THIRD INTERNATIONAL SYMPOSIUM OF IGCP-476 TECTONICS AND CLIMATE EVOLUTION OF ASIA AND ITS IMPACT ON EAST ASIAN MARGINAL SEAS DURING CENOZOIC

* * *

IGCP-476 Special Section 1: The tectonic evolution of the East Asia and its marginal seas during Cenozoic

THE OKHOTSK SEA REGION STRUCTURE-MATTER EVOLUTION IN THE MESOZOIC-CENOZOIC

Bezverkhny V.L.

V.I.Il'ichev Pacific Oceanological Institute FEB RAS, Vladivostok, Russia

The Sea of Okhotsk region is a part of the West Pacific Transition Zone - the youngest and tectonically the most active structure generation of the Pacific Tectonic Belt. On the north the region is bounded by the Udsko-Murgalskaya island arc system, on the south - by the Kuril one. Problems concerning the origin of positive and negative morphostructures of the sea bottom and of Sakhalin and Kamchatka border tectonic systems remain debatable. So these are the problems that are studied in the present report based on generalization of the results of geological and geophysical investigations carried out in this region during the last decades.

The analysis of magmatic and metamorphic complexes dredged from the Sea of Okhotsk bottom enabled us to close the question about the ancient granite-metamorphic basement of the "Okhotia" massif being hypothetically a morphostructural base of the Sea of Okhotsk borderland. Seismic data reveal here three ridges, which are regarded as remnant island arcs by M.L. Krasny (1979) and A.V. Zhuravlev (1982). The said ridges show relation with Sakhalin and Kamchatka structures where a number of island arc fragments has been found. Three generations of Cretaceous transregional island arc systems have been reconstructed based on complex interpretation of geophysical fields allowing for dredging data. The mentioned systems consist of the following formations:

i) basement complex: the Paleopacific oceanic crust (possibly with locally spread relics of the pre-Rephean continental crust);

ii) intermediate complex: dynamothermal polycyclically metamorphised oceanic and island arc formations;

iii) island arc complex: a) early stage: effusive and intrusive formations of tholeiitic series including as well boninite-marianite series and their analogues and b) mature stage: volcano-plutonic formations of gabbro-plagiogranite complexes belonging to tholeiite and calc-alkali series;

iv) post-island arc complex: gabbro-granite volcano-plutonic associations of andesite series.

So, positive morphostructures of the region are the inheritedly developing island arc system fragments within which a granite-metamorphic layer grows.

Negative morphostructures are represented by troughs oriented in accordance with the orthogonal system of island arc faults. The troughs extending along the paleoarcs develop inheritedly from their back-arc and interarc basins. The troughs oriented normally to the arcs extension are evidently inherited from transverse depressions. In early stages of development 'eugeosyncline' sedimentation followed by the formation of acoustically rigid mass took place within the troughs of both types. Due to the decrease of the crust permeability, within the early generation basins 'miogeosyncline' sedimentation accompanied by the formation of acoustically permeable part of the sedimentaty cover takes place. Lateral growth of the crust is compensated by its absorption within the remnant Benioff zones and by its obduction within Sakhalin and Kamchatka tectonic heaping border structures.

REFERENCES

1. Krasny M.L. Nature of regional magnetic anomalies of island arcs. The 14th Pacific Scientific Congress. Section B I: Theses of Reports. Moscow.: Nauka, 1979. P.15-16 (In Russian)

2. Zhuravlev A.V. Some problems of paleogeography and paleotectonics of the Okhotsk- north Japan Sea region // Geologic structure of the Okhotsk Sea region. Vladivostok, 1982. P. 26-35 (In Russian)

ABOUT JAPAN SEA OPENING ONCE AGAIN

Golozoubov V. V.

Far East Geological Institute, Vladivostok, Russia

According to I. Otofuji's “two-door” model, which is most popular at present and is based on the detailed paleomagnetic research of the well-dated sample collections, the Japanese Sea opening happened rather quickly by turning of Southwest Japan for 56° with simultaneous rotation of Northeast Japan in a counter-clockwise direction for 47° (Otofuji, 1996). In the reconstruction from these data, however, Japan is closely adjacent to the continent, and there is no place enough for the known fragments of the continental crust within the Japan Sea water area. L. Jolivet and K. Tamaki pointed to this fact and suggested that the angles of the block rotation, obtained by I. Otofuji, involve two components. The first component (30°) corresponds to the process of the basin opening, and the second one represents the result of additional rotations of small blocks against the background of the opening. The authors relate the formation of the Japan Sea basin with the right-lateral dislocations along the Hokkaido-Sakhalin and Tsushima fault systems of the meridional strike (Jolivet and Tamaki, 1992, and others).

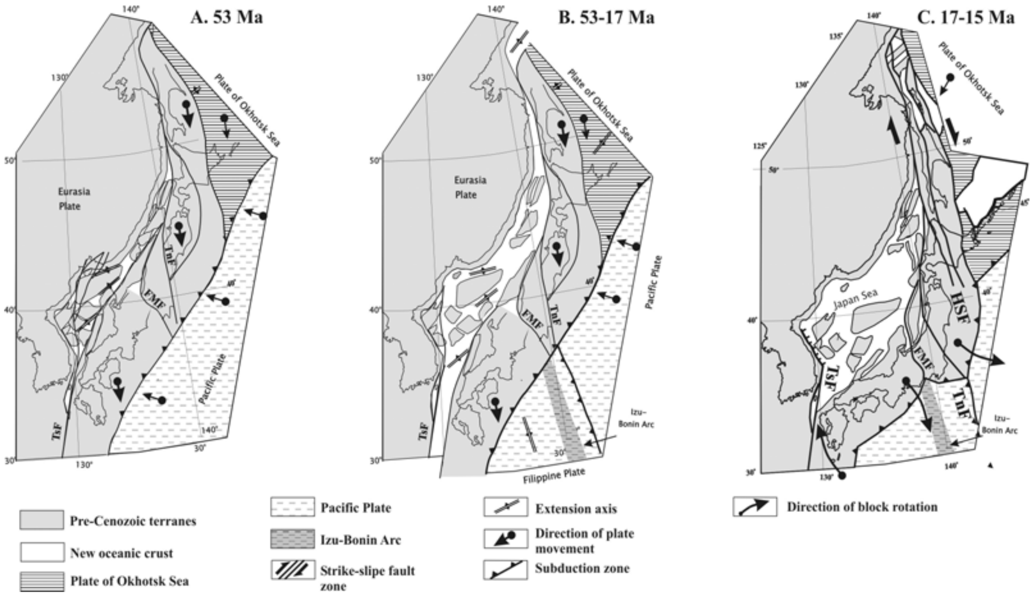

Fig. Dinamics of Japan See opening. TsF - Tsushima F. Z., HSF - Hokkaido-Sakhalin F. Z., TnF - Tanakura F., FMF - Fossa-Magna F.Z.

Thus, at present, there is no adopted variant of the Japan Sea opening. The angle of the clockwise turn of Southwest Japan has been accepted to be 40°, i.e. the average value of the competing models (Onishi and Kimura, 1995). In this connection, the author has repeated the procedure of reconstruction of the terrane position that was before the Japanese Sea opening with regard to paleomagnetic and geological data including those on deformation of the layers that were accumulated immediately before or simultaneously with this event, i.e. the Early and Middle Miocene age.

Analysis of these data showed that the Japanese Sea opening occurred at least in two stages. The first stage (Paleogene-Early Miocene) is the formation of abundant pull-apart basins through the right-lateral displacements along the Hokkaido-Sakhalin and Tsushima fault systems. The blocks of Japan, partially torn from Eurasia, moved to the south without any rotations. In the second stage (15-17 m.y.), the contour of the Japanese Sea basin similar to the modern one was finally formed by counter-clockwise rotation of Northeast Japan for 15° and clockwise rotation of Southeast Japan for about 30°.

REFERENCES
1. Jolivet L. and Tamaki K. Neogene kinematics in the Japan Sea region and volcanic activity of the northeast Japan Arc.// Proc. Ocean Drill. Program. Sci. Results, 127/128, 1992, p. 1311-1331.
2. Onishi C.T. and Kimura G. Change in fabric of mélange in the Shimanto Belt, Japan: change in relative convergence? // Tectonics, V. 14, N 5, 1995, p. 1273-1289.
3. Otofuji Y. Large tectonic movement of the Japan Arc in Late Cenozoic times inferred from paleomagnetism: review and synthesis // The Island Arc, 5, 1996. P. 229-249.

THE ELEVATION HISTORY OF THE TIBETAN PLATEAU

Harris Nigel

Department of Earth Sciences, Open University, Milton Keynes MK7 6AA, UK

The determination of the evolving palaeoaltitude of the Tibetan Plateau since the India-Eurasia collision underpins our understanding of how orography in central Asia affects the intensity of the monsoon and hence global climate change. Palaeoaltitudes, however, cannot be measured directly and need to be inferred from proxy observations that are usually model-dependent. Differing tectonic models for the behaviour of the lithosphere during continental collision have contrasting implications for the elevation of the plateau. However, two techniques recently employed for determining palaeo-elevation are independent of tectonic models, the first involving the variation with altitude of oxygen isotopes in precipitation and the second involving the change of leaf morphology with moist static energy of the atmosphere.

Elevation studies have focused on southern Tibet, largely due to the relative ease of access to the region. There is a remarkable unanimity amongst the diverse techniques applied that the altitude of the southern plateau has not significantly changed since at least the mid Miocene (ca. 15 Ma) arguing for an onset of the monsoon system during or before the early Miocene. Tectonic and geochemical studies suggest that the northern plateau is a younger geomorphological feature, but there is no quantitative estimate of the timing of its elevation. Since both the elevation and the surface area of the plateau impact on atmospheric circulation, palaeoaltitude studies need to be extended to chart the increasing areas of elevated land surface through time.

SEA LEVEL CHANGES AND CHANGE OF COASTAL REGIONS AROUND SRI LANKA DURING CENOZOIC –SINCE MIOCENE TO PRESENT

Jayawardena Upali De Silva

Department of Civil Engineering, Faculty of Engineering, University of Peradeniya, Peradeniya, Sri Lanka, udsj@pdn.ac.lk

Sri Lanka is a small Island situated at the southern tip of India. Geological formations from Precambrian to present can be seen within this 65,000 square kilometers area. The various sedimentary formations and the changes of the surface features along the coastal belt of the country have been identified as the records since Miocene. This paper highlights those events with the change of the environments.

Geologically ninety percent of the country rocks are metamorphic of Precambrian age. A few igneous intrusive bodies also can be seen within these crystalline formations. The rest ten percent is sedimentary rocks formed during and after the Jurassic. The north, north-west and south east sectors of the coastal belt of Sri Lanka have been subjected to various changes such as sea level rises, land upliftment, erosion, and submergence etc due to the global activities within last 25 million years. Sedimentary limestones, sandstones, coral reefs, older and younger beach rocks, dune sand deposits, gravel deposits etc., are some of the formations since Miocene to Holocene period. The available stratigraphic records describe the environmental changes took place in this Island since Miocene .

TECTONICS OF CENOZOIC THE ARTEM-TAVRICHANKA BASIN (SOUTH PRIMORYE, RUSSIA)

Miklovda S. V., GolozubovV. V.

Far East Geological Institute, Vladivostok, Russia

The Artem-Tavrichanka basin is in the environs of Vladivostok and is composed predominantly of the Cenozoic continental coal-bearing deposits about 1200 m thick, which are overlapped by the Pliocene coarse deposits with washout. In the Eocene time the basin was a typical pull-apart basin, whose development was simultaneous to the early stages of the Japanese Sea opening. Emplacement of the basin followed the system of Riedel R shears under the conditions of the right-lateral displacement along the faults of the north-north-east and meridional strike

(Fig.). The Miocene stage of the Japanese Sea opening manifested itself here in the intensive post-sedimentation fracturing.

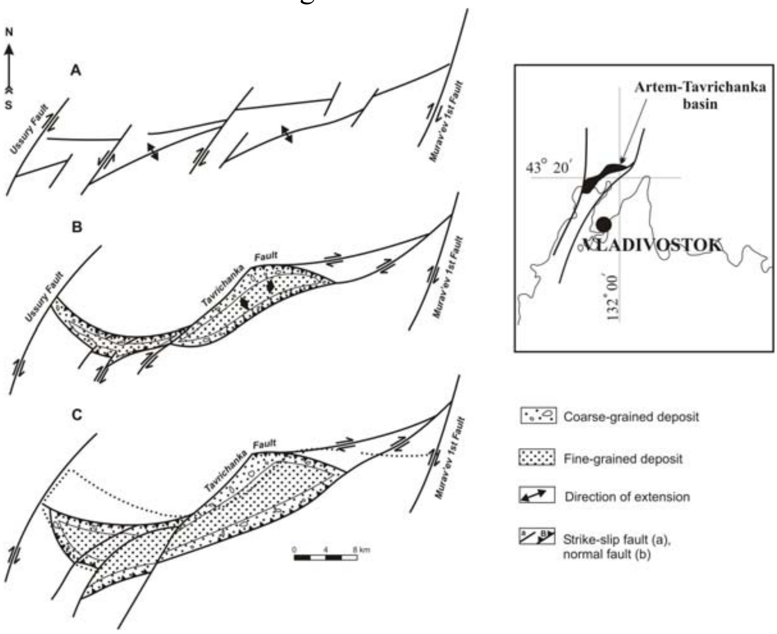

Fig. Development of the Artem-Tavrichanka basin during Eocene

CRUSTAL EVOLUTION AT AND AROUND THE INDIAN OCEAN AND CONDITION OF MARGINAL SEAS DURING CENOZOIC

Purkait Barendra* and Gangopadhay P.K.**

**Environmental Geology Division, Op: WSA, Eastern Region, Geological Survey of India, Block-DK-6, Sector-II, Salt Lake, Kolkata -700091, India.*
E-mail : baren_purkait@yahoo.co.in
***Department of Geology, Presidency College, 86/1, College Street, Kolkata-700073, India*

Stages of crustal evolution of the earth – from Achaean to Recent, are reflections of the pattern and rate of heat flow operating in the mantle. Opening and closing of oceans and movement of continental crustal blocks have generated new interest in sequential crustal evolution of the earth through the concept of plate tectonics.

Since the break up of the Gondwanaland and flight of its components, the present mosaic of crustal cover at and around the Indian Ocean has evolved for over a period of approximately 170 m.y. At its present configuration, the triple point junction of the African, Indian and Antarctic plates in SW Indian Ocean provides only an indication of apparent stable situation. That the crustal adjustment continuing since 170 m.y. had been evidenced by magmatism, transgression and regression of sea, formation of basins and orogenesis in continental regimes surrounding the gradually widening Indian Ocean. Notable geological events commencing from Cretaceous onwards from the spreading history and oceanic crustal evolution have been outlined in this study with reference to geomagnetic polarity time scale. That the Indian Ocean region is geotectonically unstable and undergoing further plate-subplate adjustments, have been recently demonstrated through the 26th December, 2004 earthquake and resultant Tsunami which affected the Indian Subcontinent, Myanmar, Indonesia and surrounding regions. This process of reorganization of the plates and subplates is still actively operating in the Indian oceanic regions. In this context, the focus of discussion has been placed on the marginal sea history for the Cenozoic (~60 m.y).

An attempt has been made to reconstruct the marginal sea condition through an assessment of Cenozoic sequence of the Indian subcontinent and adjoining Indonesian and Myanmar regions. The nature of deposition of sediments has been probed to determine the evolving Indian Ocean. Special attention has been paid to locate the heterogeneity of sediments and facies variation during the time scale. The aim is to ascertain if any violent natural process like Tsunami or earthquake related wave action have left their imprints on the evolving coastal regions of the geological past.

EVOLUTION PROCESS OF SEDIMENT TRANSPORT ON THE CONTINENTAL SHELVES OF THE BOHAI SEA, YELLOW SEA AND EAST CHINA SEA DURING THE HOLOCENE: RESULTS FROM NUMERICAL SIMULATION

Zhu Yurong

School of Environmental Science and Engineering, Shanghai Jiaotong University, 800 Dongchuan Road, Shanghai, 200240, P.R.China
E-mai:l yrzhu@sjtu.edu.cn; yurongzhu@tom.com

There has been different opinion about the dominant hydrodynamic condition, sediment source, formation time, formation mechanism, and evolution process of the sandy sediments and clayey sediments on the continental shelves of the Bohai Sea, Yellow Sea and East China Sea (BYECS) since they were discovered. Tidal currents are permanent and have been dominating the marine dynamics on the continental shelves of the BYECS since the Holocene transgression began. In order to study the above controversial issues from long-term sediment dynamics evolution process, the sediment transport patterns on the continental shelves of the BYECS at nine special periods during the Holocene were simulated under the effect of tidal currents. The results show that the formation of the comb-shaped paleo-sand ridges, which stopped developing after –52m sea level, was the result that tidal currents transported the eroded late Pleistocene material on the seabed and the material from rivers towards southeast between –80m sea level and –52m sea level. The formation of the Yangtze Shoal, which had developed well up to –30m sea level, results from that rotatory tidal currents have been fan-shapely carrying away finer sediments in the Pleistocene material and in the material supplied by rivers after –52m sea level so that coarser sediments remain finally. The mud in the central part of the southern Yellow Sea, has been a "sink" of fine sediments from different areas since –52m sea level, however, sediment supply has been not enough. The formation of the sand ridges in the west Korea Bay and the sand sheet in the Jianghua Bay is the result that rectilinear and rotatory tidal currents have been eroding the late Pleistocene material on the seabed, respectively, since the Holocene transgression maximum (HTM). The formation of the Liaodong Shoal and Bozhong Shoal resulted from that strong tidal currents have been transporting the eroded late Pleistocene material in the Laotieshan Strait to deposit in the west area of the Liaodong Peninsula since the HTM. The formation of the sandy sediment in the Haizhou Bay is the result that tidal currents have been carrying away finer sediments in the late Pleistocene material and in the material from rivers so that coarser sediments finally remain since the HTM. The formation of the Radial Sand Ridges in the southern Yellow Sea results from that radial tidal current field has been reforming the sediment from the Yellow River and the Changjiang River since the HTM. The mud in the west of the northern Yellow Sea, which is not a "sink" of fine sediment, locates at a by-pass area of sediment transport, thus, it forms when sediments from the Yellow River are transported into the Yellow Sea through the southern part of the Bohai Strait. The deposition center of the mud in the middle part of the Bohai Sea locates at its southern and northern ends, respectively, and the sediment source of the mud is one part of sediment from the Yellow River. The sediment source of the mud off the Zhejiang-Fujian coast is one part of the sediment from the Changjiang River, and the sediment from the Zhejiang-Fujian coast. The mud in the central part of the southern Yellow Sea, The mud in the west of the northern Yellow Sea, the mud in the middle part of the Bohai Sea and the mud off the Zhejiang-Fujian coast generally correspond to weak tidal current areas. The mud in the southwest area to the Cheju Island and the mud in the east of the Yellow Sea began to develop at least at –30m sea level, and their sediment sources may be partly from the Changjiang River. At a certain period of Holocene, the sediment transport pattern is controlled by the strength, the type and the asymmetry of tidal currents in different areas on the continental shelves of the BYECS. The evolution of sediment transport patterns on the continental shelves of the BYECS has been controlled by the evolution of tidal current fields since the Holocene transgression began.

IGCP-476 Special Section 2: The climatic and palaeoceanographic evolution of the East Asia and its marginal seas during Cenozoic

PALEOCEANOGRAPHY CHANGES IN THE OKHOTSK SEA DURING LATE PLEISTOCENE AND HOLOCENE ACCORDING TO DIATOMS AND GEOCHEMICAL DATA

Artemova A.V., Ponomarev S. S., Gorbarenko S. A.

V.I.Il'ichev Pacific Oceanological Institute FEB RAS, Vladivostok, Russia

Deep-sea core LV28-40 (51˚20′04″N, 147˚10′631″E; length 799.5 cm; water depth 1312 m) was taken from the Sea of Okhotsk. The samples for diatom analysis were taken at each 1.5 –3 cm interval and were studied. The taxonomic composition of diatom assemblages in the Holocene and last glaciation sediment is rather uniform and we used ecological variability of diatom species in order to recognize paleoenvironmental changes in the sea.

Chronostratigraphy of sediments and the age model of cores are based on the oxygen-isotope records, AMS 14C dating, lithological units, magnetic susceptibility, tephrochronology, carbonaceous and opal stratigraphy. The oxygen-isotope stages (OIS) 1-5a with boundary ages according to Martinson (Martinson et al., 1987) have been distinguished.

The biostratigraphic subdivision of the studied sediment core was performed on the base of the changes in the spectra of the diatom assemblages, dominant species shifting, species diversity, diatom abundance and change of the frequency of oceanic and neritic diatom groups. The results of diatom analysis were compared with the content of carbonate and organic carbon, opal, ice rafted debris (IRD) and other proxies. The main reduction in the diatom abundance correlates with decrease in the opal content in sediment. The diatom results allow us to subdivide the studied core sediments into 5 units, reflecting the total paleoenvironmental changes in warmer or colder phases during the Holocene and last glaciation (OIS 2-4).

Our interpretations based on the above - mentioned evidences indicate as follows:

The diatom abundance, species frequency and biodiversity in the diatom assemblage changes in the Okhotsk Sea sediments during the last glaciation is consistent with the common for the North Hemisphere millennium scale climate variability such as Dansgaard–Oeschger cycles and the Heinrich events found in the Greenland ice core and the North Atlantic.

The siliceous sedimentation in the Okhotsk Sea has mostly been initiated on since approximately 8.2 kyrs B.P. and likely corresponds to the regional climate warming.

Four peaks indicated by diatoms abundant and biodiversity, corresponds to the warm Holocene phases. The Okhotsk Sea environmental optimum is characterized by high plankton paleoproductivity occurred about 5700 years B.P. Horizon is characterized by the sharp growth of a number of sublithoral species *Paralia sulcata* (230-260 cm) corresponding to YD and Bolling-Allered. The disappear of the surrounded land mounted glaciers during climate warming seems to be an additional input into the summertime total ice melting and desalinity of the surface water.

The study was supported by the grants of the Russian Fund of Basic Research 03-05-65192a and by the Joint Far Eastern and Siberian branches of Russian Academy of Sciences Grant 03-II-00-006 and the Grant of FEB- RAS the Presidium № 05-III-B-06-003.

LATE QUATERNARY VARIATIONS OF TERRIGENOUS SEDIMENT FLUX IN THE ULLEUNG BASIN AND KOREA PLATEAU, EAST/JAPAN SEA

Bahk Jang Jun* and Khim Boo-Keun**

** Petroleum and Marine Resources Division, Korea Institute of Geoscience and Mineral Resources, Yusung P.O. Box 111, Daejon 305-350, Korea*
***Department of Marine Science and Marine Research Institute, Pusan National University, Busan 609-730, Korea*

In order to examine the variations of terrigenous detrital components in core sediments from the Ulleung Basin and Korea Plateau, we detail changes in grain-size composition and contents of major elements such as detrital SiO_2 (detSiO_2), TiO_2, Al_2O_3, MgO, and K_2O. In the core sediment (97PC-19) from the southern margin of the Ulleung Basin, the variations of detrital components since the Last Glacial Maximum (LGM) are characterized by the significant elevations of detSiO_2/Al_2O_3 and TiO_2/Al_2O_3 ratios with the concomitant increase of silt to clay ratios during the last deglaciation (10–15 ka). Such a prominent increase suggests an enhanced flux of detrital quartz and Ti-bearing minerals relative to Al-rich clay minerals, which can be attributed to either aeolian transport or hemipelagic advection. Similar variations of detrital components during the last deglaciation are much more pronounced in the core 95PC-1, located more proximal to the Korea

Strait, as evidenced by the high sedimentation rate and sand and silt contents. However, this temporal variation is not clearly observed in ODP site 797 in the Yamato Basin. The spatial change of the detrital components among the cores suggests a primary control of hemipelagic fluxes of riverine sediments on the variations of detrital components since the LGM in the southern margin of the Ulleung Basin. In the core sediment (96EBP-4) from the Korea Plateau, which records the variations since the marine oxygen isotope stage 8, detSiO_2/Al_2O_3 and TiO_2/Al_2O_3 ratios fluctuate in phase with silt to clay ratios and are relatively high in glacial stages. Such trend is also observed in ODP site 797, suggesting a primary control of aeolian dust fluxes on the variations of detrital components in the Korea Plateau.

THE PALEOLANDSCAPES OF A HOLOCENE OF EASTERN PART KHANKA PLAIN

Belyanin P.S.

Pacific Institute of Geographi FEB RAS, Vladivostok

The history of development of an environment of lakeside plainss has legible reflection in cuts holocene of depositions. On change of a structure assemledges in a cut it is possible to judge changes of vegetation, climate of considered territory, and consequently also of landscapes, on change of a structure of diatomite complexes it is possible to tell, what type of a pool was in territory of modern landscapes. Therefore, for reconstruction of conditions of formation paleolanscapes and their characteristics, it is necessary to receive the information from the depositions occurring in the given territory, for what research of lake-marsh depositions was conducted.

Eastern part the Khanka of flatness adjoining to a low coast of Khanka lake, in a north drains with apron plain the Ussuri river, to the south - with apron plain of Ilistay river, to east passes in high lakes-alluvial plain. The altitude it above a level of lake oscillates from 0,2 till 10-12 m. In some places there are small high grounds and hills ouval farewell-rock of nature. Lakeside flatness intercepts small rivers, taking the beginning on Khanka-Arsenievka a watershed (Spasovka, Belay, Krasnay, etc.). Flow of the rivers very sluggish.

The lake-marsh depositions of a considered part Khanka of flatness compose the maiden lake terrace formed in a course holocene of a lake transgression. The terrace is prolated along a coast zone the Khanka Lake, is sharply reamed in between two rivers of Sungach-Spassovka. Depositions cover with gentle fluid wash on a strata of lake precipitations of guerilla horizon and depositions latepleistocene-golocene of a delta the river of Spassovka.

The relevant place in a structure of lake-marsh depositions the beach facies takes. The area of development of beach depositions is dated for a coast zone of Khanka Lake also has practically solid distribution. Therefore, for obtaining the full information about paleolandscapes of Khanka the flatnesses and fluctuation of levels of lake are necessary for considering beach depositions. Their formation originated under effect of alongshore moving of detrital deposits, the formation of bars and separation by them of embayments is connected to which one.

The beach is folded by numerous barrier beaches, folded, as a rule, flaky by sands with hardpans sandy loam, saturated vegetative detritus. In a direction of lake terrace is augmented pelitic component in a structure of precipitations. In intergross downturn(reductions) are stored humic sandy loam and loams, and sometimes low-powered (0,3-0,4 m) peat.

On a coast of Khanka Lake, in 1 km to northwest from of Birch lake, on the maiden alluvial-lake terrace, be revealed a following cut reflecting changes of aircraft attitude the sediments accumulate in conditions self contained scuttlebutts, degradation, located in stage.

The top of a cut is everywhere folded by peats bog being products of disintegrating grassy sedge of vegetation. The peat is characterized by a gentle degree of disintegrating and in a base surface is usually enriched with a terrigene material. By places biogenic precipitations yet do not transfer to stage peatformation and will derivate only floating bog on a surface of growing pools.

In palinocomplex, obtained on samples from an interval of 1,1-1,3 m the combination moderately - heat-loving Quercus, Ulmus, Juglans, Corylus, Syringa and pollen of the frigid forms Betula exilis, Betula middenorfii is marked.

The containing precipitations were formed, on the concluding N.I. Belyanina, in time lateholocen fall of temperature on a boundary subboreal and subatlantic phases of a Holocene (Q^{2-3}_{IV}).

Above on a cut (section, sectional view) (deep. 0,2-1,0 m) in palinocomplex significant amount contains pollen broad-leaved of rocks:

Among a coniferous leading position the pollen Pinus koraiensis takes. From small-leaved of rocks the pollen Betula sect. Albae dominates. Among grasss the quoters of the set sedge dominate. It is necessary to mark and presence of pollen of water plants, quoters of the set Potamogetoniaceae, Sparganiaceae.

Such structure palinocomplex responds, on the concluding N.I. Belyanina, subatlantic phase of a Holocene (Q^{3}_{IV}).

Thus structure palinocomlex images development in subboreal a phase of a Holocene oak-broad-leaved of forests on bordering territories. In the subatlantic phase the distribution of marsh landscapes on lake-alluvial terrace is watched the Khanka lake and on bordering high grounds of cedaro-oak vegetative formations. Also formation of beach depositions concerns also to the subatlantic phase of a holocene, which one under effect of surges and wind effected phenomena is prolonged and now.

RATIO OF THE CONTENTS OF CHLORINE AND ORGANIC MATTER IN SEDIMENTS OF THE OKHOTSK SEA FOR AN ESTIMATION OF PALEOPRODUCTIVITY DURING LATE PLEISTOCENE AND HOLOCENE

Bosin A.A., Artemova A.V., Gorbarenko S.A., Zakharkov S.P., Yanchenko E.A.

V.I.Il'ichev Pacific Oceanological Institute FEB RAS, Vladivostok, Russia

Two sediment Cores LV 28-40-5 and LV 28-41-5 were taken from the Okhotsk Sea under of the KOMEX I Project during Cruise 28 of the RV "Academik M.A.Lavrentyev". The chlorine concentration in the sea sediments is an estimation of paleoproductivity. In Cores LV 28-40-5 and LV 28-41-5 the chlorine concentration was determined in detail (each 1 and 2-2,5 см accordingly) by fluorescent analysis, which was calibrated by the spectrophotometric method (Harris & Maxwell, 1995). The sediment stratigraphy and the age model of the core were based on the oxygen isotope analysis, lithology, magnetic susceptibility, tephrochronology. As a result, 6 oxygen isotope stages in Core LV 28-41 and 4 stages in Core LV 28-40 with the age borders by Martinson (Martinson et al., 1987) were distinguished. The average mass accumulation rate of chlorine in stages is rather identical on all extent of cores, though within the range of each stage the significant changes are observed. During the last deglaciation there were critical increases of fluxes of the chlorine, connected with terminations 1a and 1b (Bølling-Allerød and the beginning of the Holocene accordingly). The obtained data were compared to the other indicators for paleoproductivity, such as biogenic opal and organic carbon concentration, abundance of diatoms in one gram of sediment. The mass accumulation rate of Corg in Core LV 28-40 is higher, than in LV 28-41, and the mass accumulation rate of chlorine is approximately comparable in both columns. The fluxes of chlorine correlate well with the fluxes of organic matter. In Core LV 28-41 the fluxes of chlorine and diatoms were compared. The ratio of accumulation of the abundance of diatoms frustules and the mass of chlorine changed for different stages. It is connected to the change of the diatom complexes structure, changes of climate and the degree of frustules dissolution.

These studies were curried out under the RFBR support (Grant 03-05-65192) and the integration grant 03-2-0-00-006.

PALEOCLIMATE INDICATORS OF THE EASTERN YANGTZE COAST, CHINA: IMPLICATIONS AND POSSIBLE RESPONSES

Chen Zhongyuan

Department of Geography, East China Normal University, Shanghai 200062, China, e-mail: Z.Chen@ecnu.edu.cn Fax: 86-21-62232416

Many boreholes recovered from the Yangtze coast reveal 300-450 m Pliocene and Quaternary sediment. In general, sediments below 140 m of the boreholes are thought to be Pliocene – and early Pleistocene, mid-Pleistocene between 140 and 100 m, late Pleistocene between 100 and 30 m, and Holocene from 30 m to the land surface. Pollen-spore distribution of the borehole sediments discloses a series of alternated glacial and interglacial epochs in accordance with global paleoclimate change. Of particularly note is that pollen grains in the sediments of Plio- to early Pleistocene are rather scattered both in species and abundance, in which coniferous - deciduous species (Pinus, Abies, Picea, Ulmus, Deciduous Quercus, etc.) prevailed. This indicates a cool climate setting, but a warm climate pulsed as interglacial represented by Castanopsis, Oleaceae, Evergreen Quercus, Ilex, etc. During mid-Pleistocene, pollen-climate seems warmer/dryer while compared with the former Plio- and early Pleistocene pattern. Ferny and grass species, especially including Adiantum, Selayinellaceae, Artemisia, Chenopodiaceae and Potamogetona, etc., occur in a large proportion and evergreen species, particularly Oleaceae were accompanied. Climate becomes even warmer/wetter when entering into late Pleistocene and Holocene. Two major climate warming cyclicities at 10 ka scale were featured by further increasing grass, fernny, evergreen species at core depths ranging from 140 m to 40 m, and 30-0m, respectively.

Furthermore, as revealed by geochemical analysis of Quaternary borehole sediments of the Yangtze coast, Boron, Gallium, Strontium, Barium, and B/Ga and Sr/Ba is fully in agreement with occurrence of non-marine to marine sedimentary facies. However, high values of Boron and Strontium, marine-keen indicator, occurs in the alluvial sediments of Plio- and early Pleistocene, and these two highs of geochemical trace elements also keep a well pace with marine sediments of late Pleistocene and Holocene, at core depth from 100 m to core top, in which foraminifera distribution appears continuous.

Briefly, it is proposed that an overall cool and dry climate setting occurred in the study region during Plio- and early Pleistocene, as evideced by sparce occurrence of aforementioned pollen-spore and high values of Boron and Strontium, espeically the latter implying a sedimentary basin with evaporation. This is also to suggenst the highly elevated alluvial landscape of the study area during the time concerned. The study area began to be inundated by sea transgression after mid-Pleistocene, when climate became warmer and wetter as supported by diversifying pollen-spore species and abundance, and geochemical elements. We strongly suggest that this change from the former cood/dryer setting was closely associated with landscape subsidence effect emerging from late Pleistocene afterwards, which had induced largely the influence both from SE Pacific and Indian monsoon precipitaions.

TEMPORAL VARIATIONS IN THE MIOCENE-RECENT SOUTH CHINA MONSOON AND ITS EROSIONAL RECORD IN THE SONG HONG-YINGGEHAI BASIN

Clift Peter D.

School of Geosciences, University of Aberdeen, Meston Building, Kings College, Aberdeen, AB24 3UE, United Kingdom

Monsoon strength in the South China Sea region has varied both over short, orbital time scales and over millions of years due to the rise of the Tibetan Plateau. ODP Site 1148 is located offshore the Zhujiang (Pearl River) Delta on the northern margin of the South China Sea and is ideally located to record changing erosional flux from the continent. Moreover, because the Zhujiang is not apparently involved in the series of drainage capture events that have affected rivers in eastern Tibet it may act as a reliable proxy of changing continental erosion and weathering regimes. This is because erosion in its drainage basin is less controlled by plateau uplift than most other major river systems in East Asia. Studies of the mass accumulation rates, colour (which is linked to the abundance of hematite and goethite), as well as clay mineralogy, now allow large scale changes in the climate of southern China to be reconstructed since 25 Ma. Since ~5 Ma the monsoon has been strong, driving faster mass flux to the Pearl River Mouth Basin and its margin and intensifying physical rather than chemical weathering onshore. In contrast, the climate appears to have been more arid at 10–14 Ma, with a gradual shift to wetter conditions from 10 to 6 Ma. Prior to 14 Ma the climate appears to have been quite unstable, flipping between wetter and drier modes of operation. The oldest transition from arid to humid occurred just after 25 Ma, initiating a period of wet conditions and rapid erosion that lasted until 21 Ma. The period 21–14 Ma is characterized by a series of wet and dry phases, typically lasting less than 1 my each. I infer that monsoonal conditions had been established in the southern China region by shortly after 25 Ma, consistent with the evidence for a winter monsoon older than 22 Ma in the loess plateau. This monsoon did not become stable until the Pliocene yet the Early and Middle Miocene did contain periods of significant strong precipitation. Drier conditions in the Late Miocene likely reflect a weakening of the monsoon due to global climate change.

The broad scale pattern of changing continental weathering is reflected in erosion records in the Pearl River Mouth Basin, with high mass accumulation rates since 5 Ma and during the Early and Middle Miocene (24–14 Ma). In the Song Hong-Yinggehai Basin a similar general pattern can be observed. The Pliocene in particular seems to be marked as a period of dramatic mass flux. Large-scale clinoforms are seen to prograde south in the basin into the deeper waters of the South China Sea. These are derived not just from the mouth of the Song Hong (Red River) but also from the margins of Hainan Island. I interpret this flux to represent faster erosion under a more intense monsoonal climate starting 4–5 Ma. It cannot be linked to tectonic activity because the uplift and volcanism on Hainan is largely dating from only 1 Ma. The high rate of mass delivery to the Song Hong-Yinggehai Basin is at odds with a simple application of the drainage capture model of Clark et al. (2004), which would predict falling rates of sedimentation. The fast accumulation rates in the Early and Middle Miocene are also consistent with generally wetter, more monsoonal conditions at this time, though these might also reflect surface and rock uplift within the headwater regions in eastern Tibet. It is noteworthy that fast erosion in the Early and Middle Miocene casts doubt on the model of Zhang et al. (2001), which emphasizes the role of climate variability during glacial-interglacial cycles as controlling continental erosion. Fast erosion during the Early and Middle Miocene precedes glaciation, so that erosion instead appears to be controlled by precipitation, much as inferred from modern Taiwan, Himalaya and the Cascades.

HOLOCENE EVOLUTION OF THE INDUS MEGADELTA

Clift Peter D.*, Giosan Liviu, Constantinescu Stefan***, Tabrez Ali R.****, Danish Mohammad****, Inam Asif****, Alizai Anwar*******

**School of Geosciences, University of Aberdeen, Meston Building, Kings College, Aberdeen, AB24 3UE, United Kingdom*
***Department of Geology and Geophysics, Woods Hole Oceanographic Institution, Woods Hole, MA 02543, USA*
****Department of Geography, Bucharest University, Bucharest, Romania*
*****National Institute of Oceanography, Clifton, Karachi, Pakistan*
******Geological Survey of Pakistan, Karachi, Pakistan*

The Indus mega-delta is the largest river delta in the world that has never been studied with modern coring/drilling and dating techniques, although it is a rich archive of paleoenvironmental information in region where monsoon studies of the offshore have been intense. Studies based on ODP and shallower cores from the continental slope and the deep Arabian Sea have been used extensively to reconstruct the evolution of the Asian monsoon system. However, records from deltaic coastal settings are just now being added to the high-resolution information available from marine, lacustrine, and ice cores. Monsoon climate and sea level have both influenced the evolution of the Indus mega-delta; we present the results of the first scientific study in this arid delta. Understanding how sediment is moved from the river through the delta and into the deep sea is crucial to the use of submarine fan record to reconstruct continental erosion. These records can then be correlated with climate reconstructions in order to see how they relate to one another. Extensive damming of the Indus since the 1950's have drastically reduced water and sediment delivery to the coast. Bathymetric comparisons of detailed 19th century charts by the British Admiralty and 20th century chart from the Pakistan government was combined with digital analysis of satellite imagery to provide the first comprehensive study of modern morphological changes on the coast and shelf of the Indus River delta. Deltaic evolution under natural conditions between 1855 and 1954 was characterized by active sediment accumulation in two major depocenters: the nearshore zone along the entire delta coast and the western shelf between ~25 and 40 m water depth. Until 1954, the shoreline advanced or was stable along most of the delta coast. The progradation rate at the active mouth surpassed 100 m/year. The clinoform at the mouth has directly built into the head of a major submarine canyon that dissects the shelf. Major sediment bypassing of the shelf by sand from the river is supported by Nd isotope data from the area, showing different sources for the sandy river and fan sediments compared with shelf clays. Nd isotopes also show a gradually increasing Himalayan, as opposed to Karakoram, influence on provenance since the last glacial maximum. This change is probably linked to a strengthening of the summer monsoon after the LGM causing faster erosion in the Himalaya but not in the Karakoram, which lie in the rain shadow. Such development is in contrast to the stability of the Bengal Delta system since the LGM. The whole Indus River is more Himalayan in character than was the case prior to 5 Ma, probably due to major drainage capture of the Punjabi tributaries away from the Ganges.

INSTABILITY OF THE LAST GLACIAL CLIMATE FROM THE SRXFA DATA FOR THE BOTTOM SEDIMENTS IN THE OKHOTSK SEA

Goldberg E.L.*,*, Gorbarenko S.A.**, Shaporenko A.D.*,***, Bosin A.A.**, Leskov V.Yu**, Chebykin E.P.***

**Limnological Institute of the SB RAS, 664033 Irkutsk, Russia*
***V.I.Il'ichev Pacific Oceanological Institute FEB RAS, Vladivostok, Russia*
****Budker Institute of Nuclear Physics of SB RAS, 630090 Novosibirsk, Russia*

We can be now positive that the last glacial period (24-74 ky) in Greenland was interrupted by at least 19 warm spells with a 12-15C ° temperature increase [1-3]. The warm periods began extremely rapidly (for 40 to 80 years [4,5] or even 10 years in the Younger Dryas [6]) and lasted 400 to 2000 years; the returns back to cold were almost as abrupt as the transitions to warming (Dansgaard-Oeschger events, D/O). Moreover, the Greenland and Canadian ice sheets were broken at least 6 times during the same period providing enormous discharge of calved icebergs into the Atlantic Ocean (Heinrich events, H) [7,8]. The abrupt and prominent climate excursions were detected worldwide, including the equatorial and tropic zones and the northern Pacific [9-11]. They are synchronous over the Northern Hemisphere, and in the Southern hemisphere the most prominent events are about 1000 years in advance [12, 13]. The events are not quite periodic with millennial-scale pacings of 1-2 ky (1500 year cycle) or 4-6 ky [8]. Neither mechanisms nor causes of synchronicity (asynchrony) of these climate shifts are clearly understood.

The objective of this study was to obtain multi-element data from the bottom sediments of the Okhotsk Sea with a 100-300 yrs resolution and trace unambiguous evidence of the warm spells during last glacial time.

We measured the concentrations of Cl, K, Ca, Ti, V, Cr, Mn, Fe, Co, Ni, Cu, Zn, Ga, As, Se, Br, Rb, Sr, Y, Zr, Nb, Mo, Pb, U, Th, Sn, Sb, Cs, Ba, La, Ce, and some other elements in 8 meters of sedimentary core LV 28-40 retrieved at a depth of 1312 m at 51°20, 045 N and 147°10, 613 E in the Okhotsk Sea. The applied SR XFA techniques and preliminary results of factor analysis of the collected multi-element data are reported in our companion paper [14]. Sampling interval was 1 cm for chemicals and 2-3 cm for other proxies.

The age-depth model of the core was obtained by the correlation of its magnetic susceptibility (MS) profile with the MS record of core st 936 with reliable ^{14}C ages [11] and by matching the volcanic glass horizons in the two cores (tephra K_2 [11]).

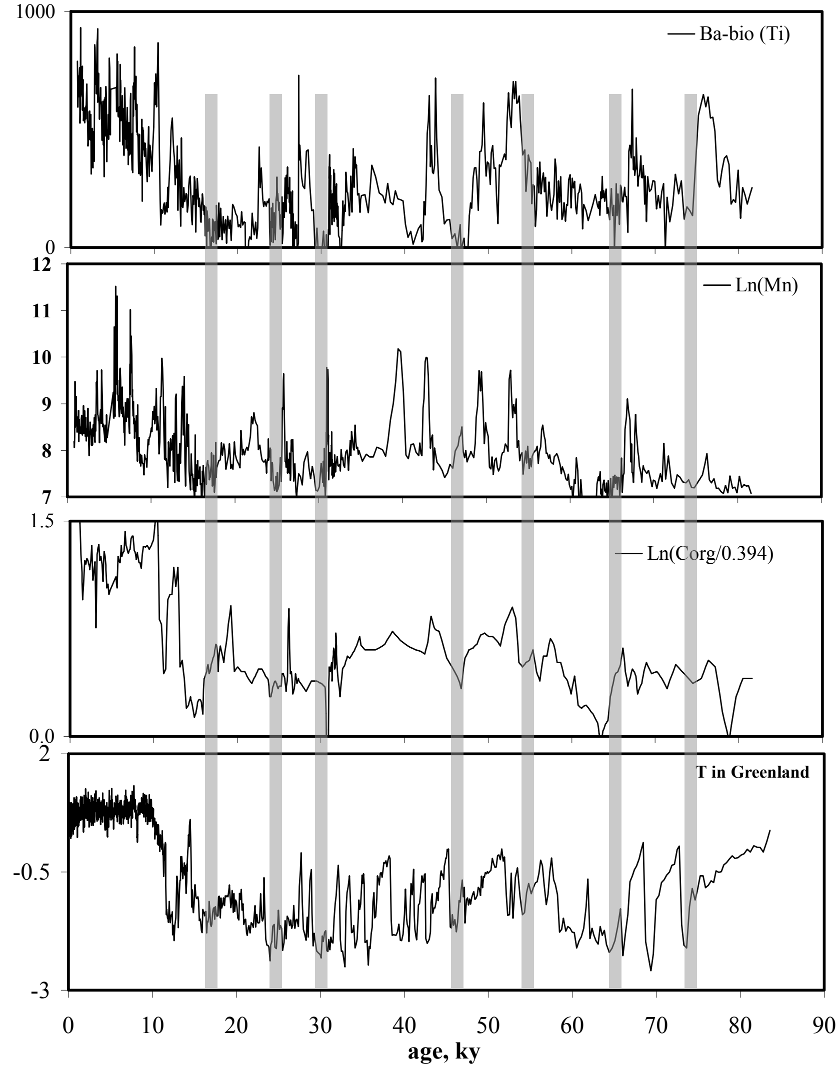

Figure. The profiles of Bio production (Ba_{bio} and C_{org}) and seawater ventilation (Mn) in the Okhotsk Sea on the age-depth scale of this study are correlated with the air temperature above Greenland. The shaded lines point to the timing of Heinrich events H1-H7. Minimums of Bio production and C_{org} and elevated seawater ventilation in the Okhotsk Sea are synchronous with H-events in the North Atlantic.

Biogenic Ba (Ba_{bio}) in the bottom sediments provides a reliable production proxy. It precipitates as biogenic barite from water during diagenesis of sinking particles of dead organic matter at great sea depths [16]. The content of Ba_{bio} was estimated by subtraction of its terrigenous component (Ba_{ter}) from the total bulk concentration in sediment. The terrigenous component, in turn, was found from empirical regional $(Ba/Ti)_{ter}$ ratios in the intervals with the lowest Ba_{tot} contents:

$$Ba_{bio} = Ba_{tot} – (Ba/Ti)_{ter} * Ti$$

These intervals are also marked by the absence of biogenic carbonate and lowest organic carbon. The $(Ba/Ti)_{ter}$ ratio of 0.145 obtained here for the Okhotsk Sea is consistent with the upper crust average of ~ 0.130. Similarly, Ba_{bio} contents were estimated using Ba_{ter} normalized to K, Th, Rb, Nb, La, and Ce. The Ba_{bio} profiles based on calibration to these typical terrigenous elements and their empirical regional ratios are almost identical. Figure shows SR XFA profiles of Ba_{bio}, C_{org}, Mn and $\delta^{18}O$ concentrations in Greenland ice. The oxygen isotope record correlates with the air temperatures above Greenland. Gray vertical bars mark the coldest and driest events (H-events). Low frequency trends of Ba_{bio} and C_{org} are similar to PC2 trend, which characterizes the input of terrigenous material from the Amur River waters ([14]. Heinrich events from H1 to H7 except H4 match bio production (Ba_{bio}) and C_{org} minimums in the Okhotsk Sea. Abrupt Mn decrease in the same intervals point to either strengthening of ventilation of seawater during these periods or sudden increase of terrigenous sedimentation. In contrast, maximums of bio production (Ba_{bio}) and C_{org} in the Okhotsk Sea match warm interstadials (D/O [1-3]) during the last glacial period.

Thus the analyzed high-resolution multi-element records provide unambiguous evidence for almost synchronous response of the Okhotsk Sea to abrupt warm and cold events in the Atlantic.

Grants #121 and # 175 from the Siberian Branch of the Russian Academy of Sciences and grant # 143 from SBRAS – FEBRAS funded this study.

REFERENCES

1. Dansgaard W. et al, Nature, **364**, pp.218–220, 1993
2. Taylor K. C., Lamorey G. W., Doyle G. A. et al, Nature, **361**, pp. 432–436, 1993
3. Johnsen S. J., Clausen H. B., Dansgaard W., et al, Nature **359**, pp.311– 313, 1992
4. Severenhaus et al, Science, **286**, pp. 930-934, 1999
5. Lang C., Leuenberger M., Schwander J. et al, Science, **286**, pp.934–937, 1999
6. Alley R. B., Meese D. A., Shuman C. A. et al, Nature, **362**, pp.527–529, 1993.
7. Heinrich H, Quaternary Research, **29**, pp.142-152, 1988
8. Bond, G. C., and Lotti R., Science, **267**, pp.1005–1010, 1995
9. Hendy I.L., Kennett J.P., Paleoceanography, **15**, pp.30-42, 2000
10. Kiefer T., Sarnthein M.S., Erlenkeuser H. et al, Paleoceanography, **16**, pp.179-189, 2001
11. Gorbarenko S.A., Southon J.R., Keigwin L.D. et al, Palaeogeography, Paleoclimatology, Palaeoecology (PPP), 209, pp.281-301, 2004
12. Blunier, T., and E. J. Brook, Science, **291**, pp. 109–112, 2001
13. Blunier, T., et al, Nature, **394**, pp.739–743, 1998
14. Goldberg E.L. et al, High-resolution elemental composition of bottom sediments from the Okhotsk Sea as climate change proxies, this issue
15. Martinson D.G, Pisias N.G., Hays J.D. et al, Quaternary Res., **27,** pp.1-29, 1987.
16. Dymond J., Suess E., Lyle M., Paleoceanography**, 7,** pp. 163-181, 1992

URANIUM SERIES ISOTOPES AND ELEMENTS FROM BOTTOM SEDIMENTS OF SIBERIAN LAKES FOR HIGH-RESOLUTION CLIMATE RECONSTRUCTIONS

Goldberg E.L.*,Grachev M.A.*, Chebykin E.P.*, Phedorin M.A.*, Khlystov O.I.*, Zolotarev K.V.*Kalugin I.A.****

**Limnological Institute of SB RAS, 664033 Irkutsk, Russia*
***Institute of Geology of SBRAS, 630090 Novosibirsk, Russia*
****Budker Institute of Nuclear Physics of SB RAS, 630090 Novosibirsk, Russia*

The aims of this paper were the development of models and quantitative reconstructions of climate humidity for the watershed of Baikal and Teletskoye Lakes (Altai).

The physicochemical model using geochemical properties of uranium isotopes is developed for Lake Baikal. The Isotopes of uranium ^{234}U, ^{238}U and ^{230}Th in the sediments over an interval of the last 100 ky were measured by ICP-MS method with sampling frequency of 1 sm (it is ~200 years for Lake Baikal). Full uranium was measured on same column on a wet core at scanning station SXRFA with the resolution of 1 mm (~20 years). Uranium isotopes are delivered to lakes by rivers with terrigenous sediment particles (in secular equilibrium $^{234}U/^{238}U=1$) and in the soluble form ($^{234}U/^{238}U$ in water ~2 is unequilibrium). Dissolved disequilibrium uranium is adsorbed onto Fe films which precipitate from water on fine terrigenous particles in oxidized conditions and becomes buried in sediment where it gradually reaches secular equilibrium for about 700-1000 ky. Modeling of U fluxes to the lake bottom shows that the supply of disequilibrium uranium ceased in glacial times, i.e., the river input was almost zeroed and atmospheric precipitation evaporated within the drainage basin. River runoff (**Q**) is found from the mass balance of measured authigenic uranium adsorbed on particles ($^{238}U_{aut}$) as

$$\mathbf{VdU_{aut}/dt = KQU_{riv} - QU_{aut} - S\ K\ U_{aut}\ \hat{J}_{ter}\ (1),}$$

where V and S are the lake volume and surface, respectively; U_{riv} is average U concentration in tributaries; $\hat{J}_{ter}$ (MAR) is measured terrigenous flux to the bottom; K is constant of ^{238}U sorption by Fe-hydroxides which have been found empirically from the data on modern Baikal.

Atmospheric precipitation **(P)** and evaporation **(E)** have been simulated through parametrization of their coherence and use water balance for watershed: $\mathbf{Q = (P\text{-}E)_{S\text{бас}}}$. The results obtained after quantitative high-resolution reconstruction of runoff and P during the last of 100 ky are presented in fig1.

Precipitation and air temperatures in Altai were reconstructed from element concentrations using a multi-dimensional linear response function, which is of broad use in paleoclimate studies. The trends of 29 elements measured in Lake

Teletskoye cores were converted into five orthogonal functions (EOF) that account for 63% of variance in geochemical data. Few elemental records were duplicate and thus non-informative due to a strong correlation of element groups. The same were the results for closely correlated seasonal air temperatures and precipitation from Barnaul Station (plainland of Altai), where only three EOF of ten seasonal series account for 65% of climate data variance. Correlation coefficients of the annual, winter, and winter-spring air temperatures are as high as 0.89-0.92. Summer temperatures are less variable, and 75% of warming in the 20th century is associated with cold seasons (winter and spring). The calibration interval was 1840 to 1995, i.e., covered the entire instrumental period.

The problem was solved as a least-square inversion of a matrix equation that relates the predictor $\hat{\mathbf{G}}$ (five EOF geochemical (SRXFA) series) and the predictant $\hat{\mathbf{A}}$ (two vectors of climate parameters, annual (or winter) air temperature and precipitation).

$$\hat{\mathbf{A}} = \hat{\mathbf{G}}*\hat{\mathbf{Y}} + \hat{\mathbf{E}}_{\mathbf{res}} \quad \mathbf{(2)}$$

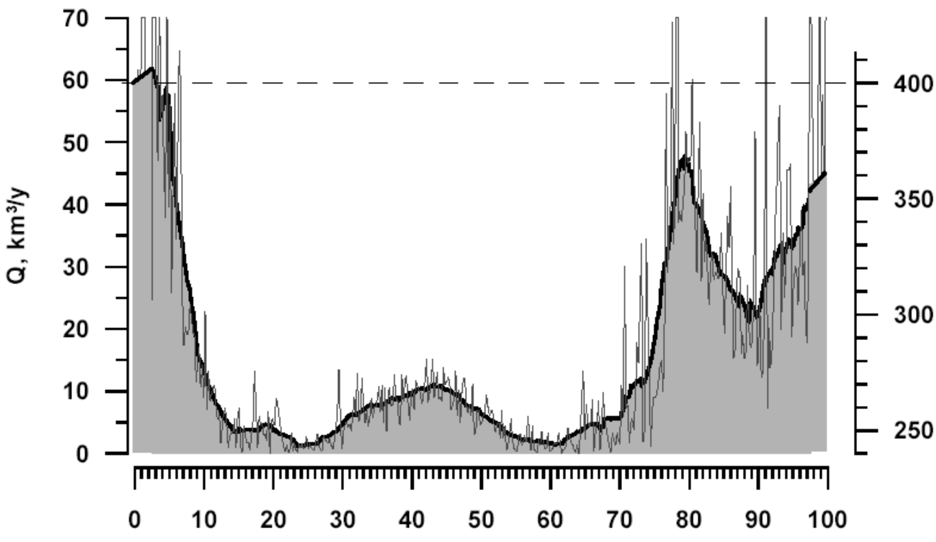

Fig. 1. Reconstructed paleo runoff and precipitation in East Siberia

$\hat{\mathbf{Y}}$ matrix is the transfer function found within the calibration interval (index 1) where the matrix of the air temperatures and precipitation (**$\hat{\mathbf{G}}$1**) is known.

$$\hat{\mathbf{Y}} = \mathbf{(\hat{G}1T*\hat{G}1)\text{-}1*\ \hat{G}1T*\ \hat{A}1\ (3)}$$

The obtained transfer function was substituted into (2) to reconstruct temperatures and precipitation outside the calibration interval. Figure 2 shows annual air temperatures and annual precipitation predicted to a 1-sigma error.

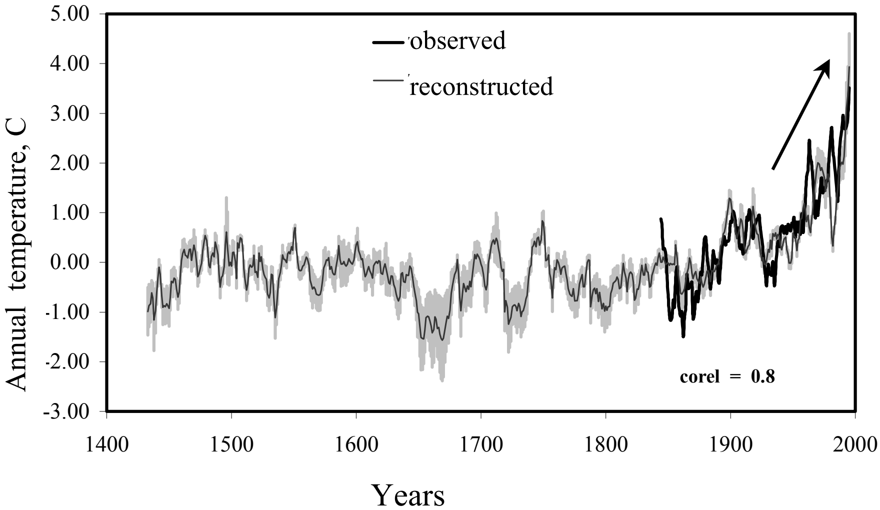

Fig. 2. Reconstructed annual temperature in Altai (Barnaul Station) over the last 550 years.

The study was funded by grants 121 and 175 from the Siberian Branch of the Russian Academy of Sciences.

ORBITAL AND MILLENNIUM SCALE PALEOCEANOGRAPHY CHANGES IN THE OKHOTSK AND BERING SEAS AND FAR NW PACIFIC DURING LAST GLACIATION AND HOLOCENE

Gorbarenko S.A.*, Goldberg E.L.,***, Vasilenko Yu*, Artemova A.V.*, Pshenova O.Yu.*, Ivanova E.D.*****, Ignatjev A.V.******, Leskov , V.Yu* , Kashgarian M.****, Zakharkov S.P.*, Bosin A.A.*, Botsul A.I.**

** V.I.Il'ichev Pacific Oceanological Institute FEB RAS, Vladivostok, Russia*
***Limnological Institute of the SB RAS, 664033 Irkutsk, Russia*
****Budker Institute of Nuclear Physics of SB RAS, 630090 Novosibirsk, Russia*
*****Lawrence Livermore National Laboratory, P.O. Box 808, L-397, Livermore, CA, 94550, USA*
******Pacific Institute of Geography FEB RAS, Vladivostok, Russia*

Suite of the sediment cores recovered from the Okhotsk Sea, Bering Sea and Far Northn-Western Pacific were studied by complex lithological, isotope geochemical, physical and paleontological methods in order to clarify the orbital and millennium time scale variability in the sea paleoenvironment and surrounded land climate.

The age model of the studied sediment was reconstructed by the identification of the standard oxygen isotope stages in the d18O benthic foraminifera curves, AMS 14C dating of planktonic and benthic foraminifera, tephrochronology, magnetic susceptibility sediment records and early dated lithological units (Gorbarenko et al., 2002; Gorbarenko, Artemova 2003).

Among several cores from the Okhotsk Sea the sediments of core Lv 28-40-5 from the western part of sea were investigated most complexly by the lithological approach including the ice rafted debris counting, d18 O and d13C of the benthic and planktonic foraminifera measurement, opal, chlorophyll, carbonate and organic carbon content, synchrotron radiation XFA elemental measurements and grain size analysis. The diatom and benthic foraminifera analyses of this core were performed in order to reconstruct the climate, surface and bottom water condition changes. Detailed results of these geochemical, sedimentological and paleontologial proxies and they interpretation will be presented in satellite reports of the current conference.

Productivity changes of the studied region on the orbital time scale is an important problem, which is connected with the atmosphere-ocean CO2 exchanges during interglacial -glacier periods and its climate impact. The mass accumulation rate of the total organic carbon (MAR TOC) in the region sediment was calculated and the productivity was assessed based on the original and literature results of the organic carbon content in sediment, corrected was chronostratigraphy and available lithophysical data of the dry bulk sediment density. In spite of the preferentially terrigenous sedimentation and low carbonate and opal content in the glacial sediment, organic matter fluxes into the bottom of the Far Northwestern Pacific during the glacial maximum (MIS 2) were several times greater than those during the Late Holocene (last 6 kyr) with the climate condition close to the present one. In the southern and western Bering Sea the glacial MAR TOC was only 2-1,5 times more than that for the Late Holocene. These results are consistent with the early paleontological data (Sancetta, 1992), however contradict to the later conclusion (Narita et al., 2002; Kienast et al., 2004). Strong sea ice coverage and significant shorting of the summer productivity seasons in the Okhotsk Sea damped the productivity and organic matter fluxes to the bottom in this marginal basin during the glacial time being compared with the modern ones.

The data set of IRD, grain size, results of the wide spectra elemental content and isotope geochemical proxies in sediment and paleontological data (diatom, pollen, benthic and planktonic foraminifera) all clearly denotes the millennium scale climate and environmental variability in the Okhotsk Sea, Bering Sea and Far Northwestern Pacific during the last glacial period and Holocene.

Increase in the sea ice intensity proxies in the studied region during the glaciation were apparently connected with strengthening of the winter East Asia monsoon during cold Greenland ice sheet Dansgaard Oeschger stadial (Dansgaard et al., 1993) and more significantly rises during the cycles coeval with the North Atlantic Heinrich events (Heinrich, 1988). The cycles with the decrease of the Amur river discharge into the Okhotsk Sea were likely connected with the summer monsoon shrink and climate cooling and drying at the Amur river area during the glaciation.

The study was supported by grants of the Russian Fund of Basic Research 03-05-65192a and by the Joint Far Eastern and Siberian branches of Russian Academy of Sciences grant 03-II-0-00-006 and grant of Presidium of REB- RAS 05-III-B-06-003.

RISS-WURM TRANSGRESSION IN TATAR STRAIT

Grebennikova T.A., Korotky A.M., Ivanova E.D.

Pacific Institute of Geography, Far Eastern Branch of the Russian Academy of Sciences

The new data on climatic rhythmic and evolution of the natural environment in Riss-Wurm Interglacial are received from studying sediments of 10-12 meter terraces in the northern part of Tatar Strait (48 degrees North, Cape Bui). Sea sediments are revealed within the interval of 3.2-12.6 meters. While studying diatom seaweeds, benthos foraminifera and molluska fauna, it is established that sea sediments fix two rhythms of transgressive phases. Sediments within the interval of 10.4-12.6 meters correspond to the first rhythm of transgression. Accumulation of sediments in the very bottom of the bed occurred on the shallow under conditions of active hydrodynamics and high decrease in salinity. It is proved by the high contents in a structure of diatoms of brinish water *Pleurosira laevis* f. *polymorpha* (Kütz.) Compere*, Melosira moniliformis* (O. Müll.*)* that are mostly typical of the very fresh closed water areas. In the upper part of this layer (10, 4-11.1meters) the coastal-sea species *Paralia sulcata* (Ehr.) Kütz. (up to 90 %) in a combination with warm-water and moderate - warm-water *Campylodiscus echeneis* Ehr.*, Arachnoidiscus ehrenbergii* Bail., *Cocconeis scutellum* Ehr. var. *scutellum, Nitzschia littoralis* Grun.*, Rhabdonema arcuatum* (Lyngh.) Kütz. var. *arcuatum* dominate. It is typical of open gulfs and bays and testifies to the gradual rise of a sea level. At this time, the temperature of the surface waters in the Tatar Strait was close to the present one.

Along the section interval of 5.0-7.8 meters accumulation of alluvial sediments (flood and channel facies) likely occurred. In this layer of sediments a very rich fresh-water complex (99 %) is encountered. Planktonic *Aulacoseira italica* (Ehr.) Sim var. *italica., A. granulate* (Ehr.) Sim. var. *granulata, A. ambigua* (Ehr.) Sim. var *ambigua* are wide spread in various fresh-water reservoirs and dominate in its structure.

Sediments within the interval of 3.2-4.9м correspond to the second rhythm of transgression. In the ecological structure of a diatom complex (in the interval of 4.3-4.9м) oceanic, neritic and sublittoral species are found. Representatives of a sublittoral group of diatoms are most numerous; *Paralia sulcata* (Ehr.) Kütz., *Cyclotella striata* (Kütz.) Grun., *C. stylorum* Bright., *Actinocyclus octonarius* Ralfs dominate among them; southern – boreal species including *Thalassionema nitzschioides* Grun., *Actinoptychus senarius* (Bail.) Ralfs, tropical *Pseudoeunotia doliolus* (Wall.) Grun., *Bacteriastrum hyalinum* Lauder are distinguished among neritic species. In the group of oceanic diatoms the southern-boreal species such as *Coscinodiscus asteromphalus* Ehr., *C. perforatus* Ehr., subtropical and tropical species including *Coscinodiscus nodulifer* A. S., *C. wailessii* Gran et Angst, *Planktoniella sol* (Wall). Schutt, *Rhizosolenia bergonii* Perag. are encountered. Such structure of the complex testifies to the fact that sediments were formed in the coastal part, which is completely open for the penetration of waters of the high sea. The temperature of surface waters in this area at this time was rather high that is proved by the presence of high specific variety of subtropical (up to 7 %) and tropical species (up to 6 %). Distribution of these species in the Sea of Japan is connected at present with the waters of Tsushima current.

A rich complex of benthos foraminifer *Discoislandiella umbonata, Islandiella japonica, Retroelphidium subclavatum, Trifarina kokozuraensis, Uvigerina akitaensis, Retroelphidium subclavatum, Cassandra singularis, Buccella limpida, B. granulata* is established there. The structure of a complex is characteristic for an open shelf (with depths up to 100 meters), with mid-annual bottom temperatures from 0°C up to 2°C and normal salinity. Among benthos foraminifera a plenty of planktonic species is marked, among which *Globigerina pachyderma sin.* and *Globigerina bulloides* are the leading ones.

In a cover of this layer in the interval of 3,2-4,2 meters beach sediments with shells of molluscs *Mya japonica* (Jay), *Mya sp., Cardium sp., Crenomytilus grayanus* (Dunker), *Nucela sp., Littorina sp.* (A.M.Lebedeva's definition) are revealed. This complex of shells corresponds to the facies of the coastal shallow waters.

In overlapping continental sediments at a depth of 3.15meters from the roof of a terrace the fresh-water diatoms typical of the periodically drained wetlands are found in which *Pinnularia borealis* Ehr., *Hantzschia amphioxys* (Ehr.) Grun. var. *amphioxys, Eunotia praerupta* Ehr. *var. praerupta* dominate.

Thus, in a cross-section of the 10-12 meter sea terrace in the Bui River mouth the sediments of 2 phases of maximal transgression are opened during a climatic optimum of the beginning of the Late Pleistocene. In the middle of transgression the decrease of the sea level up to the mark of +5 meters is fixed by a fresh-water diatom complex. During the second rhythm the temperature of the surface waters was 5-7oC higher than the present one. At that time a significant rise of the sea level made active the entrence of the warm Pacific waters into the northern part of the Sea of Japan. The presence of tropical species such as *Coscinodiscus wailessii* Gran et Angst, *Rhizosolenia bergonii* Perag. in a diatom complex testifies to it. At present the northern border of their areas is located 13-15 degrees isotherms. A layer of shingle beds with the fauna of sea molluscs corresponds to the maximal rise of the sea level up to the mark of +8 meters. The buried soil above and a cover complex of psephitic sediments contain only fresh-water forms of diatoms.

SPATIAL-TEMPORAL DYNAMICS OF SOME METEOROLOGICAL PARAMETERS IN THE RUSSIAN FAR EAST IN THE LATTER HALF OF THE 20TH CENTURY

Grigorieva E.A., Fishman B.Ye., Shlufman K.V.

Scientific secretary Institute of Complex Analysis of Regional Problems, FEB RAS, 4, Sholom-Aleikhem St., Birobidzhan, JAR, 679016

The most essential parameter of the characteristics of modern climate changes is the average annual temperature of the air. For the real estimation of the thermal influence of the environment on a man′s health it is necessary to take into account the dynamics of the extreme temperatures – the minimal and maximal temperatures of the air as they indicate a degree of a climate temperature comfort. The data on the expected dynamics of the atmospheric precipitation have great value for economic activities.

The data on the annual minimal air temperature (it is observed at radiating colding at night and at advective colding – at any time of the day), on the maximal air temperature (basically in the day-time) and on the annual quantity of atmospheric precipitation were used to characterize the climate in the territory of the middle and southern part of the Khabarovsk Territory and the Jewish Autonomous Region for the period 1966-2000. 13 hydrometeorological stations (HMS) are located in a rectangular limited from 46 up to 57^{o} N and from 132 up to 142^{o} E. Three stations are located at the coast of the Okhotsk and Japan seas, the others – on the continental part of the territory.

First of all, the features of the spatial-temporal structure of the annual values of the examined meteorological parameters have been considered. The mathematical device including the methods of the cluster-analysis has been applied to construct an empirical model of the investigated parameters dynamics. Allocation of clusters as groups of hydrometeorological stations was carried out with the help of three independent approaches: calculation of the spatial pair correlation coefficients, definition of the maximal observable divergences and an estimation of the root mean square error.

The greatest number of close connections in the temperature clusters was revealed using the approach based on the calculation of spatial pair correlation coefficients, whereas the large number of close connections in the atmospheric precipitation was provided by the last method of the root mean square error.

Realization of three cluster analysis approaches on three parameters of meteorological regime has revealed the following spatial features of typical dynamics.

All three approaches reveal reliably the presence of two practically independent clusters on the minimal temperatures: "northern" and "southern" ones. It is possible to assume, that for the examined territory similarity of thermal processes during colder time of day is caused, first of all, by a relief: the first group are the stations located in the mountain district, the second, southern one, are the stations located basically in a plain part.

While studying the maximal temperatures the "distance" set by the spatial pair correlation coefficients provides high enough level of connection between all continental HMS, that indicates spatial similarity of thermal processes in the warm time of day within the whole territory. Other two approaches reveal southern cluster with practical absence of connections between the other HMS. Coastal stations have not come in any cluster, and they are not connected among themselves.

The precipitation appeared to be poorly interconnected with low values of the spatial pair correlation coefficients. In some cases phase opposition is marked in fluctuations of precipitation (with the negative values of the correlation coefficients). Apparently, this is explained by a character of atmospheric processes, first of all, and depends on the prevalence of different forms of atmospheric circulation. Fluctuations of deposits are nonsynchronous even at the close by located stations that are connected with the difference of their site in relation to the moisture-laden streams.

Thus, as a result of the described approaches of the empirical modeling for the territory of the southern part of the Russian Far East on dynamics of the minimal and maximal temperatures and precipitation during 1966-2000, the existence of two spatial clusters of HMS that can be designated conditionally as “northern” and “southern” ones has been revealed. It is possible to note some qualitative differences in them: connections are less expressed in the "northern" cluster; its structure is more friable. "Southern" group of HMS has more precise character of connections on all parameters and approaches. Distinctions in character and structure of clusters reflect the influence of both local climatic features, and of the large-scale atmospheric processes. Thus, the coastal HMS have not come in any of the groups.

Division of hydrometeorological stations into the clusters of typical dynamics on the annual values of meteorological parameters allows making the following conclusions. First of all, using an empirical model, it is possible to pass from a dot character of process on a separate HMS to the averaging within all space of a certain cluster. Secondly, having a high level connection between two HMS it is possible to carry out modeling of the dynamics of the given parameter at one station, of the appropriate value -at another station.

RAPID FLUCTUATION OF ALKENONE TEMPERATURE AND FRESHWATER IMPACT ON THE OKHOTSK SEA DURING THE PAST 120 KYR

Harada N.*, Sakamoto T., Uchida M, Shibata Y.***, Ahagon N.****, Aoki K.*****, and Ikehara M.********

**Institute for Observational Research for Global Change, Japan Agency for Marine-Earth Science and Technology, Yokosuka, Japan,*
*** Institute for Frontier Research on Earth Evolution, Japan Agency for Marine-Earth Science and Technology, Yokosuka, Japan,*
**** NIES-TERRA AMS Facility, National Institute for Environmental Studies, Tsukuba, Japan,*
***** Hokkaido Univ., Sapporo, Japan,*
******National Insittute of Advanced Industrial Science and Technology, Tsukuba, Japan,*
*******Center for Advanced Marine Core Research, Kochi Univ., Kochi, Japan*

Sea-ice expansion in the Okhotsk Sea in winter is sensitively affected by global warming and cooling. Regionally, the southwestern Okhotsk Sea is closely linked to climate change in East Asia, including Japan, because the cold sea surface temperature (SST) in the southwestern Okhotsk Sea influences directly the development of the Okhotsk atmospheric high pressure system, and the activated Okhotsk high causes cold climatic conditions in northern Japan. Therefore, environmental change in the Okhotsk Sea indicates two-way interactions as a sensitive mirror reflecting global climate change and as a driving force of regional climate change. To better understand how surface environmental changes in the Okhotsk Sea can influence climate change in East Asia, SSTs were estimated in the southwestern Okhotsk Sea for the past 120 kyr with millennial to centennial time resolution using the long-chain unsaturated alkyl ketone (alkenone) thermometer. Sediment core (58 m in length) IMAGES MD01-2412 used in this study was collected at the southwestern Okhotsk Sea. The alkenone temperature, which corresponds to the SST to 20 m depth in autumn, showed repeated abrupt changes at a centennial timescale, especially during the last glacial period, 20–60 kyr before present (BP). The alkenone temperature changed concurrently with changes from interstadials (warm events) to stadials (cold events) in the d18O record of the

GISP2 ice from Greenland, although some interstadials could not be identified in the alkenone temperature record. Furthermore, High SST and low SSS events over the past 120 kyr correlated with interstadials. We find that these warm fresh ater events were closely related to an enhanced Asian monsoon. These findings increase our understanding of the close linkage between high and low latitudes in relation to climate change.

A COLD EVENT DURING MIS 6 AT THE EAST SEA (JAPAN SEA): GEOCHEMICAL EVIDENCES

Hyun Sangmin*, Kim Jung-Moo, Shim Won-Joon*,Woo Kyung-Sik***, Yoon Seok-Hoon****, and Suk Bong-Chool***

**Korea Ocean Research and Development Institute (KORDI)*
***Department of Earth Science, Korean Minjok Leadership Academy*
****Department of Geology, Kangwon National University*
*****Department of Oceanography, Cheju National University*

Stable oxygen isotope of foraminifera and alkenones variation of the two piston core (MB96EBP-4 and M04-PC1A) were conducted to elucidate the evolution of paleoceanography of the East Sea (Japan Sea). Paleoenvironmental changes since the last ~ 320 ka was reconstructed based on the oxygen isotope compositions of forminifera and alkenons data from the deep-sea sediments of the piston core taken from the Korea Plateau in the East Sea (Japan Sea). Oxygen isotopic records of the planktonic foraminifera, that were estimated to be ca. 320 ka in age, show the Marine Isotope Stage (MIS) from 1 to 8. Comparing this result with previously reported stable isotope data in the East Sea as well as the global oxygen isotope trend, it is suggested that paleoceanographic and paleoclimatic changes in the East Sea has been quite different from those of open oceans: it reserves freshwater input signals and steep drop of paleotemperature (about 2 per mil heavier) at the MIS 2.1 and 6.2, respectively. Paleotemperature variations of the surface water in the East Sea were reconstructed using unsaturated longchain alkenones (ULA) along with oxygen isotope data. The result shows that paleotemperature was about 10oC lower than today's surface temperature during the MIS 6.2. However, paleotemperature during the MIS 2.2 was characterized by relatively small temperature drop of about 3~4 oC. Both oxygen isotope and ULA data show the systematic coeval trend throughout the late Quarternary. The two core data suggesting local oceanographic condition were more distinctive feature and have prevailed since the MIS 6 in the East Sea.

FLUCTUATION OF SURFACE WATER COOLING DURING MIS 3-5 IN THE NORTHERN JAPAN SEA

Ikehara Ken* and Itaki Takuya**

**Geological Survey of Japan, AIST. Tsukuba, 305-8567, Japan*
***University of Tokyo, Tokyo, 113-0033, Japan*

The East Asian winter monsoon has been characterized by cold and dry air blown out from the Siberian high to the surrounding lows. Cold and dry northwesterly is the most characteristic feature of the modern winter monsoon over the Japan Sea. The extremely cold air has refrigerated the surface water along the Far East coast of the northern Japan Sea, and has formed cold and dense water. Modern oceanographic observations indicate that the sea-ice formation along the coast during the extremely cold winter is an important process on the deep-water formation. Therefore, formation both of sea-ice and deep-water is the signal of the stronger surface water cooling by the stronger winter monsoon. Occurrence of the ice-rafted debris (IRD) is a proxy of sea-ice extend. Large fluctuations in IRD during oxygen isotope stage 3-5 were found in a core collected from off Rumoi, Hokkaido, Japan suggesting the stronger winter monsoon. Some peaks in this period would be correlated to the Heinrich events in the north Atlantic. On the other hand, abundance of a radiolarian species, *Cycladophora davisiana*, which prefers a cold and oxygenated deep/intermediate water mass, is an evidence on ventilation along the northern coast of Japan Sea. Relative abundance of *C. davisiana* in a core collected from the southern Japan Sea also showed the large fluctuation with millennial time-scale during stage 3-5. This indicates that the deep-water ventilation also changed frequently. At least, some peak occurrences in IRD were correlative to those in *C. davisiana*, indicating larger sea-ice expansion and stronger ventilation (stronger winter monsoon). Deep-water formation in the Japan Sea during the period, however, also was controlled by water stratification caused by low-salinity water supply to the Japan Sea according to the summer monsoon. Therefore, careful discussion is necessary for the reconstruction of temporal changes of deep-water ventilation from one or a few core records of *C. davisiana*. Occurrence of IRD was not concordant with that of dark layer which formed under stronger summer monsoon. This indicates winter monsoon affected by high-latitude (polar) circulation did not have a simple seesaw like relation to summer monsoon related to low-latitude circulation.

MILLENIAL-SCALE VARIABILITIES OF SUBSURFACE TEMPERATURE AND THERMOCLINE DEPTH IN THE SEA OF OKHOTSK DURING THE LATE QUATERNARY

Ikehara Minoru*, Oba Tadamichi, and Kawamura Kimitaka*****

**Center for Advanced Marine Core Research, Kochi University, B200 Monobe, Nankoku, Kochi 783-8502, Japan, E-mail: ikehara@cc.kochi-u.ac.jp*
***Graduate School of Environmental Earth Science, Hokkaido University, W5N10, Kita-ku, Sapporo, 060-0810, Japan*
****Institute of Low Temperature Science, Hokkaido University, W8N19, Kita-ku, Sapporo, 060-0819, Japan*

The Sea of Okhotsk is characterized by an extended seasonal sea-ice cover and is considered as a possible source area of the North Pacific Intermediate Water (NPIW). Therefore, the reconstruction of past sea surface temperature (SST) and subsurface structures in the Sea of Okhotsk is indispensable for the study of the past variations in the NPIW formation and of the detailed climate changes in the Northwest Pacific. We measured the concentration of alkenones in the Sea of Okhotsk surface sediments to understand the distribution of the marine biomarkers. We also produced the detailed oxygen isotopes of planktonic and benthic foraminifers and alkenone SSTs for a core XP98-PC1 (51°00'N, 152°00'E, 1107m water depth) with high sedimentation rate (~10 cm/kyr), which was collected from the slope off Kamchatka Peninsula in the Sea of Okhotsk.

Alkenones are detected in the entire Okhotsk Sea surface sediments including the northwestern continental shelf. The concentrations of alkenones are not shown a systematic distribution pattern in the Sea of Okhotsk. Calculated alkenone SSTs in the Sea of Okhotsk represent summer to autumn SST in the 0-20 m interval, based on the comparison of the modern SST profiles at the each site.

The alkenone records indicated that the SSTs were almost constant throughout the Holocene at approximately 8.5°C at the site of core XP98-PC1. Alkenone SSTs are also lowered by 2°C at the early deglaciation and a similar warm SST were detected in the glacial periods in the Okhotsk Sea. Oxygen isotopes of planktonic foraminifera (*Grobigerina bulloides* and *Neogloboquadrina pachyderma*), however, showed the short-term fluctuations during the last 70 kyrs. Because the average depth habitat of *N. pachyderma* was estimated for ~100 m in the southern Okhotsk Sea (Bauch et al., 2002), the planktonic oxygen isotope variabilities were mainly caused by a rapid change in subsurface dichothermal layer (DTL) temperatures due to thermocline depth oscillation. The warmer DTL in the Sea of Okhotsk may correspond to warmer climate signals of the Polar Circulation Index in the Greenland ice core (Mayewski et al., 1997) and the regional sea level high stands (Razjigaeva et al., 2004). Therefore the millennial scale oscillations of subsurface temperature and thermocline depth were periodically occurred in the Sea of Okhotsk. These results suggest that past variability of DTL and subsurface structure may have been caused by the time-series variation of deep mixing rates due to the Asian monsoon intensity over the Sea of Okhotsk.

PRELIMINARY RESULTS FROM MECHERCHAR JELLYFISH LAKE, PALAU

Jordan Richard W., Konno Susumu, Genka Rieko, Inoue Nozomi

Dept. of Earth & Environmental Sciences, Faculty of Science, Yamagata University, Yamagata 990 8560, Japan

High-resolution marine records from tropical regions are usually based on coral analyses, however, marine lakes also have the potential to provide palaeoenvironmental data. The Republic of Palau, a group of islands in the western equatorial Pacific, has about 70 marine lakes, many of which are surrounded by dense jungle on uninhabited islands. Mecherchar Jellyfish Lake is the most famous of these lakes and as a tourist site is one of the most accessible. Its fame stems from the abundance of photosynthetic jellyfish in the upper 15 m of the lake, the crystal clear anoxic bottom layer, and the 3 m-thick bacterial layer in the middle of the water column. Over the last 5 years we have visited the area on numerous occasions, investigating the present ecology and diversity of the lake and the lagoon outside. We have also taken short cores up to 1.5 m, using a diver to push composite acrylic tubes into the soft sediments of the lake bed. The top 70-80 cm of these cores consist of biogenic siliceous remains (diatoms and sponge spicules), and plant debris derived largely from the lakeside mangroves. Underlying this upper layer are calcareous sediments composed of shell fragments and benthic foraminifers, and organic matter derived from phytoplankton. A previous US investigation of the lake showed that this boundary between the siliceous and carbonate-rich sediments represents the end of the Little Ice Age (ca 1900 AD), a period of cooler and drier conditions which seemingly restricted the mangrove distribution. At present our simple coring techniques have prevented us from acquiring longer cores, but in the future we hope to take >5 m cores in the hope of reaching the Medieval Warm Period. If we are successful, the cores will be analyzed for diatoms, sponge spicules, foraminifers, pollen, as well as plant, plankton and bacterial biomarkers. It is also hoped that coral analyses in the lagoon outside the lake will allow us to correlate climatic changes downcore with more accuracy.

SIBERIAN SUBAERIAL REALM - THE NATURAL MAGNETIC ARCHIVE OF PALEOCLIMATIC FLUCTUATIONS IN CENTRAL ASIA

Kazansky A.Yu., Matasova G.G., Zhdanova A.I.

Institute of Geology, SB RAS, Academic Koptyug ave. 3, Novosibirsk, 630090, Russia. E-mail: kaz@uiggm.nsc.ru

Magnetic properties of loess-soil deposits are widely used for the reconstruction of paleoclimate in many regions of a globe. In the majority of papers the basic concern is focused on the analysis of loess magnetism in China, Europe, and America. The distinction in loess and paleosol magnetic properties allows us to correlate the time of their deposition with concrete climatic epochs and with local paleoenvironments. Two basic models, which are accounting for recording of paleoclimatic changes in magnetic properties of loess and paleosols are known. The "Chinese-pedogenic" model of paleoclimatic record is based on the magnetic enhancement of humic horizons of paleosols with ultrafine pedogenic magnetic grains, which causes enlarged values of low-frequency magnetic susceptibility (XLF) and frequency dependent magnetic susceptibility (FD) in paleosols in comparison with loess [Heller, Evans, 1995]. Loess-soil deposits in Alaska [Beget et al., 1990, in Central Siberia [Chlachula et al. 1997, Matasova et al., 2001] demonstrate opposite behavior of magnetic properties, i.e. enhanced XLF values in loess horizons and reduction of magnetic susceptibility in humic horizons of paleosols without any FD increase ("Alaskan wind-vigor" model). It is supposed that such behavior is conditioned by variations of transport velocity and deposition of loess material as a result of wind vigor changes in different climatic periods.

Our results have shown that on the basis of only magnetic susceptibility measurements not all loess-soil deposits can be attributed to a known type of paleoclimatic record. In some Siberian sections magnetic susceptibility of loess and paleosols does not differ in values and seems to be not informative from the point of view of paleoclimatic reconstruction. Such pattern can be reference for the whole region and thus magnetic properties of loess-soil deposits here are considered as unfavorable for paleoclimatic reconstruction.

We present the detailed analysis of rock magnetic properties of loess-soil sequences of Siberian subaerial realm at a new methodical level. Rock-magnetic properties XLF, FD, anisotropy of magnetic susceptibility (AMS) and some kinds of laboratory-induced magnetization (ARM, SIRM) were investigated in detail for 19 sections distributed over the western (West Siberian Plane, Altai foothills and Kuznetsk depression) and central parts of Siberia (Yenisey valley and near-Baikal region). The results obtained indicate that magnetic properties and magnetic fabrics of loess-palaeosol deposits in the western and south-western Siberia depend on superposition of the two known mechanisms (“Chinese” and “Alaskan”). In general the “Alaskan” wind-vigor mechanism predominates the magnetic enhancement in loess of the Siberian subaerial realm. “Chinese” pedogenic mechanism plays a minor, but a non-negligible role. Ultrafine minerals are formed in situ and their presence is mainly indicated by high FD-values in palaeosols. Both mechanisms are active and their relative contribution depends on local climate. The Kuznetsk Ala-Tau mountain ridge is the geographical natural barrier between rather humid climate in the south-west and a rather dry, cold climate in the north-east. Correspondingly, the wind-vigour enhancement dominates in the north-east, whereas in the south-west pedogenic magnetic mineral enhancement gains in importance. Another natural geographical barrier seems to be East Sayan Mountin ridge, which separates dry, cold climate in Yenisey region and warmer, wet (influenced by Baikal Lake) climate in near-Baikal area. According to present day climate parameters the Siberian subaerial realm is divided in different sub-zones. The magnetic parameters reflect this subdivision and suggest that the climate of the past 180 000 years has not changed to a greater or lesser extent. However, the amplitude of past global climate changes is also reflected in Siberian palaeosols. The marine oxygen isotope stage 3 is less pronounced in Siberia than stage 5, which is in agreement with observations on the Chinese Loess Plateau and other sedimentary record worldwide.

The unaltered loess has retained its primary magnetic fabric with orientation of magnetic grains according to the predominant palaeowind direction. The palaeowind intensity probably is pronounced in the AMS degree. Palaeowind directions for loess units are more or less uniform (from WSW-ENE to W-E) and close to modern wind direction all over the studied area. In palaeosols, however, the distribution of maximal and minimum AMS axes is a sensitive indicator for the degree of pedogenesis.

To summarize briefly, magnetic properties of loess-paleosol sequences in Siberia store a natural archive of paleoclimatic fluctuations in the Central Asia and rock-magnetic measurements seem to be the powerful tool for the paleoenvironmental reconstruction over the Asian continent.

REFERENCES

1. Heller, Evans, 1995, Reviews of Geophysics and Space Physics, 33, 211-240;
2. Beget et al., 1990, Geology, 18, 40-43;
3. Chlachula et al. 1997, Canadian Journal of Earth Sciences, 34(5), 679-686
4. Matasova et al., 2001, Geophysical Journal International, 147, 367-380.

MILLENNIAL-SCALE PALEOCEANOGRAPHIC VARIATIONS IN THE JAPAN BASIN (EAST/JAPAN SEA) DURING THE LATE QUATERNARY

Khim B.K.[*], Ikehara K.[**] and Irino T.[***]

**Department of Marine Science, Pusan National University, Pusan 609-735, Korea*

***Institute for Marine Resources and Environment, National Institute of Advanced Industrial Science and Technology, Tsukuba 305-8567, Japan*

****Graduate School of Environmental Earth Science, Hokkaido University, Sapporo 060-0810, Japan*

Two gravity core sediments (GH99-1239 and GH99-1246) obtained from the Japan Basin show millennial-scale basin-wide paleoceanographic variations in the East/Japan Sea during the late Quaternary. Precise chronostratigraphy of core sediments was reconstructed on the basis of the stratigraphic correlation with known tephra layers as well as well-dated dark laminated mud (DLM) layers. The preservation potential of DLM seems to be controlled by the water depth at a first approximation; the deep-water core (GH99-1246) exhibits more numbers of DLM due to the low sedimentation rate and more sensitivity to degree of oxygenation. Various kinds of geochemical properties corroborate the formation condition of thick and thin DLM layers, corresponding to MIS 2 and 6 as well as presumable D-O cycles, respectively. The degree of concurrent paleoproductivity can be estimated using TOC, opal, and $\delta^{15}N$ and $\delta^{13}C$ of sediment organic matter, although the decoupling between TOC and opal remains unexplained. Core GH99-1239, located in the high-sedimentation rate and shallow site, shows distinctly the typical glacial-interglacial paleoceanographic change along with particularly the interesting Holocene variability. Core GH99-1246, located in the low-sedimentation rate and deep site, preserves the obvious millennial-scale paleoceanographic changes, which are associated with activity of East Asian summer/winter monsoon. Sea-level induced paleoenvironmental variations related to glacials and interglacials are unique and basin-wide in the East/Japan Sea, featuring the supplementary monsoon effect governed by millennial-scale variation, resulting in the formation of thin dark laminated mud layers.

PALEOCEANOGRAPHY OF THE EASTERN YELLOW SEA SINCE THE LAST GLACIAL MAXIMUM

Kong Gee Soo* and Park Soo Chul**

** Petroleum and Marine Division, Korea Institute of Geoscience and Mineral Resources, Daejeon 305-350, Korea*
***Department of Oceanography, Chungnam National University, Daejeon, 305-764, Korea. Tel: +82-42-821-6434, Fax: +82-42-823-9815, E-mail: scpark@cnu.ac.kr*

A 34 meter-long AMS ^{14}C-dated sediment core was examined in order to reconstruct the paleoenvironmental changes that have taken place in the southeastern Yellow Sea during the last 16,600 years. To achieve this, we analyzed the geochemical compositions of organic matter, the benthic foraminiferal assemblages, and the stable isotopes of benthic foraminiferal tests. The organic geochemical results show that terrigenous organic matter was dominant in the southeastern Yellow Sea between 16,600 and 4,300 cal. yr BP, probably due to the influence of river runoff; marine organic matters, originating from surface primary productivity, began increasing drastically after 4,300 cal. yr BP. Benthic foraminiferal assemblages reveal that brackish species were dominant before 3,500 cal. yr BP, but that saline species dominated after this time. Also, the $\delta^{18}O$ values of the benthic foraminifer Cibicides lobatulus showed that a change from high-amplitude to low-amplitude fluctuations took place at 3,500 cal. yr BP. These multi-results indicate that the southeastern Yellow Sea changed from an estuarine to a modern marine shelf environment, probably due to the inflow of the Yellow Sea Warm Current, between 4,300 and 3,500 cal. yr BP. The time discrepancy of 800 years indicates that a modern marine shelf environment was not fully developed in the southeastern Yellow Sea until 3,500 cal. yr BP, even though the sea began to be influenced by the oceanic current at 4,300 cal. yr BP

DATA SYNTHESIS FOR THE RECONSTRUCTION OF THE PAST EAST/JAPAN SEA SURFACE

Lee Kyung Eun

Division of Marine Environment and Bioscience, Korea Maritime University, Busan 606-791, South Korea

Geochemical data such as alkenones and foraminiferal oxygen isotope data are required to reconstruct the past sea surface condition. In the East Sea, previous studies on these proxy data have provided the potential utilities of use of these proxies. However, data recovered so far are spatially very limited to the southern

and eastern marginal part of the sea, and other areas potentially important have not been covered yet. Since the East Sea contains both a subtropical anticyclonic gyre in the south and a subarctic cyclonic gyre in the north with a subpolar front in the central part of the sea, synthesis of several proxy data from different area within the sea will be very important to understand what truly happened during the past. Keeping working together as a working group under the IGCP-476 will provide a best opportunity to do research on these matters.

ORBITAL AND MILLENNIUM SCALE SEA ICE COVERING CHANGES IN THE OKHOTSK SEA DURING LAST 200 THOUSAND YEARS

Leskov V.Yu., Gorbarenko S.A., Artemova A.V., Vasilenko Yu.P.

V.I.Il'ichev Pacific Oceanological Institute FEB RAS, Vladivostok, Russia

In order to study the sea-ice coverage changes in the Okhotsk Sea, combined studies of the ice rafted debris (fraction >0.15mm) and diatom species were carried out on fourteen sediment cores from different parts of the sea.

The oxygen-isotope records, radiocarbon AMS data, carbonate and opal stratigraphy, sediment magnetic susceptibility, tephrochronology and paleontological results were used to obtain a sediment chronostratigraphy and to MIS 1-7 distinguish in the studied cores.

Intensity of the sea ice debris (IRD) accumulation in the sediment was measured by counting by IRD per gram of sediments and by percent of coarse fractions more 63 and 150 mkm.

As a result, six schemes of the IRD average accumulation rate (AAR IRD) for the period 0-6 kyr with the environmental conditions close to the modern ones, the transition time (6-12.5 kyr) and the MIS 2, 3, 4 and 5e were reconstructed. Diatom spectra records in three cores allowed us to study the changes in the oceanic and neritic diatom species during these periods. Spatial distribution of the AAR IRD in these schemes allows us to reconstruct the change of the IRD drifting and paleo surface water current in the Okhotsk Sea.

Lithological and paleontological proxies clearly showed a strong increase in the ice formation on the northern shelf of the glacial Okhotsk Sea, its extent, major ice melting and IRD discharge in the central part of the sea during cold MIS 2, 4 and 6. The average seasonal duration of the ice coverage during the glaciation was longer than the modern ones. However, the ice coverage in the Okhotsk Sea did not last the whole year through and melted completely during summer time, except for the far northwestern part which is adjacent to the Amur River estuary. The large increase of the sea-ice formation in winter on the northern shelf of the glacial sea led to a significant enhancement of the intermediate water formation in the Okhotsk Sea and ventilation of the western Pacific subarctic.

More detailed records of the IRD and coarse fraction % (cores LV28-40-5 and LV 28-34) indicate the millennium scale variability of the sea ice formation connected with the climate changes and intensity of the Siberian High and cooling during cold D/O stadials.

The study was supported by the grants of the Russian Fund of Basic Research 03-05-65192a and by the Joint Far Eastern and Siberian Branches of the Russian Academy of Sciences grant 03-II-0-00-006 and grant of Presidium of REB- RAS 05-III-B-06-003.

POLLEN RECORDS FROM THE SOUTHERN PART OF THE JAPAN SEA AS REFLECTION OF CLIMATIC CHANGES IN HOLOCENE

Melnikova T.A.

Institute of Biology and Soil Science, Far Eastern Branch Russian Academy of Sciences, e-mail: melnikova@ibss.dvo.ru

Study of fossil pollen and spores is very important to get information about the evolution of vegetation and changes of environmental conditions. Pollen and spores are transported into sediments by wind or water streams, sometimes even from long-distance regions.

The pollen and spores from deep-sea deposits of the core situated in the southern Japan Sea were studied. The analysis of palynological records in detail shows the changes in surrounding vegetation during Late Pleistocene and Holocene caused by climatic fluctuations.

At the end of Late Pleistocene surrounding land was dominated by mixed conifer forests and deciduous broadleaved trees (fig. 1). The climate gradually became warmer but remained still rather cold and dry in comparison with the modern one.

Later, in Preboreal and Boreal phases of Holocene, the coniferous forests were gradually replaced by the broadleaved oak-dominated forests. It is known, that solar radiation in July in the Northern Hemisphere 9000 yr ago was at least 7 % greater than at present (Kutzbach, 1981). But cold winters (Milankovitch, 1941; Prell, Kutzbach, 1987) did not allow the majority of megathermic vegetation to be distributed actively.

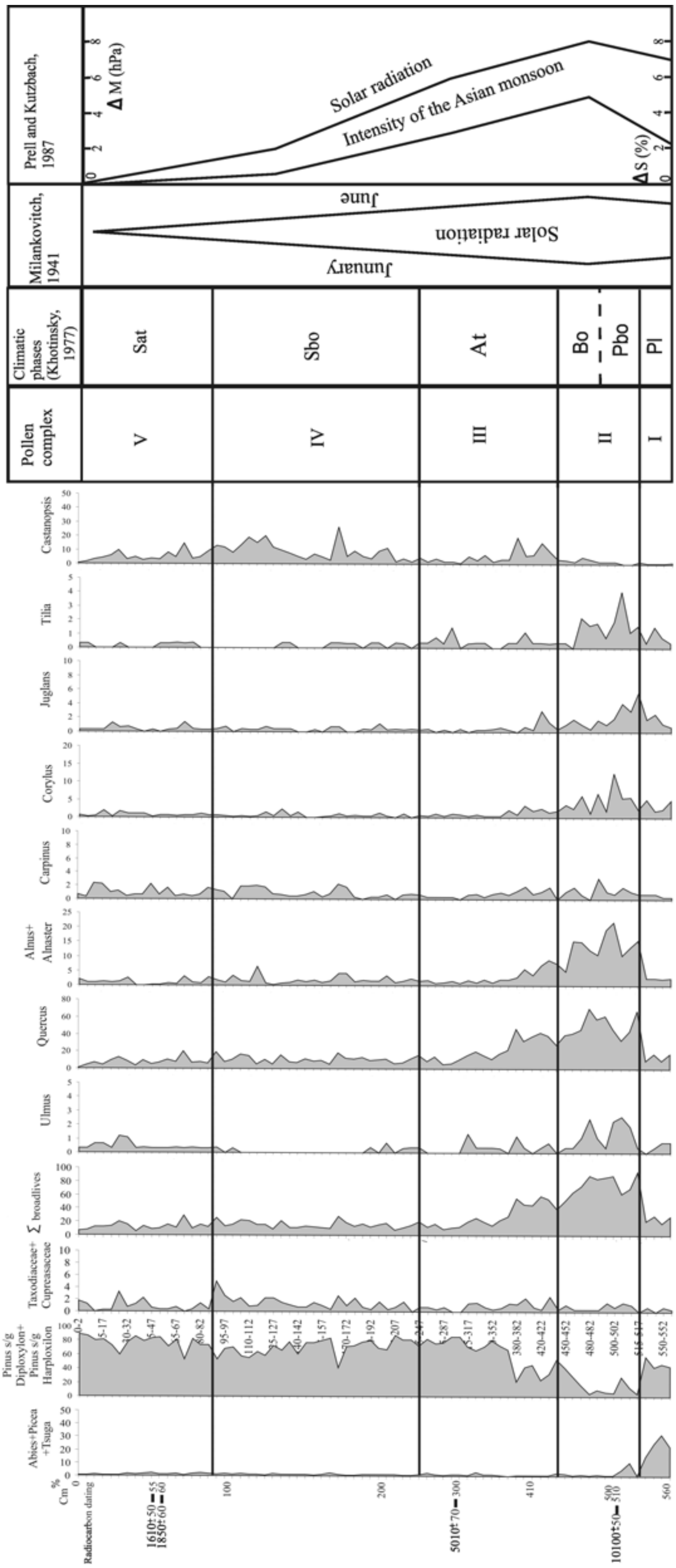

Fig.1. The pollen diagrams of core J-3, changes of solar radiation and intensity of the Asian monsoon.

Palynological data indicate that Holocene climatic optimum should be counted an interval corresponding to Atlantic and Subboreal phases. That time the evergreen broadleaved forests, formed mainly by *Castanopsis*, occupied the surrounding land. The climate became softer and winters were warmer. More uniform receipt of solar radiation on seasons leads to decrease in the annual amplitude of temperatures: July temperatures were a little reduced, and those of January – increased (Milankovitch, 1941; Prell, Kutzbach, 1987).

After 2,5 ka the area of evergreen broadleaved forests reduced. The climate became colder and drier.

The palynological records are correlated with the results of radiocarbon dating (Gorbarenko, Southon, 2000) and also researches of Japanese (Yasuda, 1978; Tsukada, 1986, 1988), Korean (Kong, 1994) and Russian (Verkhovskaya at.al., 1992) palynologists.

The study was supported by grants of the Presidium of RAS and FEB RAS (№№ 05-1-P12-022 and 05-1-P25-078).

THE FEATURE OF THE SUBFOSSIL POLLEN COMPLEXES FROM ALLUVIAL SEDIMENTS AND ITS COMPARISON WITH THE VEGETABLE ASSOSIATIONS OF KUNASHIR ISLAND (KURIL ISLANDS)

Mokhova L.M.

Pacific Institute of Geography FEB RAS, Vladivostok

Study of pollen complexes is one of the important methods of paleogeographic analyses for the reconstruction of main paleolandscapes. For correct interpretation of the pollen complexes for paleoclimatic and paleolandscape reconstructions from Quaternary deposits, it is necessary to study the correspondence of the subfossil pollen complexes to the modern vegetation. Such studies were carried out on Kunashir Island.

Kunashir Island consists of four unequal territory parts, connected by lowland necks. Mountain relief, drainage system, flowing into the Pacific ocean and Okhotsk Sea, determine large variety of ecotopes by microclimatic conditions. The western coast, protected especially in summer from the dominant winds from the Pacific, has more favorable conditions by comparison to a lower neck on the eastern coast.

By discussion of main the components of the pollen complexes (PC) it is obvious that they have well marked forest characteristic. Here, the arboreal pollen dominates (50-80%). And also the PC are found with the dominant herboreal plants, ferns and lycopodiums (52-79%). It is typical for the PC, received from the swamp lowland surfaces with numerous shallow pools, covered by forb meadows and shrubs with ferns and lycopodiums, and also hydrophytes (*Potamogeton, Typha* etc.).

In the PC, received from the Okhotsk Sea area, the vegetation is formed by the boreal and nemoral species with the dominant of the *Quercus dentata, Quercus crispula, Ulmus japonica, Acer may*rii and sharing of the *Betula ermanii, Abies sachalinensis, Picea jezoensis, P. glehnii* etc.

The arboreal pollen (52-71%) is presented by the *Abies* (20-56%), *Alnus* (24-51%), *Betula* (8-17%). The *Pinus s/g Haploxylon* is found single. 4-9% are fitted to the share of the broad-leaves species. Near the oak plantations the *Quercus* pollen makes 28- 40%, *Ulmus* – 2-5%, *Phellodendron* – 2-17%. The pollen of the *Aralia, Tilia, Syringa, Euonymus* and *Viburnum* is presented single. The herboreal pollen and spores is 11-30%.

The herboreal pollen and spores dominate (60-70%) in the PC, received from the Pacific areaof the island, where forb meadows, bamboo (*Sasa*) and shrubs are spread. The arboreal pollen is presented by *Abies* (25-30%), *Picea sect. Omorica* (10-11%), *P. sect. Eupicea* (3-10%) and *Pinus s/g Haploxylon* (7-9%). The small-leaved pollen consists of the *Betula* (до 17%), *Alnus* and *Alnaster* (up to 7%), *Myrica* (up to11%), *Salix* (23-34%). Among the broad-leaved pollen the *Quercus* (9-15%) dominates, *Phellodendron*, *Juglans, Tilia* and *Ulmus* pollen is found single. The PC reflects both local and vegetation of the Golovnin volcano foot. Here the next formations are marked out – cereal- forb, birch-oak, birch-alder with Manchurian walnut and basswood impregnations.

The PC, received from the alluvial sediments of Sernovodsky neck, the most part of which is swamped and covered by the meadow forb with the fir-abies-birch associations, are poor both in pollen quantity and in species content. The arboreal pollen is 50%. The *Abies* (up to 37%), *Picea sect. Eupiceae* (up to 28%) and *Picea sect. Omorica* (up to 25%) pollen prevails, and *Pinus s/g Haploxylon* is up to 6%. The small-leaved pollen is presented single, and the broad-leaved pollen is absent. The herboreal pollen is about 24%, spores – 26%.

The next samples were collected from a dark-coniferous zone with the small areas of the broad-leaved forests (*Quercus crispula*, *Phellodendron sachalinence, ulmus japonica, Acer*), *Salix hultenii* massif, *Ledum* etc. The feature of the PC is small presence of the herboreal pollen (4-18%) and large value of spore (42-47%). The arboreal pollen is from 40 up to 52%. The dark-coniferous pollen dominates (46-60%). The broad-leaved pollen is presented by single seeds of the *Quercus, Phellodendron* and *Rhus.* The PC adequately reflect both the local vegetation and that of one of the around territories.

The next group of the pollen samples is collected from the Pacific area of the Southern Kuril neck. Here, the meadow and swamp vegetable associations and birch-fir-abies forests are spread on the Mendeleev Volcano slopes. In the PC composition the herboreal pollen dominate (up to 65%). The arboreal pollen is 35%. In this group the dark-coniferous pollen prevails (*Picea sect. Omorica* – 25%, *Abies* – 17%, *Picea sect. Eupicea* – 2,4%, *Pinus s/g Haploxylon* – 2%), also *Pinus s/g Diploxylon* and *Cypressaceae* pollen is found. The small-leaved species are presented by the *Betula* (21%), *Alnus* (5%), *Alnaster* (3%) and *Myrica* (1%) pollen, etc. Among the broad-leaved species the *Quercus* (5%) and *Ulmus* (2%) pollen prevails. The herbs are presented by various species, including the hydrophyte pollen.

The next group of the PC was received from the sediments of the Kunashir northern part. There, dark-coniferous forest with *Abies sachalinense,* abundance of the *Hydrangea, Toxicodendron, Actinidia* ect. are located. One of the background plants is bamboo (*Sasa*). The highly herbal associations are typical for river coasts. The PC has the good marked forest type. The arboreal pollen quota forms 55-72%, herbal - 3-22%, spore - 3-33%. Among the arboreal pollen the dark-coniferous one dominates (50-60%). Among the small-leaved-birch, alder, willow, waxberry is found. The broad-leaved pollen is presented by 2-6% (*Omorica, Ulmus* etc.). The forb pollen is presented in small quantities.

The comparable analyses of the vegetation composition of the Kunashir Island and subfossil pollen complexes (PC) allow us to do the following conclusions.

In the PC, received from the alluvial sediments of various vegetable formations, in the main the autochthonous pollen prevails. The PC composition in most cases corresponds both to the local one and to the around territory vegetation. At that time, the pollen of many nemoral species, participating in forming of the vegetable associations, is not presented because of poor pollen productivity.

The correlation of the pollen and spore groups in some PC confirms the dominating role of the coniferous vegetation in the forest associations, but often the *Picea sect. Eupiceae* pollen content is reduced by comparison with its participation in the planting of trees. The same can be noted for *Betula sect. Costatae* pollen. The cedar pollen is found single and rarely in spite of considerable spreading in some vegetable formations.

Pollen entrance from the neighbour territories (*Cryptomeria, Carpinus, Corylus* etc.) at the expense of active wind transferring essentially does not change the PC structure.

INFLUENCE OF TECTONIC EVENTS ON ENSO AND MONSOON IN A COUPLED OCEAN-ATMOSPHERE GCM

Motoi Tatsuo and Kitoh Akio

Meteorological Research Institute, Japan

The uplift of the Himalaya and Tibetan Plateau (HTP) and the closing ofthe Indonesian Seaway (IS) are considered to have induced reorganizations of ocean and atmosphere general circulations and climate changes. In the present study the effects of these tectonic events on El Nino and the Southern Oscillation (ENSO) and on monsoon are examined by a series of experiments with a coupled ocean-atmosphere GCM.

Movement of precipitation area to inland of the Asian continent in the summer with the uplift of HTP is found. The southwesterly monsoon flow from the Indian Ocean becomes strong by the uplift. The transported moisture by the flow reaches to the East Asia and forms the baiu rainband. The closing of IS prevents the exchange of water between the Pacific and the Indian and causes the redistribution of sea surface temperatures (SST) with ENSO modulation.

POSSIBLE VARIATIONS IN ASIAN SUMMER MONSOON, ASIAN WINTER MONSOON, AND WESTERLY IN ASSOCIATION WITH SUMMER INSOLATION AND DANSGAARD-OESCHGER CYCLES

Nagashima Kana*, Tada Ryuji*, Tani Atsushi, Sun Youbin*, Isozaki Yuko*, and Toyoda Shin*****

**Department of Earth and Planetary Science, Graduate School of Science, University of Tokyo, 7-3-1 Hongo, Tokyo 113-0033, Japan*
***Department of Earth and Space Science, Graduate School of Science, Osaka University, 1-1 Machikaneyama, Osaka 560-0043, Japan*
****Department of Applied Physics, Faculty of Science, Okayama University of Science, 1-1 Ridai, Okayama 700-0005, Japan*

The region under the influence of Asian monsoon system covers a large area from the low latitude tropics to the high latitude Eurasian continent, and Asian monsoon is believed to exert significant influence on the global climate (An, 2000). Moreover, millennial-scale variations in Asian monsoon and its possible association with Dansgaard-Oeschger (D-O) Cycles have been demonstrated by previous studies (Porter and An, 1995; Tada et al., 1995, 1999; Irino and Tada, 2000; Wang et al., 2001). These studies demonstrate that Asian monsoon system plays a significant role on the millennial-scale abrupt climate changes. Thus, it is critical to reconstruct spatial patterns of the millennial-scale variation in the Asian monsoon in order to understand the role of atmospheric circulation on propagation of D-O Cycles.

Millennial-scale variations in Asian monsoon and its probable association with Dansgaard-Oeschger (D-O) Cycles have been demonstrated by previous studies (Porter and An, 1995; Tada et al., 1995, 1999; Irino and Tada, 2000; Wang et al., 2001). These studies demonstrate that Asian monsoon system plays a significant role on the millennial-scale abrupt climate changes. However, the origin and nature of the millennial-scale variations in Asian monsoon are poorly understood. In order to understand the nature of millennial-scale variability of Asian monsoon and its linkage with the D-O Cycles, it is critical to reconstruct spatial pattern of the millennial-scale variability of the Asian monsoon.

In the Japan Sea, continuous eolian dust accumulation during the last 200 kyr is revealed by Q-mode factor analysis and multiple-regression analysis of chemical and mineral compositions of the Japan Sea sediment (Irino and Tada, 2000, 2002). Since grain size of eolian dust is considered to record the information about the intensity of dust transport wind and distance from the source area whereas the flux of eolian dust is considered to record the extent of dust source area, sedimentary record of the Japan Sea provides the opportunity to explore temporal and spatial variations of Asian monsoon.

In this study, we first examine the provenance of detrital quartz in the sediment cores recovered from northern (KT94-15-5; 40°09'36"N, 138°12'05"E) and southern (MD01-2407; 37°04'06"N, 134°42'00"E) sites in the Japan Sea based on quartz crystallinity and ESR (Electron Spin Resonance) signal intensity. From the results, the method to extract the information on eolian dust from the sediment is developed, and Western desert in China and Siberia to Northeast China area are identified as the provenance of eolian dust in the Japan Sea sediment. Then, temporal changes in the grain size and flux of eolian dust in the Japan Sea sediment and their latitudinal changes are obtained from the northern and southern sites in the Japan Sea.

The temporal and spatial variations in provenance, grain size, and flux of eolian dust in the Japan Sea indicate orbital to millennial-scale variations. Namely, the grain size and flux of eolian dust is large with larger size at northern site than southern site, and Siberia to Northeast China area is the dominance source of eolian dust during the periods of smaller insolation at 30°N in June and stadials of D-O Cycles. Whereas the grain size and flux of eolian dust is small and Western desert in China is the dominance source of eolian dust during the periods of larger insolation at 30°N in June and interstadials of D-O Cycles. These orbital to millennial-scale variations reflect expansion (shrinkage) of dried area or increased (decreased) wind intensity around Western desert in China and shrinkage (expansion) of dried area or decreased (increased) wind intensity around Siberia to Northeast China area during the periods of larger (smaller) insolation at 30°N in June and interstadials (stadials), which probably indicate northward (southward) shift of westerly jet axis, and northward (southward) shift of Asian summer monsoon limit or decreased (increased) wind intensity of Asian winter monsoon.

VARIATION OF BIOGENIC FRACTION IN SEDIMENT OF THE EAST SEA: PALEOCEANOGRAPHIC IMPLICATION

Park Yu-Hyeon, Hyun Sangmin

Korea Ocean Research and Development Institute (KORDI)

Sediments of seven piston cores from the East Sea (Japan Sea) ware analyzed to tracking evolution of paleoceanographic and paleoclimatic changes. The variation of organic carbon shows distinctive pattern between the last glacial maximum (LGM) and the Holocene. Carbonate contents are similar to those for organic carbon and also serve to distinguished pattern in Holocene from LGM sediment. Carbonate contents are significantly higher during the glacial interval in several core sediment samples exhibit a striking contrast with constant Holocene. The variations of biogenic fractions occurred between the LGM and the Holocene are related with the productivity changes, preservation, and supply changes from neighboring continent. The C/N ratio of organic matter is higher than 10 in glacial interval in several core sediments, indicating a terrigenous supply of organic carbon is responsible for the increase of biogenic fraction during the glacial period. Increased carbonate content during the glacial period is thought to relate with increase preservation, as known to previous works, however, its variation is, at least, connected with productivity changes during glacial period. Biogenic opal content also shows typical Holocene and LGM variation. Therefore, biogenic fractions (organic carbon, carbonate and biogenic opal) clearly related productivity changes. Provably local oceanographic condition was triggered these rather specific variations in biogenic fractions. Global climatic changes in terms of glacial-interglacial time scale also promote the variation of biorgnic fraction of the East Sea.

GLOBAL - REGIONAL LINKAGES OF CLIMATE VARIABILITY IN THE ASIAN PACIFIC

Ponomarev V., Saveliava N., Rudykh N, Dmitrieva E, Kaplunenko D, Plotnikov V, Salomatin A.

V.I.Il'ichev Pacific Oceanological Institute FEB RAS, Vladivostok, Russia

The major patterns of the climatic oscillations and trends in the monthly mean surface air temperature, precipitation, and river discharge in the Northeast Asia and Alaska Peninsula, as well as, in the sea surface temperature (SST) of the Northwest Pacific and ice extend in its marginal seas are revealed from the observational records. The methods of linear trend estimation, EOF decomposition and wavelet analyses are applied to reveal major patterns of the different scale climate variability in the studied area. Patterns, seasonality, and regional linkages of linear trend and dominating oscillations associated with high positive or negative anomalies, its relation to the global scale anomalies are demonstrated. It is shown that the semi-centennial summer cooling during the second half of the 20th century in some offshore continental areas of Asia accompanies the semi-centennial negative SST anomaly dominating during summer in the western subarctic pacific gyre. At the same time, the winter warming in the continental and marginal area of the North East Asia and Alaska Peninsula accompanies the positive SST trend predominating in the Kuroshio and Aleutian current systems in winter.

Wavelet transforms show the evolution of frequency, amplitude and phase of the climate oscillation of the ENSO (3–7 years), decadal (8–13), and interdecadal (18–30 years) time scales. The bi-decadal (18–26 years) oscillation both in the air temperature and precipitation is indeed most evident in the subarctic marginal Northwest Pacific zone, particularly, in the Kamchatka Peninsula and Okhotsk Sea area. The decadal scale (8–13 years) oscillations are most evident in the arctic marginal zone including the western Bering Sea all the year round, as well as over land in the latitude band of Kuroshio-Oyashio Extension area mainly in months of the cold period of a year. Due to the nonlinear dynamics in the ocean-atmosphere system the frequency of the prevailing variability in the joint decadal-interdecadal band is drifting from the decadal to interdecadal scale or from the interdecadal to decadal scale within the observational records. The period of interdecadal variability in some large scale areas shifts to the red spectrum and comes to about 30–40 years band. The long-term oscillations with a period of 50–60 years (Minobe 1997) is also typical for the Chukotka Peninsula where the winter anomalies of this scale both in the air temperature and precipitation have an opposite sign in comparison with the summer one. It is also related to the estimation of the negative winter air temperature trend and the positive summer air temperature trend in this area for the latter half of the 20th century. Similar to that, a frequency of the dominating oscillations in the air temperature, precipitation, and SST can drift in some areas from ENSO to decadal scale and back. The ENSO scale variability with a period of about 3–7 years in the air temperature, precipitation, and sea surface temperature is one of the prevailing oscillations both in subtropic and subarctic regions of the Northwest Pacific, its marginal seas, and adjacent land area of the Northeast Asia. The general feature of the unlagged linkage between the Northwestern Asian Pacific and ENSO is that the winter El Niño accompanies the warming in the subtropic ocean/land area, and the cooling in the subarctic one during winter. In the summer following the winter El Nino the cooling is typical both for the subtropic and subarctic ocean/land marginal area. The alternating patterns and seasonality of positive and negative temperature anomalies of ENSO time scale in the Northwest Pacific Region are similar to patterns and seasonality of the semi-centennial climatic trend in the Northwest Pacific SST. It seems to be that it is due to interdecadal variability of ENSO and asymmetry of ENSO cycle with prevailing El Nino during last decades. The correspondent Northeast Asian Monsoon system interdecadal variability and semi- centennial change are presented.

BENTHIC FORAMINIFERA AS INDICATOR OF THE FAST LATE QUATERNARY CLIMATIC CHANGES IN THE OKHOTSK SEA (CORE LV 28-40-5)

Psheneva O.J.*, Ivanova, Ye.D., Gorbarenko, S.A.***

** V.I.Il'ichev Pacific Oceanological Institute FEB RAS, Vladivostok, Russia*
***Pacific Institute of Geography FEB RAS, Vladivostok, Russia*

The study of the deep-sea benthic foraminifera has contributed significantly to our understanding of the past oceanic and climatic conditions. They provide valuable information on the physical and chemical characteristics of the ocean-floor environment. The use of benthic foraminifera as palaeoceanographic and palaeclimatic proxies essentially is the study of the patterns of distribution, abundance, species composition and structure of the fossil assemblage.

The sediment samples for the foraminifera analyses were taken from deep-sea cores LV28-40 (51˚20′04″N, 147˚10′631″E; length 799.5 cm; depth 1312m) locating in the basis of a continental slope of the central part of east Sakhalin, in the region washed by the East Sakhalin Stream. The samples were taken at each 2-3 cm interval and washed in an 0.063 mm sieve. The stratigraphy and the age of sediments in these cores were based on oxygen-isotope records, AMS ^{14}C dating, magnetic susceptibility and tephrachronology. The benthic foraminifera data were compared with the data on the content of carbonate and organic carbon, opal, ice rafted debris (IRD), and the results of diatom analysis for this core.

As a result, 4-1 and upper part of 5a isotope stages (MIS) and melt water pulses 1A and 1B separated by Younger Dryas cooling were marked out in the core and changes of the benthic foraminifera complexes were identified for every age interval.

The upper layers of substage 5a are represented by individual shells.

Deposits, which were formed during the MIS 4-2, are characterized by non-homogeneous low species type of complexes, and low total number shells. The opportune species *Alabamminella weddellensis* and *Uvigerina auberiana* are the dominant species. They characterize a comparatively high level of dissolved oxygen along with seasonal input of phytodetritus to the sea bottom. The number changes of these species are due to changes of warm and cold stadial on the background of general cooling climatic trend. The subsequent comparison of our data with data for global climatic events, known as Dansgaard–Oeschger cycles (including warm interstadials and coold stadials - Heinrich events), are recorded in the Greenland ice core records, will allow us to conclude about possibility of their correlations.

Significant change in the benthic foraminifera complexes is observed in sediments formed during the 1B (interval 225-200 cm) and 1A (266-240 cm) terminations. On the background of a sharp rise of organic carbon content and ice drift particles, an increase of species diversity and abundance is noted. A high frequency of such species as *Valvulineria ochotica, Uvigerina peregrina*, and *Cassidulina laevigata*, and representatives of the genus Brizalina, along with a simultaneous decline of *Alabaminella weddellensis* and *Uvigerina auberiana*, is observed. This kind of change in the structure of benthic foraminifera characterize conditions of a sharp increase in bioproductivity in connection with an increase of spring and summer seasons on the background of general warming. The Younger Dryas deposits are characterized by a decrease of quantitative parameters in the foraminiferal complexes. The Holocene complexes of microfauna reflect conditions of stable input of organic material. However, the total number of foraminifera shells is lower than during the deglaciation.

GEOCHEMISTRY OF A SEABED CORE SAMPLE OFF ORISSA COAST, BAY OF BENGAL AND ITS CLIMATIC IMPACT ON MARGINAL SEAS OF INDIAN TERRITORY DURING CENOZOIC

Purkait Barendra

Environmental Geology Division, Eastern Region, Geological Survey of India, Block-DK-6, Sector-II, Salt lake, Kolkata-700091, India, e-mail: baren_purkait@yahoo.co.in

The monsoon system is a thermodynamic atmospheric circulation characterized by strong seasonality of wind direction, temperature and precipitation. The Asian monsoon comprises the southwest (Indian) monsoon and the southeast (east Asian) monsoon. The former is the major source of precipitation over the Indian subcontinent and the western part of southeast Asia, and the latter has a dominant influence over the eastern part of southeast Asia and east Asia.

The paper uses an integrated approach of sedimentological, mineralogical, geochemical, palaeontological and geochronological studies of a vibro-core seabed sample of 4.626 m length at a water depth of 13.2 m off Orissa coast of Bay of Bengal, Eastern India, to reconstruct the palaeo-climatic conditions of the Indian subcontinent at the sea margin during late Cenozoic. The sample was collected during the Geological Survey of India cruise ST-138 on board R.V. Samudra Kaustabh. The core sample studied is mainly of medium to very fine sand with clay admixture and shell fragments.

A total of 16 sub-samples at an interval of 20 cm and core width of 5 cm out of the total core length, were prepared and numbered serially as 1, 2, 3, ….16 from top to bottom of the core for detailed study.

Results of sedimentological study indicate that there are two distinct regimes of depositional sedimentary environments. The upper part of the core upto a depth of ~1.50m (sub-sample no.6), sediments are unimodally distributed, very fine sandy silt (mean size= 4.328φ, 0.05mm), very well sorted (sorting=1.572φ, 0.336mm), with positive skewness (skewness=0.349) indicative of preponderance of tails of finer sediments. The sediments are leptokutic distributed (kurtosis = 1.2) indicative of a relatively high energy of deposition. Sediments of the lower part of the core of > 1.5m depth (sub-sample nos 8 to 16), are bimodally distributed indicating different provenances. Sediments are of fine sands (mean size = 3.395 φ, 0.095mm), also very well sorted (sorting =2.697 φ, 0.154mm) but better sorted than the upper part, and negatively skewed (skewness = - 0.231) indicating preponderance of tails of coarser sediments. The sediments are platykurtic distributed (kurtosis=0.830) indicating a relatively low energy of deposition.

Results of chemical analyses indicate that there is a gradual increase of Ca % upto almost the middle of the core with a proliferation of Ca % (maximum 7.47 %) at the core depth of ~ 2.40 m but the value of Ca % decreases down depth with the decrease of Sr value. From the core depth of ~ 1.50 m and shallower, there is almost a constant presence of Rb (~50 ppm) but with the increase of depth from ~ 1.5m, the Rb decreases with a general decrease of Sr (from > 3.20 m depth) and Ca (from > 2.40m depth). The elemental analyses indicate that Al is positively correlated with Mn, Ti, Mg and Fe indicating their terrigenous source whereas Al and Ca are negatively correlated indicating the authigenic nature of Ca.

Results of XRD from the relative abundance of minerals indicate the presence of kaolinite (small amount) with Illite as trace amount reflecting the climatic variation from the humid (in the upper ~1.20m of the core length) to a relatively arid climate below (>1.50m of core length) where the trace amount of Illite was observed. A considerable amount of epsomite was also noted followed by aragonite in the upper part (~1m) of the core. Presence of evaporite group of minerals like epsomite indicates prevalence of arid to semi-arid climatic condition at the time of deposition. It appears that the formation of epsomite demarcates a regressive phase of the coastline. Late Pleistocene – Early Holocene aridity (12.5 to 10 Ky BP) appears to be the cause of the formation of epsomite. Intermittent occurrence of carbonates (calcite and dolomite) throughout the core from top to bottom, suggests intermixing of fresh water conditions with brine rich in HCO3, pointing to the short-term transgression and regression of the shoreline frequently, with fluctuation in brine concentration and composition.

The microfaunal assemblages indicate a shallow basinal condition of brackish, lagoon to less than 30m depth where the temperature is 150 to 330 C (tropical to sub-tropical regions), salinity brackish to normal. The presence of small fragile spines of some of the foraminifer species indicates that they live in water where the wave action and bottom agitation are not strong enough. Hence, they live on calm water. They are near shore species, since their complete tests and slender spines are preserved. Thus, the faunal assemblages throw light on the surrounding climatic condition of this region.

Results of geochronological studies indicate that the ratios of 87Sr/86Sr for two sub-samples vary from 0.7092267 to 0.7092210. The results are very much comparable with the present day seawater radiogenic strontium content.

LAST GLACIAL MAXIMUM LANDBRIDGE DISAPPEARANCE AND THE LANDSCAPE EVOLUTION ON SOUTH KURILES

Razjigaeva N.G.*, Ganzey L.A.*, Belyanina N.I.*, Grebennikova T.A.*, Mokhova L.M.*, Ganzey K.S.**

**Pacific Institute of Geography FEB RAS, Vladivostok, Russia*
***Far East State University, Vladivostok, Russia*

Islands of the Minor Kuril Arc, a relict of the extensive Last Glacial Maximum landbridge are of interest from the point of view of vegetative zones migration on the background reduction of the area during the Late Pleistocene-Holocene climatic changes. The basic objects on Zeleniy, Yury, Shukotan Islands were peatbogs and soil profiles (pollen, diatoms, ^{14}C-dating, tephrastratigraphy). The peat of small islands is spread by volcanogenic clay, which is waterproof horizon. Pollen assemblages from the clay reflect the development of tundra landscapes and conditions of the cold dry climate of the Last Glacial Maximum (pollen zones *Betula exilis-Ericales*; *Betula exilis-Alnaster-Larix-Pinus pumila*). At that time, permafrost was wide spread, traces of which are well expressed by cryogenic structures (wedges, involutions). At this time larch forests occupied Nemura Peninsula (pollen zones HB-1 *Larix-Picea* and HB-2 *Larix*) (Igarashi et al., 2001). Apparently, similar vegetation could exist on Shikotan Island with the mountain relief. Pollen spectra with high amount of shrub birch pollen were found on Kunashir Island. Active destruction of the landbridge began during the Late Pleistocene-Holocene transgression. Shikotan Island separated from the land before the beginning of Holocene, because the depths of the Shpanberg Strait are about 50 m, and the further biotic component development occurred due to the transformation of the flora inherited from the glacial age, and to a lesser degree due to settling from surrounding islands. Active swamping of small islands began at Eearly Holocene (^{14}C-date 8870±110 PB, GIN-12550). The factors of swamping were progressing warming, increase of humidity, flat relief and the presence of water-emphasis clay. Active tectonic submersion promoted swamping of the island coasts too. Pollen assemblages reflect the development of the fir-larch open forest (pollen zone *Picea-Larix-Ericales-Sphagnum*). Larch and dark-coniferous forests with *Picea glehnii* occupied Nemuro Peninsula at the Holocene beginning (pollen zone HB-3 *Larix-Picea*, HB-4 *Picea-Abies*). On Kunashir Island birch forests were wide spread in the southern area before 7000 BP. Isolation of Kunashir and small islands began in Middle Holocene. Rare forests with *Picea glehnii* with participation of *Abies* and *Ulmus* (pollen zone *Picea-Abies-Polypodiaceae*), probably, existed on small islands. At that time, their paleosol was formed (^{14}C-date 6130±130 BP, GIN-12558). In the second half of Middle Holocene (^{14}C-date

5150±100 BP, GIN-12548) when the islands area decreased, vegetative communities from *Picea glehnii* quickly degraded under the ocean influence (strong winds and fogs). Pollen spectra reflect bog-meadow vegetation (pollen zone *Gramineae-Compositae-Polypodiaceae*). Probably, tree pollen were brought from the East Hokkaido coast where fir forests (pollen zone HB-6 *Picea*) were replaced by oak forests about 5000 BP (pollen zone HB-7 *Quercus*). All sites include a volcanic ash layer with low K_2O, which is correlated to the Hokkaido marker ash Ma-f. Nemoral forests occupied most part of Kunashir. On small islands pollen spectra with *Myrica tomentosa* predominance indicate increase of oceanic influence at Subboreal (pollen zone *Myrica-Polypodiaceae,* ^{14}C-date 2970±60 BP, GIN-12547). Late Holocene pollen assemblages reflect the climate similar to the modern one (pollen zones *Myrica-Gramineae-Compositae; Myrica tomentosa-Betula sp.-Compositae.*). Some volcanic ash layers were met in the sites, which are correlated to Ta-c, B-Tm, Ko-c2, widespread on the East Hokkaido. Pollen zone of *Betula-Quercus* (HB-8) with abundance of *Myrica tomentosa* pollen was distinguished for the last 700-800 years on Nemuro. Thus, a factor of isolation had a great role in the development of the Minor Kurile Arc landscapes during the time of destruction of the Last Glacial Maximum landbridge during fast transgression. The size of the island land and relief features influenced the landscape development too. Degradation of the land area led to the break of the vegetation zones borders, microclimatic and hydrological conditions, etc. Apparently, isolation of Shikotan Island at the Latest Pleistocene can explain the absence of the oak forests widely distributed in the south of Kunashir and East Hokkaido where they appeared in Middle Holocene. If oak forests were on Shikotan in Middle Holocene their appearance can be explained only by settlement from the adjacent islands. The *Pinus pumila*, sensitive to air dryness, probably, was replaced here by *Juniperus sargentii* and *J. sibirica* in conditions of the Last Glacial Maximum dry climate, it is absent now on Shikotan. Larch forest on a southeast coast, apparently, is a relict of the landscapes of the Last Glacial epoch. On Hokkaido the larch disappeared about 6000 BP (Igarashi et al., 2002). Low flat relief, active swamping and cooling influence of the ocean prevented the development of forest vegetation on small islands in the south of the Arc. Late Holocene and modern pollen spectra of Zeleniy Island include allochtonous tree pollen due to the wind input from the adjacent islands (*Abies*, *Picea*, *Pinus* s/g *Diploxylon*, *Cryptomeria*, *Betula*, *Quercus, Ulmus*, *Juglans*, *Tilia*). May be this fact indicates to the change of the atmospheric circulation in this part of the ocean since Late Holocene. *RFBR grants 03-05-65229, 05-05-64063.*

LONG -TERM VARIABILITY OF SEVERAL HYDROLOGICAL CHARACTERISTICS IN THE NORTHWEST SEA OF JAPAN

Rudykh N.I., Ponomarev V.I.

V.I.Il'ichev Pacific Oceanological Institute FEB RAS, Vladivostok, Russia

Instrumental investigation in the Sea of Japan began from the end of 19 century. Pacific Oceanological Institute database consist of about 300,000 checked oceanographic data on this region. [1]

Considered are variability of temperature, salinity and dissolved oxygen in the North-Western part of the Sea of Japan chosen from this database. Also meteorological data (air temperature, precipitation and atmospheric circulations in the Sea of Japan region) and their comparison with hydrological data (water temperature, salinity) are analyzed.

Some common features of variability in hydrological and meteorological characteristics are found.

During the second half of 20 century there is a growth of temperature of water, the layer of minimum of the dissolved oxygen falls, its maintenance in deep waters of the sea decreases.

In interannual fluctuations of salinity the periodic component is allocated into 6-8 years as into 2 years. Negative unlagged relationship between summer PDO and air temperature/ precipitation/ salinity anomalies are typical for the Northwest Sea of Japan area. [2]

Warming in proper water of the Sea of Japan is prevailing in 90s. Precipitation a little bit decreases. Vertical stratification and stability increase. [3]

REFERENCES

1. Dmitrieva E.V., Rudykh N.I. Realization and development of the oceanographic data base for the Sea of Japan// *6-th IOC/WESTPAC International Scientific Symposium Challenges for Marine Science in the Western Pacific, 19-23 April 2004, Hangzhou, China. Abstract Volume*

2. Ponomarev V.I., Krokhin V.V., Kaplunenko D.D., Salomatin A.S. Multiscale climate variability in the Asian Pacific. *J. Pacific Oceanography, vol. 1, № 2, p. 125-137. Vladivostok: , 2004.*

3. Grigoryeva N., Ponomarev. Seasonal and interannual variability of the sea water temperature near the Tuman River estuary // *Proc. APN Workshop, Nankin, China 2004, 6 p.*

MILLENNIAL-SCALE VARIATIONS OF SEA-ICE EXPANSION AND ITS RELATION TO OKHOTSK SEA INTERMEDIATE WATER FORMATION IN SOUTHWESTERN PART OF THE OKHOTSK SEA DURING 120 KYR

Sakamoto T.*, Harada N., Ikehara M.***,. Kanamatsu T.*,. Uchida M.**, Aoki K.****, Iijima K.*, Sakai H.*****, Shibata Y.******, Takahashi K.*******, Toyofuku T.*,. Katsuki K.*******, Okazaki K.********, Asahi H.***, and Kawahata H.******

**Institute for the Research on Earth Evolution(IFREE), Japan Agency for Marine-Earth Science and Technology (JAMSTEC),*
***Institute of Observational Research for Global Change, JAMSTEC,*
****Kochi Univ.,*
*****National Institute of Advanced Industrial Science and Technology,*
******Toyama Univ.,*
*******NIES-TERRA AMS Facility, National Inst. for Environmental Studies,*
********Kyusyu Univ.*
*********Ocean Research Institute, Tokyo Univ.*

Sea ice coverage in the Okhotsk Sea is sensitively affected by fresh water discharge from the Amur River, cold winter regime under the Aleutian Low, and global climate change. The sea ice formation in the Okhotsk Sea has a great impact for Okhotsk Sea Intermediate Water (OSIW) formation through cold Dense Shelf Water (DSF), which is originated as dense brine rejection during sea ice formation and is one of major components for OSIW. The fluctuation of ice-rafted debris (IRD) in a 58-m long sediment core IMAGES MD01-2412, recovered at the southwestern part of the Okhotsk Sea, was investigated in order to reconstruct sea ice history and to reveal its relation to the OSIW formation during 120 kyrs, Obvious stretching effect by giant piston coring was observed only in the top part of 4 m of the core by anisotropy of magnetic susceptibility and physical properties measurement. Age model of the core was obtained by AMS ^{14}C dating of planktonic foraminifer shells, oxygen isotope stratigraphy for benthic foraminifer calcite, and tephra chronology, resulting 115 kyrs of the core bottom age. Millennial scale rapid warm and cold shifts in the core were identified in an alkenone-derived sea surface temperature record with GISP2 oxygen isotope data. Sea ice expansion in the Okhotsk Sea was reconstructed by measurement of sand fraction IRD of terrigenous particles, dropstone, and magnetic susceptibility. Seasonal sea ice fluctuated abruptly with large amplitude during the glacial but with relatively small variation during the Holocene and the last interglacial. The millennial scale sea-ice expansion occurred at the timing of cold spikes of alkenone SST. It implied that autumn cold alkenone SST by reduced Amur River discharge (warm and fresh) in cold stadial periods resulted in huge expansion of sea ice coverage in the Okhotsk Sea. The millennial scale sea-ice variation was also correlated with the Polar Circulation Index (PCI) of GISP2 ice core that is a relative measure of the average size and intensity of polar atmospheric circulation. The enhanced polar atmospheric circulation during stadial regime have accelerated the large sea ice expansion in millennial time scale during the glacial (MIS 2, 3, and 4) coupled with the reduced Amur discharge. Therefore two main factors of enhanced polar atmospheric circulation and reduced Amur discharge would influence sea ice expansion at stadials. On the other hand, during the interglacial (MIS 1 and 5) when the polar circulation has not been intensified, sea ice also expanded in small amplitude in cold SST condition. At that time, weak Amur River discharge should have been dominant for sea ice formation. The founding the millennial scale sea ice expansion in the NPIW source region is as important evidence for the changes of the NPIW expansion. Vast sea ice expansion during cold stadials could precede the DSW formation resulting in increases of the OSIW formation and in the NPIW expansion during cold intervals.

HOW OLD IS THE ASIAN MONSOON SYSTEM ? PALAEOBOTANICAL CONSTRAINTS FROM CHINA

Sun Xiangjun*, and WANG Pinxian***

**Laboratory of Marine Geology, Tongji University, Shanghai 200092, China,*
***Institute of Botany, Chinese Academy of Sciences, Beijing 100093, China*

The recent discovery of monsoon records in early Miocene (e.g., Guo et al., 2002; Jia et al., 2003) raised a question of the time when the East Asian monsoon system initiated. A distinguishing feature of the modern monsoon system is its geographic distribution which disturbs the zonal pattern of indigenous to the planetary climate system, and the appearance of the monsoonal climate pattern in the geological records should signify the onset of the monsoon system.

Here we present the results of a compilation of palaeobotanical and lithological data from 125 sites over China, that has revealed two completely different patterns of climate zones: the Palaeogene pattern with a broad belt of aridity stretched across China from west to east, and the Neogene pattern with the arid zone restricted to northwest of China which has persisted until today. The reorganization of the climate system around the Oligocene/Miocene boundary provides evidence for the establishment of the modern East Asian monsoon.

Since then, the Neogene has witnessed significant variations of the monsoon system, including enhancement of aridity and monsoon intensity at about 15-13 Myr, around 8 Myr and 3 Myr. The new data do not support the onset of the Asian monsoon system around 8 Myr (e.g., An et al., 2001). Rather, the new data led to a hypothesis that the transition to the monsoon climate system in East Asia occurred in the latest Oligocene.

PALEOCEANOGRAPHY OF THE BERING SEA AND CENTRAL ARCTIC OCEAN

Takahashi Kozo and IODP Leg 302 Scientific Party

Department of Earth & Planetary Sciences, Graduate School Sciences, Kyushu University

The Bering Sea is situated in an important location for the global circulation of water masses. It is linked to the Pacific Ocean through the channels of the Aleutian Island Arc as well as to the Arctic Ocean through the Bering Strait today, which is further linked to the Atlantic Ocean. The history of the water mass circulation via the Bering Sea is of global interest since the changes in circulation have a profound effect in climate change. However, not many piston cores nor drilled cores from the Bering Sea existed thus far and hence the paleoceanographic information in the region has been meager. Thus, we organized R/V Hakuho-maru Cruise to the Bering Sea in 1999 and acquired seven piston cores to proceed with paleoceanographic analyses, along with site survey effort on a planned deep-sea drilling. The cores are strategically located in the regions such as the Umnak Plateau, the Bowers Ridge, and off the Bering Shelf. These locations enabled us to reconstruct the history of the spacio-temporal distribution of surface and deeper water masses as well as sea-ice.

We acquired pertinent data on sedimentology, paleomagnetics, stratigraphy, micropaleontology, and geochemistry. Much of paleoceanographic interpretations stem from studies of siliceous and calcareous mircrofossils such as diatoms, radiolarians, and planktic and benthic foraminifers and chemical parameters such as C, N, opal, and CaCO3. The stratigraphic data were mainly derived from d18O of planktic foraminifers, paleomagenic intensity and susceptibility, and the last occurrence of Lychnocanoma nipponica sakaii, radiolarian datum. With the oldest bottom age of 132ka at UMK-3A, most of cores covered the age range of 83 to 89 kyrs, permitting us to proceed high resolution analyses. Details of the paleoceanographic reconstruction will be discussed.

In addition to the above piston core studies, a planned drilling will also be briefly discussed. A detailed study of the Plio-Pleistocene evolution of millennial to

Milankovitch scale climatic oscillations in the Bering and Okhotsk Seas will shed light on northern high latitude paleoceanography. Biological, chemical and physical oceanography as well as adjacent continental climate of the Okhotsk and Bearing Seas are highly sensitive to global climate conditions, and are recorded by variations in the sedimentary composition of diatoms and other microfossil groups, as well as many other paleoclimatic indicators.

Intermediate water formation in these regions can be tracked using paleoceanographic proxies of subsurface water that can be related to open Pacific records. Sediments can not only be used to produce records of climate and intermediate water ventilation in these critical marginal seas, but can also be applied to testing the effect of changes in the Bering Strait Gateway and it influence (via the Arctic) on heat and nutrient partitioning between the Atlantic and Pacific. The planned drilling will provide continuous and high resolution paleoenvironmental records from these critical marginal seas for the first time. These new records can then be used to understand the processes that influence intermediate water ventilation and its role in global climate change over the last 5 Ma.

Recently in 2004, IODP Leg 302 Arctic Coring Expedition to the central Arctic Ocean has been successfully carried out and we have obtained significant amount of sediment cores covering the Cenozoic and Cretaceous in age. The information derived from Leg 302 are complimentary to the Plio-Pleistocene Being Sea paleoceanography to be performed and thus it will be briefly discussed here as well.

THE UP STREAM DISCOVERY OF THE DANSGAARD-OESCHGER CYCLES IN THE OKHOTSK SEA LINKED WITH THE NORTH PACIFIC INTERMEDIATE WATER FORMATION

Takahashi Kozo*, Ono A.*, Katsuki K.*, Okazaki Y., Sakamoto T.*****

**Graduate School Sciences, Kyushu University*
***Ocean Research Institute, University of Tokyo*
****IFREE/JAMSTEC*

Millennial-scale oceanographic oscillations were identified in the southern Okhotsk Sea based on high resolution measurements of total organic carbon (TOC), C/N ratios, and biogenic opal, employing Core MD01-2412 (53 m) with the bottom age of 115 ka. The oscillations are linked with the Dansgaard-Oeschger (D-O) climatic cycles. Inadequate data existed in the source regions of the North Pacific Intermediate Water (NPIW) formation thus far. We report the first decisive documentation of the D-O cycles in the up stream source region of the NPIW, illustrating that the D-O cycles observed in the down stream regions (e.g., Santa Barbara Basin) due to expansion of the NPIW were in part governed by the climatic variations occurred in the Okhotsk Sea. Increases in TOC and C/N ratios reflect abrupt sea level rises associated with 14 interstadial events over the past 115 kyrs, attributing to the downward transport of eroded continental shelf sediments.

NEGATIVE ANOMALY OF BENTHIC FORAMINIFERAL CARBON ISOTOPE IN IMAGES CORE MD01-2412

Takashi Toyofuku*, Sakamoto Tatsuhiko*, Ikehara Minoru, Kitazato Hiroshi***

**IFREE, JAMSTEC, e-mail: toyofuku@jamstec.go.jp*
***Center for Advanced Marine Core Research, Kochi University*

We analyzed stable isotopes of benthic foraminifera Uvigerina akitaensisfrom a deep sea core MD 01-2412 which at 1225-m water depth off Hokkaido in the southwestern Okhotsk Sea (N 44.5, E 145). We measured stable isotope compositions of foraminiferal specimen through this core. Carbon isotopes of foraminifera indicate about –1 per mil (VPDB) through this core. Many stable isotopic measurements, however, indicate biased negative carbon isotopic value. The most depleted value was –9.5 per mil (VPDB). We found that the negative carbon isotopic spikes are seemed to correspond to the brownish colored foraminiferal abundant layers in the sediment core.

In this study, we will present morphological, geochemical and mineralogical characters of the “Brownish” foraminifera. The both surface of chamber walls of the specimens are covered by authigenic carbonates. This just surface part has more depleted carbon isotopic composition than the bulk foraminiferal test. Electron probe measurements show that magnesium contents are high in the surface authigenic part. Iron and sulfur contents are also detected in the surface layer. The existence of these elements suggest that the authigenic carbonates should be calcified under a reductive environment.

NUMERICAL STUDY OF THE IMPACT OF THE EXTERNAL FORCING VARIATION UPON THE CIRCULATION IN THE JAPAN SEA

Trusenkova O.

V.I.Il'ichev Pacific Oceanological Institute FEB RAS, Vladivostok, Russia

Although the Japan Sea is a mid-size East Asia marginal sea, it, like an ocean, can be divided into subtropical and subarctic regions, very different in circulation and thermohaline structure. The principal factors affecting the hydrographic regime of the Japan Sea are an inflow of the Kuroshio branch in the Korean Strait and intensive wintertime cooling associated with the northeast Asia winter monsoon. It is important to understand how the change in regional climatic conditions affects the circulation and thermohaline structure in the Japan Sea. A good tool for that is a numerical oceanic model, which incorporates the complete thermodynamics including prognostic equations for seawater temperature and salinity, surface forcing by heat and freshwater fluxes, and surface mixed layer sub-model. The 3D primitive equation numerical MHI model in isopycnic co-ordinates (Shapiro, 1998) is such a model. In the simulations performed, external forcing includes wind stress and atmospheric variables needed to calculate, with the use of simulated sea surface temperature (SST) and salinity (SSS), surface fluxes; no kind of restoration conditions towards climatic sea temperature or salinity is applied. Previous numerical studies of the Japan Sea, such as by Yoon and Kawamura (2002), employed the similar approach for water temperature but not for salinity. It is actually more trying to obtain realistic salinity distribution without assimilation of oceanographic data and this is a focus of the present study. The simulations are based on 1/8° lateral grid, with 12 layers in the vertical. Surface forcing is based on monthly mean fields of necessary atmospheric variables mostly from the NCEP/NCAR Reanalysis Project and the GPCP (Global Precipitation Climatology Project) precipitation. The Korean Strait is the major inflow port, with seasonally varied transport, the greatest in October and lowest in February. The Kuroshio branch enters the Japan Sea throughout a year, carrying saline (fresher) water in winter (summer); in summer – autumn the fresh Yellow Sea water flows in. The northern tip of Tatarsky Strait (Nevelskoy Strait) is also an inflow port in winter and spring, with small but important transport of fresh water from the Amur River Estuary. The outflow ports are the Tsugaru and La Perouse (Soya) Straits. The simulated circulation and thermohaline structure are consistent with observational evidence (Yurasov and Yarichin, 1991). In this paper, seasonal variation of the simulated surface freshwater flux, i.e. precipitation – evaporation residual (P – E) and salinity is briefly discussed. Average P – E manifests an excess of evaporation in autumn and winter, with the greatest upward flux in December, and an excess of precipitation in spring and summer, with the greatest downward flux in July (Fig.1a). Annual cycles of the simulated SSS (Fig. 1b) are consistent with the P – E cycles, while the SSS extremes lag 1-2 months behind P – E, with the lowest SSS in August – September and greatest SSS in January – March (Figs. 1b and 1d). Average simulated and long-term SSSs reveal the same pattern of seasonal variation (Fig. 1d). The long-term SSS is taken from the US Navy's Generalized Digital Environmental Model dataset (GDEM) and the simulated SSS is from two simulations, with lower (below 106 m3/s) and higher (about 2 106 m3/s) transport in the Korean Strait in February. The decreased (increased) supply of saline water in the Korean Strait results in the lower (greater) simulated SSS, with extremes of 34.06/33.25 (34.15/33.45) ppt in February/August (Fig. 1d).

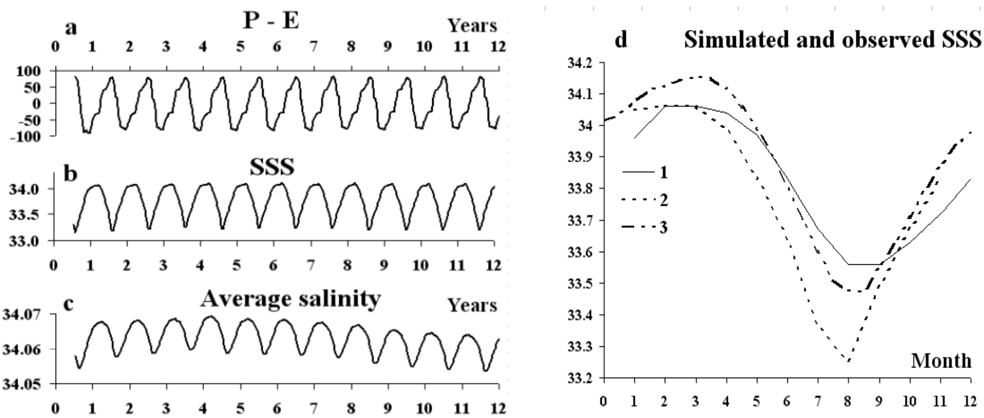

Fig. 1. Simulated P – E (a; mm/month; positive when directed upward), SSS (b; ppt), and average salinity (c; ppt); average annual cycle (d) of long-term GDEM (1) and simulated SSS under lower (2) and higher (3) wintertime transport in the Korean Strait.

Average simulated salinity represented in Fig. 1c reveals seasonal variation from 34.05 to 34.07 ppt, synchronized with the SSS seasonal signal, with only a slight decreasing trend of 0.01 ppt for annual mean during 12 years of integration. Note, that the boundary condition applied for salinity does not guarantee its conservation; therefore, minor drift of the average simulated salinity implies that the periodical quasi-steady regime is reached in the simulations performed under the forcing of external sources of fresh (or saline) water, without assimilation of the observed salinity.

LONG ECCENTRICITY CYCLES IN MONSOON VARIATIONS

Wang, Pinxian

State Key Laboratory of Marine Geology, Tongji University, Shanghai 200092, China

Paleo-monsoon studies initiated nearly thirty years ago with late Quaternary variations of the African and Indian monsoons. Because of the relatively short time intervals involved, studies on orbital-scale monsoon variability have been restricted to the precession and obliquity bands (20kyr and 40kyr), with the short eccentricity (100 kyr) as the maximum in time length. Recently, as the high-resolution paleoclimate studies extend back to earlier geological times, interest in the long-term orbital cycles, in particular the 400-kyr long eccentricity, is rapidly growing.

Eccentricity enters in the global climate system mainly through its modulation of the precession amplitude, and precession mostly affects low-latitude processes. Therefore, the short and long eccentricity cycles are clearly recorded in the monsoon history. Monsoon-induced lithological cycles are best expressed in the Pliocene sections in the Mediterranean deep-sea deposits, where an astronomically calibrated time scale based on eccentricity and precession was applied to the global stratotypes (e.g., Hilgen, 1991). Our recent studies show that the global oceanic carbon reservoir also displays a 400-kyr eccentricity cyclicity at least over the Late Cenozoic, presumably due to the monsoon-related weathering rate and silica supply, which controls the diatom/ coccolith ratio in the phytoplankton and then burial ratio of organic/inorganic carbon in the ocean bottom. However, the 400-kyr cyclicity was disturbed by the establishment of bi-polar large ice-caps and replaced by a kind of 500-kyr pseudo-periodicity in the Quaternary. The 500-kyr occurrence of "carbon-13 maximum (δ^{13}Cmax)" in the Pleistocene is accompanied by extreme climate events in low latitude regions and preceded the major expansion of the boreal ice-sheet (Wang et al., 2003, 2004).

This long-eccentricity cycles are of vital importance in paleoclimate studies for two reasons. First, the 400-kyr eccentricity is the most stable cyclicity in orbital forcing throughout the geological history and has been reported from monsoon records of various periods, ranging from the Triassic to the Cenozoic. Second, the Earth system is now again passing through a new carbon-13 maximum event. Prediction of the future natural changes of the global climate is impossible without understanding the physical and climatic meaning of the long-term carbon cycles related to long eccentricity.

POLLEN EVIDENCE FOR VEGETATION HISTORY FROM THE KOREAN WETLANDS SINCE THE LAST GLACIAL MAXIMUM

Yi Sang Heon, Yang Dong-Yoon, Kim Ju-Yong

Geological and Environmental Hazards Division, Korea Institute of Geoscience and Mineral Resources, Daejeon 305-350, Korea. Email: shyi@kigam.re.kr

Vegetation changes and human impacts were reviewed on the basis of pollen analyses from archaeological sites, wetlands and lakes of Korean Peninsula since the Last Glacial Maximum (LGM). Conifers of Subarctic zones and deciduous broadleaved trees of mountain climate zones gradually disappeared during the time frame of 10,000 yr BP. During the period from 8000 to 6000 yr BP cool and dry climate conditions were changed to mild and humid conditions under which the thermophilous hardwoods of alder (*Alnus*) - oak (*Quercus*) and coniferous pine tree (*Pinus*) flourished in the western lowland of Korean Peninsula. On the other hand, in Mid-eastern Korean Peninsula, oak and pine trees were dominant, but alder did not remain dominant during this period. This vegetation reflected by pollen analysis can be seen in western lowland areas, e.g. Ilsan and Gyeonggi Province. During the mid-Holocene optimum, 6000-4500 yr BP, deciduous broadleaved trees including alder (*Alnus*) and ash (*Fraxinus*), and other hydrophilic trees grew vigorously. However grasses were very rare. From 3000 yr BP, there was a sharp decrease in temperate thermophilous trees, whereas there appeared sudden dominance of coniferous trees, especially *Pinus,* followed by spore and grasses. Grasses have been known as a main indicator of short-time changes after the introduction of agriculture. Such synathropogenic grasses as Mugwort *(Artemisia)*, Chenopodiaceae and Umbelliferae came especially under those circumstances. Therefore the appearances of cultivated grass (e.g. Gramineae) together with synthropogenic grasses indicate that agriculture began during this period.

The distinct changes in vegetation are recognized in about 2000 yr BP. Prior to this time broadleaved deciduous trees (e.g., *Quercus*, *Betula* and *Alnus*) predominated, whereas grassland vegetation was relatively low. However, thermophilous hardwoods that were replaced by the conifer-grassland vegetation after 2000 yr BP are interpreted as human impacts rather than climatic changes.

Pollen zonation established in the Korean Peninsula since LGA are follows.

1. Northeastern Korean Peninsula: 6 pollen zones

Pollen Zone UI (17,000-15,000 yr BP): Conifers *Picea*-*Abies*-*Pinus* (*Haploxylon*)-*Larix* stage. Pollen Zone UII (15,000-10,000 yr BP): Herb and Pteridophyta stage. Pollen Zone UIII (10,000-6700 yr BP): *Quercus* stage. Pollen Zone UIV (6700-4500 yr BP): *Pinus*-*Quercus*-*Carpinus* stage. Pollen Zone UV

(4500-1400 yr BP): *Quercus-Pinus* stage. Pollen Zone UVI (1400-present): *Pinus* and Herbs stage.

2. Southeastern Korean Peninsula: 2 pollen zones and 3 pollen subzones

Pollen Zone I (10,000-6000 yr BP): *Quercus* stage. Pollen Zone II (6000-present): *Pinus-Quercus* stage. Pollen Subzone IIa (6000-4000 yr BP): Lower *Pinus* dominant substage. Pollen Subzone IIb (4000-2000 yr BP): *Pinus-Quercus* substage. Pollen Subzone IIc (2000-present): Upper *Pinus* dominant substage

3. Western Korean Peninsula: 3 pollen zones

Pollen Zone I (6000-5000 yr BP): *Alnus-Quercus* stage. Pollen Zone II (5000-4500 yr BP): *Alnus-Quercus-Pinus* stage. Pollen Zone III (4500-2600 yr BP): *Alnus-Pinus* stage.

CHLORINE, Mo,I AND Br CONTENT IN SEDIMENTS AS A PROXY OF THE OKHOTSK SEA PALEOPRODUCTIVITY DURING THE LATE PLEISTOCENE AND HOLOCENE

Zakharkov S.P.*, Artemova A.V.*, Bosin A.A.*, Yanchenko E.A.*, Gorbarenko S.A.*, Goldberg E.L.,***, Sovetnikova L.N.***

** V.I.Il'ichev Pacific Oceanological Institute FEB RAS, Vladivostok, Russia*
*** Limnological Institute of the SB RAS, 664033 Irkutsk, Russia*
****Budker Institute of Nuclear Physics of SB RAS, 630090 Novosibirsk, Russia*

Estimations of paleoproductivity were made from chlorine, Mo and Br concentrations in the Okhotsk Sea sediments. The dissolved sediment extracts contain a variety of chlorine originating from phytoplankton chlorophyll *a*. The comparison between chlorine concentration and the commonly accepted indicators for paleoproductivity such as biogenic opal and organic carbon concentration showed that the chlorine concentration depends on the productivity which is determined by the nutrient supply in the photic zone.

Large inputs of organic matter to the sediment should lead to large changes in the redox conditions at the water-sediment interface and in the uppermost sediment column, where most mineralization occurs. Molybdenum and iodine are good indicators of such changes. Molybdenum is greatly enriched in sediments in anoxic basins, most probably as a result of coprecipitation with iron monosulphides. Bromine and iodine in marine sediments is uniquely controlled by the organic matter content and by its diagenesis, whereby the enrichment of brome and iodine relative to the OC indicates the deposition under the oxygenated bottom water conditions. Thus, Br/OC and Mo/Fe ratios can both indicate large variations in redox conditions in the sediment and/or in the bottom-water ventilation.

The sediment stratigraphy and the age model of the core were based on the oxygen isotope analysis, lithology, magnetic susceptibility, tephrochronology, carbonate calcium, and opal stratigraphy for the Okhotsk Sea sediments.

The highest concentrations of OC and chlorine occurred during OIS 1.

In the same period the oxidizing conditions prevail, that is visible from low values Mo/Fe and rather large I/OC and Br/OC

The increase of the oxygen contents at the water-sediment interface at high receipt of OC can be connected only to one more intensive ventilation controlled probably by the reduction of the waters stratification in the Okhotsk Sea in the OIS period.

But even in that period the maximal flows of OC and chlorine on horizons 195 -210 and 230-240см caused the reduction of oxygen at the water-sediment interface and as a consequence-increase of Mo/Fe at that time.

During OIS 2,3 and 4 the smaller flows of OC and chlorine and higher values of Mo/Fe were observed

The I/OC and Br/OC ratio profile indicates the Mo/Fe profile, although the variations are not as well marked.

These changes in the chlorine concentration are in agreement with other indicators and correlate with the productivity variations for the central part of the Okhotsk Sea during the past 80 kyr.

POSSIBLE MILLENNIAL-SCALE VARIATION OF THE WESTERLY JET DURING HOLOCENE RECORDED IN AEOLIAN DUST IN THE SEDIMENTS OF THE JAPAN SEA

Zhai Qiumin*,, Nagashima Kana*, Tada Ryuji*, Kido Yoshiki* and Yokoyama Yusuke***

**Department of Earth and Planetary Science, University of Tokyo, Tokyo 113-0033, Japan*

***College of Environment and Planning, Henan University, Kaifeng 475001,China*

Researches on Chinese loess, stalagmites and Japan Sea sediments reported that East Asia Monsoon changed in concert with Greenland and North Atlantic climate during last glacial period (Porter et al, 1995; Wang et al, 2001; Nagashima, 2003; Tada, 2004). Recent research on stalagmites from South China reports that the Asian Monsoon during Holocene also links to North Atlantic climate and solar changes (Wang et al, 2005).

In our research, we analyzed a gravity core D-GC-6 from Oki Ridge in the southern Japan Sea, which is located at 37°03.9670`N, 134°42.178`E. Using Horiba

La-920 laser grain size analyzer, we analyzed grain size distribution of the detrital fraction and obtained the median size and content of aeolian dust which was transported from mainland Asia into Japan Sea. The two parameters nearly change in correlation, even though there are some time lags, the high media value correlate with high content. They present three high stages and low stages respectively from 3.4ky BP to the present, high peaks occurs during 0.46-1 ky, 1.7-2.8 ky and 3.2-3.3 ky, whereas low stages are during 0-0.46ky, 1-1.7 ky and 2.8-3 ky, correlating within dating error with Bond events 0-2 and weak Asian Monsoon events respectively (Bond, et al, 1997; 2001; Wang et al, 2005), almost have a 1500 yr cycle. These variation also can be compared with the gray scale of the sediments (L*), which shows consistent variation with intervals of large content and median diameter of aeolian dust corresponds to intervals of high gray scale during the last 1 ky, whereas shows inverse variation with intervals of large content and median diameter of aeolian dust corresponds to intervals of low gray scale during 1-3.4 ky BP.

Nagashima (2005) demonstrates that the aeolian dust is transported to the Japan Sea mainly by wes-terly jet during Holocene. If so, the low Aeolian dust stages reflect weak westerly jet stages which coincide with the recent 3 weak Asian monsoon events 0.5,1.6, 2.7 ky BP and possible link to ice rafted events in the North Atlantic during Holocene. But according to Tada (2004), gray scale of sediments in Japan Sea is the index of East Asian Summer Monsoon, if so the inversed variation of L* comparing to aeolian dust grain size during 1-3.4 ky BP will be contradicted with weak Asian monsoon events. Therefore to discuss the mechanism of the two climate systems, we will continue the work on early Holocene part and public the data soon.

IGCP-476 Special Section 3. The monsoon evolution and tectonic-climate linkage in the East Asia and NW Pacific.

DYNAMICS OF THE MONSOON INTENSITY IN HOLOCENE ON THE SOUTH OF THE RUSSIAN FAR EAST

Bazarova V.B.

Pacific Institute of Geography FEB RAS, Vladivostok, Russia

Atmospheric circulation over the Far East has the features, caused by irregular heating and cooling of land and ocean. These ones are reflected in the structure of a thermal barometric field with a view to the season change disposition of the high-pressure ridges and barometric troughs. In consequence of the Far East climate it is considered monsoon.

On the basis of the voluminous reference data, P.V.Novorotsky (1999) calculated the Khromov's monsoon indexes (*J*). These ones served the base for the map construction of the monsoon spreading and degree of its stability in the southem part of the Russian Far East. By the value of the monsoon indexes the south of the Far East can be divided in to three parts: monsoon ($J \geq 60\%$), areas monsoon tendency ($J = 40\text{-}60\%$) and the areas without monsoon areas circulation ($J < 40\%$). The most part of this territory belongs to the areas with monsoon tendency or without monsoon circulation. Only for ¼ territory the monsoon circulation is typical. Such territory division is connected in general with the features of the summer atmospheric circulation, disposition of the main mountain ranges and barometric field in this region. Monsoon circulation is observed in general along the Okhotsk Sea and Japan Sea coasts and also on the plain parts of the Lower Amur (Middle Amur, Amur-Amgun and Udyl-Kizi plains).

In summer in these latitudes the monsoon transfer usually appears on account of interaction of the Far-Eastern depression, formed mainly in the Amur basin, and the high pressure fields over the marginal seas (Sea of Japan and Okhotsk Sea) and the North-Western Pacific. The anticyclone, located over the Okhotsk Sea in summer, is most stable among all appearing over the Far-Eastern seas. This one renders the most influence on the air mass transfer over the Okhotsk Sea coast and southern areas of the Far East. The widest zone of stable monsoons is observed on the western coast of the Okhotsk Sea and the Amur lower reach. Here, the monsoon streams penetrate through the Amur plain from Nikolaevsk up to Komsomolsk-on-Amur, i.e. almost for 400 km from the coast.

Maximum cyclonic activity in the southern part of Far East falls on summer and spring, minimum – on winter and autumn. Warming up of the continent, meridian disposition of the mountain ranges and the formation of anticyclones over the marginal seas block the cyclones, shifting from the western areas. These reasons promote the formation of the Far-Eastern barometric depression. To the north from 49^{o} N the southern part of the Far East is under the influence of the middle latitude monsoons, caused by the interaction of anticyclones of the Okhotsk Sea and the Far-Eastern barometric depression (Novorotsky, 1999).

For the study of the monsoon dynamics in the Holocene in the southern areas of the Russian Far East the three swamp systems were studied within the Lower Amur basin.

The "Dudi" swamp system (52^{o} 01' N, 140^{o} 08' E) – now the Amur active washes away the peat – began to form in the middle of Boreal (8370±115 BP SOAN-4449). Peat deposit is mesotrophic type and has natural drainage. The precipitations dominate in alimentation of the swamp system. Three interruptions of the peat accumulation are determined in the section (8000-8200, 7000-7200 and 3500 BP). The changes in the composition of the vegetation cover fall over on these age periods. Instead of sphagnum moss the arboreal and herbaceous components began to dominate in the botanic composition of peat. Also, the mineral components of peat are increased, and the rate of peat accumulation is decreased. The reasons of such changes are lowering of the swamp water level.

The "Chlya" swamp system (53° 32' N, 140° 13' E) is spread on the north-eastern coast of Chlya Lake. Now peat is washed away by the lake. The peat accumulation began in the middle of Praeboreal (9700±80 BP SOAN-4719). Peat deposit is mesotrophic type and has natural drainage. Two interruptions of the peat accumulation are determined in the section (7000-7200 and 6500 BP). The same way as "Dudi" section the mineral components in the peat are increased, and the arboreal and herbaceous components began to dominate in botanic composition. Just as in the above-mentioned peat the reason of such changes was the lowering of the swamp water level.

The most northern "Tyapka" swamp system (53° 42' N, 140° 07' E) began to form at the beginning of the Praeboreal (9975±120 BP SOAN-4025). Peat deposit is oligotrophic type. Two interruptions of the peat accumulation are determined in the section (8000-8200 and 3500 BP). That time the swamp surface dried out, and the arboreal and herbaceous vegetation forced out the sphagnum moss. At the Boreal finish the rate of peat accumulation decreased. The same way as in the above-mentioned swamp systems the reason of the change of vegetation component and decreasing of the peat accumulation rate was the lowering of the swamp water level.

All three studied swamp systems are spread within the areas with monsoon ($J > 60\%$) and monsoon tendency (J=40-60%). Their hydrological regime depends on precipitations, which are one of the summer monsoon descriptions. The interruptions of peat accumulation were connected to the decreasing summer precipitations. All in above-mentioned allows us to suppose the summer monsoon intensity and stability were slackening because of the instability of the Okhotsk anticyclone and weak expressiveness of the Far-Eastern depression on the Boreal termination, Atlantic beginning and middle, Subboreal middle.

The "Gur" swamp system is spread within the northern part of the Middle Amur plain (50° 00' N, 137° 03' E), where monsoon tendency is well expressed (J = 40-60%). Peat deposit is eutrophic type, and the age is 12120±75 BP (AA-36274). On the lower part of the peat section a layer of the eolian sediment (5-10 cm) is studied. The pollen and C^{14} analysis data of the under and over lying layers evidenced it is sedimentation during the Younger Dryas in cold and dry climatic conditions (10000-11000 BP). The granulometric composition of the eolian sediment evidences the transfer from the interior continent parts of Mongolia and China. The transfer is carried out by dust storms in winter. The thickness of the dust layer (5-10 cm) evidences the activity and stability of the winter monsoon during the Younger Dryas.

Thus, the paleogeographic studies of the swamp systems within the southern areas of the Russian Far East allow us to reconstruct the dynamics of the monsoon intensity and support the reasons of its instability during the Holocene.

INFLUENCE OF JAPAN SEA ON CENOZOIC FLORAS ADJACENT TO COAST IN GEOHISTORIC ASPECT

Pavlyutkin B.I., Golozoubov V.V., Mityureva E.V.

Far East Geological Institute of FEB RAS, Vladivostok

The problem of the age of the Japan Sea basin is discussed in many papers by both Japanese and Russian geologists, tectonists and paleogeographers. By present, the more or less orderly model of the Japan Sea origin has been elaborated. It is based predominantly on geological data and radioisotopic datings. With some differences in opinions about the mechanism and time of the Japan Sea origin, most of researchers date its age as Early Miocene.

In this connection, it is interesting to examine how much these conclusions are in agreement with the materials of paleobotanic investigations. On the territory of Japan and Primorye, many well-studied Miocene leaf floras are known. As the vegetation is a rather sensitive indicator of climate, then the method of flora referencing to significant paleoclimatic events has become most popular for determination of the fossilized flora age. One of the global paleoclimatic events is so-called the main climatic optimum of Miocene (MCO) that stands for the warmest period in the interval of the Early to Middle Miocene transition. The most dramatic illustration of the MCO is a pair of the conjugate in time paleofloras of the Honshu western coast: moderately leaf-fall Aniai flora, related with the continental coal-bearing deposits of the Early Miocene first half, and replacing it Daijima thermophile flora restricted to the coast-sea sediments.

In the continental part of the Japan Sea coast (Korea, Primorye), analogs of the Daijima-type floras are considered the "Engelgardia" floras, which are rather thermophile and close to the subtropical ones, even in the northern district of Primorye. This has served as the basis for a cardinal revision of the vertical sequence of the Tertiary floras. However, the supporters of the "mechanical" extension of the paleoclimatic situation, established on the territory of Japan, to the continent didn't take into account the fact that any climatic (including paleoclimatic) phenomenon resulted from the interaction of two factors: global and regional. The end result is governed by their single or different direction, when they either strengthen each other or, in contrast, are mutually compensated.

The climate in temperate latitudes of East Asia is monsoon. In winter (the most unfavorable period for the plant life) it is controlled by the East-Asian monsoon that formed tentatively at the Early/Late Oligocene boundary (Wang, 1984). Bar maximum that is persistent in winter above Mongolia and South Transbaikalye of Russia, generates masses of cold and utmost dry air. They move to the east causing little precipitation on the continent in winter. When passing over the Japan Sea water area, which does not freeze due to the temperature difference at the water/atmosphere boundary (gradient reaches 20^{o}), the air heats up at the expense of the latent heat turbulent flow and becomes saturated with moisture. At the contact with ridges of Japan, the air currents rise up, cool down, and produce abundant precipitation on the western coast of Honshu. The model of hydro- and atmosphere interaction has been developed by climatologists long ago (Vitvitsky, 1980).

In the opinion of Japanese paleobotanists the effect of "sudden" sharp rise in temperature at the end of Early Miocene on the Japan western coast is related, first of all, with origin (opening) of the Japan Sea and penetration into it of a branch of the Tsushima warm current that washes out Honshu in the west and goes through the Sangarsky strait to the Pacific Ocean. This powerful warm "river" began to play the role of a peculiar heater, which defends the territory of the Japan western coast from dry cold winds of the winter East-Asian monsoon. On the opposite continental coast of the Japan Sea, climate has not undergone any essential changes.

Thus, before origin of the Japan Sea, when the territory of Japan was a member of the Asian continent (tentatively up to the middle of Early Miocene), climatic conditions in the districts of formation of Aniai flora and its analogs on the territory of Primorye (flora of Siniy Utes) and Korea (flora of Channgi) were similar, and this dictated a great resemblance of these floras. Later on, under the action of the Japan Sea opening the climate on the western coast of the Japanese Islands significantly improved, whereas on the continent it remained relatively stable. Temperature gradually decreased there in agreement with total cooling of the planet in temperate and high latitudes. Paleofloras of this level in Primorye, dated with radioisotopic methods, do not principally differ from the Siniy Utes phytocomplex.

This suggest the conclusion, important for the paleofloristics, about uselessness of searching in the continental sector of the Japan Sea coast, including Primorye, for the analogs (by the thermophile degree) of the Japanese Miocene floras beginning from the Daijima level. They could not be formed there by reason of different paleoclimatic conditions.

TERRESTRIAL BIOMARKER FLUXES IN SETTLING PARTICLES FROM THE WESTERN SEA OF OKHOTSK

Seki Osamu, Yoshikawa Chisato, Nakatsuka Takeshi, Kawamura, Kimitaka, Wakatsuchi Masaaki

Institute of Low Temperature Science, Hokkaido University, Japan

Settling particles and surface sediments collected from the western region of the Sea of Okhotsk were analyzed for total organic carbon (TOC), long-chain n-alkanes and their stable carbon isotope ratio to investigate sources and transport of total and terrestrial organic matter in the western region of the sea. The stable carbon isotope measurements of TOC in time-series sediment traps indicate lateral transport of resuspended organic matter from the northwestern continental shelf to off Sakhalin via the dense shelf water (DSW) flow at the intermediate depth.

The n-alkanes in the surface sediments showed strong odd carbon number predominance with relative lighter stable carbon isotope values (from -33 to -30 □$B"s□(B). They fall within the typicalvaluesof C3-angiosperms, which is the main vegetation in east Russia, including the Amur River basin. On the other hand, the molecular distributions and stable carbon isotope values of n-alkanes in the settling particles clearly showed two different sources; terrestrial plant and petroleum in the Sea of Okhotsk.

We reconstructed seasonal change in the fluxes of terrestrial n-alkanes in settling particles using the mixing model proposed by Lichtfouse and Eglinton (1995). Results of the terrestrial n-alkane fluxes indicate that there are two transport pathways of terrestrial plant n-alkanes to sediments off Sakhalin, the Sea of Okhotsk. One is lateral transport of resuspended particles with lithogenic material from the northwestern continental shelf by the DSW flow.

Another is the top-down transport of terrestrial plant n-alkanes, which is independent of transport of lithogenic material. The latter may include the input of organic aerosols derived from terrestrial higher plants possibly associated with forest fires in Siberia.

EAST ASIAN MONSOON VARIABILITY LINKED TO GLOBAL CLIMATE CHANGE

Sun Youbin*,, Chen Jun*, Clemens Steven C.***, Ji Junfeng*, Tada Ruiji****

**Institute of Surficial Geochemistry, Department of Earth Sciences, Nanjing University, Nanjing 210093, China*

***Department of Earth and Planetary Sciences, Tokyo University, Honggo 7-3-1, Tokyo 033-1133, Japan (Email: youbin@eps.s.u-tokyo.ac.cn)*

****Department of Geology, Brown University, Providence, RI 02912-1846, USA*

A 180-m-thickness loess-paleosol sequence from the northwestern Chinese Loess Plateau was investigated to generate a high-resolution record of the East Asian monsoon (EAM) variability over the last seven glacial cycles. Magnetic susceptibility and grain size records are regarded as indicators of changes in the summer and winter monsoon, exhibiting distinct orbital-scale EAM variations over the past 720 kyr as well as prominent millennial-scale EAM variability during the last 140 kyr. In contrast to stacked monsoon indices from the central Chinese Loess Plateau and oxygen isotope records from the deep-sea sediments, our better-resolved magnetic susceptibility and mean grain size records exhibit evident precessional cycles, suggesting a sensitive response of the EAM to precessional forcing. Shorter and abrupt oscillations of the winter monsoon are superimposed on the glacial-interglacial cycles, especially during the last 140 ka. Based upon good correlation of Dansggard-Ochesger (DO) events revealed by the monsoon indices (i.e., loess grain size and stalagmite $\delta^{18}O$) and $\delta^{18}O$ record of NGRIP ice core over the interval 20-60 ka, we suggest that 8 DO-like events can be identified within the interval 80-130 ka (corresponding to paleosol S_1 and MIS 5). Spectral analyses of the mean grain size and NGRIP $\delta^{18}O$ records reveal that the frequencies of millennial-scale climate variability are different between 80-120 ka and 20-60 ka, implying that driving mechanism of millennial-scale climate variability may be varied from the last interglacial to last glacial/interstadial.

PLIO-PLEISTOCENE UPLIFT OF HIMALAYA, NORTHERN TIBET, AND TIAN SHAN AND THEIR POSSIBLE LINKAGE WITH THE WESTERLY JET MEANDERING AND ONSET OF THE DANSGAARD-OESCHGER CYCLES

Tada Ryuji*, Sun Youbin*, Nagashima Kana*, Isozaki Yuko, Tani Astushi**, and Toyoda Shin*****

**Department of Earth and Planetary Science, Graduate School of Science, University of Tokyo, 7-3-1 Hongo, Tokyo 113-0033, Japan*
***Department of Earth and Space Science, Graduate School of Science, Osaka University, 1-1 Yamadaoka Suita, Osaka 565-0871 Japan*
****Research Institute of Natural Sciences, Okayama University of Science, 1-1 Ridai-machi, Okayama-shi, Okayama, 700-0005, Japan*

Our study on the Late Quaternary sediments in the Japan Sea revealed centimeter- to decimeter-scale repetitive deposition of organic carbon rich dark layer and organic carbon poor light layer in the sea is associated with millennial-scale rapid climatic changes known as Dansgaard-Oeschger Cycles [DOC]. Our study further suggests such deposition of dark and light layers has been resulted from changes in nutrient flux into the sea from the East China Sea caused by the changes in Yangtze River discharges in response to the variation in East Asian summer monsoon intensity. We examined the evolution process of deposition of the dark and light layers by examining core photographs of ODP Leg 127. The result suggests that meter-scale (orbital-scale) alternation of the dark and light layers started around 2.5 Ma but centimeter- to decimeter-scale (millennial-scale) alternations of the dark and light layers did not start until ca. 1.6 Ma. Clear millennial-scale signal appeared around 1.6 Ma and became distinct by 1.2 Ma. Thus, it is possible that the DOC started at least by 1.6 Ma.

We also examined provenance of eolian quartz in the late Quaternary sediments of the Oki Ridge (MD01-2407) in the south central Japan Sea using its electron spin resonance [ESR] signal intensity. The result suggests changes in eolian dust provenance in association with the DOC. Namely, eolian dust was mostly supplied from northeast China or Siberia during stadials and mostly from western desert of China during interstadials of the DOC. We interpret that such provenance changes would imply dust transport by intensified winter monsoon wind during stadials and by westerlies just like at present during interstadials. Such a change in dust transport wind system implies N-S oscillations in westerly jet axis in association with the DOC.

Even at the present, westerly jet axis moves to the south of Himalaya during winter and the westerly jet axis jumped to the north of Tibet during the early spring.

This suggests that Himalaya, Tibet, and possibly Tian Shan play a role of topographic barrier and create bimodality of westerly jet circulation path over East Asia. Thus we hypothesize that uplift of Himalaya, northern Tibet, and Tian Shan during Plio-Pleistocene was responsible for creation of bimodality of westerly jet circulation and ultimately the cause of DOC. Increase evidence based on thermo-chronological studies supports the Plio-Pleistocene uplift of Himalaya, northern Tibet, and Tian Shan. Furthermore, our preliminary study on the provenance of loess-paleosol sequence in Loess Plateau, China based on ESR signal intensity and crystalinity of quartz suggests gradual changes in provenance dominantly from the north(Siberia) to dominantly from the west(Western Desert) during Plio-Pleistocene, which is consistent with the idea that Western Desert also developed during this time. Eolian dust source to the Loess Plateau became dominantly from the west by ca. 2 Ma, approximately the same time as the probable onset of millennial-scale changes in eolian dust provenance in the Japan Sea sediments in association with the DOC.