangbanna Tropical Botanical Garden, Chinese Academy of Sciences, China*
[3] *Graduate University of the Chinese Academy of Sciences, China*
[4] *East Tennessee State University, USA*

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

Bowen Song[1,2], Kexin Zhang[1,2], Jingfang Lu[3], Chaowen Wang[2], Yuan-yuan Sun[4], Yadong Xu[1,2]

[1] *Faulty of Earth Sciences, China University of Geosciences, Wuhan 430074, China, bwsong1985@yahoo.cn*
[2] *State Key Laboratory of Biogeology and Environmental Geology, China University of Geosciences, Wuhan 430074, China*
[3] *Institute of Oceanology, China Geological Survey, Qingdao, 266003, China*
[4] *Department of Earth Science of University of Hong Kong, Hong Kong, 999077, China*

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

Jin-Jin Hu[1,2], Zhe-Kun Zhou[1,3]

[1] *Key Laboratory of Biodiversity and Biogeography, Kunming Institute of Botany, Chinese Academy of Sciences, Kunming 650201, China, hujinjin@mail.kib.ac.cn*
[2] *Graduate University of the Chinese Academy of Sciences, Beijing 100049, China*
[3] *Xishuangbanna Tropical Botanical Garden, Chinese Academy of Sciences, Mengla 666303, China*

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.