88-2 BTH 19 Nakagawa, Takeshi

ASYNCHRONOUS CLIMATE CHANGES BETWEEN JAPAN AND THE NORTH ATLANTIC DURING THE LAST DEGLACIATION: FULL DESCRIPTION

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In the oral symposium we present the results of our high-resolution pollen analytical study of the annually-laminated lacustrine sediments of Lake Suigetsu, Japan, and attempt to provide some explanations of the observed asynchrony in deglacial climate changes between the North Atlantic and Japan. In the limited time allowed for the presentation, however, we can only outline the pollen-based climate reconstruction method employed, and are able to present selected results only. Here we present a fuller description of the method, and illustrate the results of reconstructions attempted for additional climatic parameters. The methodological problems involved will be expanded in open discussion.

The poster displays the following information:

1) The principles of the best-modern-analogues technique,
2) The principles of error estimation using Montecarlo simulation,
3) The comprehensiveness of the pollen and climate databases used for climate reconstruction,
4) The distribution of the modern vegetation and climates of Japan
5) Topography of the Lake Suigetsu area, with some landscape photos,
6) Photograph of the Lake Suigetsu core section,
7) Full pollen diagrams from Lake Suigetsu and Lake Mikata (adjacent to Lake Suigetsu),
8) Possible periodicity in the pollen curves,
9) Reconstructed curves of (i) Temperature of the warmest month, (ii) Temperature of the coldest month, (iii) Seasonal temperature variability, (iv) Warm Index (Cumulative monthly temperature above 5 °C), (v) Cold Index (Cumulative monthly temperature below 5 °C), (vi) Mean annual temperature, and (vii) Annual precipitation.
10) Chronology-based correlations with other regions,
11) Comparison of varve and 14C age distributions for Lake Suigetsu and Cariaco Basin.

88-3 BTH 20 Fink, David

THE LAST GLACIAL MAXIMUM AND DEGLACIATION EVENTS BASED ON BE-10 AND AL-26 EXPOSURE AGES FROM THE MT. TRIKORA REGION, IRIAN JAYA, INDONESIA

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We report paired 10Be and 26Al exposure ages from the equatorial high altitude region of Mt. Trikora, central Irian Jaya (~3500 m, latitude of 4 S). Purmooree Valley, one of many moraine dammed valleys that drain north from the mountain crest, is ~8 km long, 2 km wide, and is delimited downvalley by broad moraines with relief of >100 m. Five major moraine systems in the lower valley section were sampled. Individual mean boulder ages range from 14ka to 27ka, exhibit clear continuos exposure without complex burial patterns and, more importantly, group into two age brackets – younger proximal ages and older distal ages. Production corrections due to cosmic ray shielding, sample thickness and paleo-geomagnetic variations are included. Published scaling algorithms generate age differences of ~5%. Age errors include all analytical errors and a 7% error in production rate. Final errors are typically 8-14%. The single sample from the defined outer or oldest moraines (P4, P5) had a mean age of 27.0 ± 1.9 ka; three samples from the crest of an intermediate moriane (P3) with a mean age 18.0 ±1.1 ka and three others, strewn within the valley floor between P2 and P3, 21.5 ± 1.4 ka. Five samples relating to the inner moraines, P1 and P2, have a mean age of 15.2 ± 1.2ka – distinctly younger than those of the P3 system. Based on this, we suggest that the LGM in Irian Jaya commenced at least 21.5 ka ago reaching peak intensity at ~18 ka, concurrent with the average global LGM age. The LGM ice front probably remained close to its maximum extent (defined by P3) until at most 15ka. The inner moraine system (P1,P2) formed at 15.2±1.2ka during the last deglaciation and represents the youngest glacial feature in this region. This glacial readvance phase appears not to be consistent with the Younger Dryas cold period that is so prominent in the GISP 2 record. Interestingly, this conclusion is reminiscent of cosmogenic exposure ages from sequences of re-advance moraine features in New Zealand and Tasmania by Fink et al (2002). D. Fink et al, Int. AMS-9 Conf, abstract O11A-1, p92-93, Japan, Sept . 2002.

88-4 BTH 21 Clark, Douglas H.

COMPLEX TIMING AND PATTERNS OF GLACIATION IN THE AMERICAN CORDILLERA DURING TERMINATION 1

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Evidence from alpine glacial deposits in the American Cordillera suggest that glacier fluctuations, and therefore the climatic conditions that caused them, during the late-glacial were spatially and temporally complex.

In the Sierra Nevada, LGM glaciers retreated gradually between 17,000 and ~15,000 ^{14}C yr BP (~20,000-18,000 cal yr B.P.) and subsequently stagnated between ~14,000 and 15,000 ^{14}C yr B.P. (~16,800-18,000 cal yr BP). By ~13,100 ^{14}C yr BP (~15,500 cal yr. BP), ice had largely or entirely disappeared from even the highest cirques. Cirques remained essentially ice-free between 13,100 and 12,200 ^{14}C yr BP (15,500-14,200 cal yr. BP), after which glaciers reformed and readvanced a short distance during the Recess Peak event. The Recess Peak glaciers lasted about 1000 yrs, disappearing by ll,200 ^{14}C yr BP (~13,100 cal yr. BP). The Sierra Nevada remained largely or entirely free of glacier ice for the next ~9000 cal yr, including during the Younger Dryas (YD) chronozone.

Glacier deposits indicate a mixed record in the North Cascades; alpine deglaciation began by ~17,000 ^{36}Cl yr BP, with two late-glacial readvances (~14,000 and 13,000 ^{36}Cl yr BP; Swanson and Porter, 1997) in the eastern Cascades, but only one (ending by ~13,200 cal yr BP) in the western Cascades near Mt. Rainier (Heine, 1998). During the YD, glaciers appear to have retreated at Mt. Rainier while simultaneously advancing further north in the Enchantment Lakes Basin. Proposed YD alpine glacier advances to near sea-level in the northernmost Cascades (Kovanen and Easterbrook, 2002) remain controversial, and may instead have been substantially smaller (Burrows, 2000).

In southern Idaho, glaciers retreated to the cirques by 13,000 ^{14}C yr BP (~15,400 cal yr BP), but experienced a minor readvance between ~12,800 – 11,000 ^{14}C yr BP (~15,100-13,000 cal yr BP); no YD advance is apparent. In the Rockies, small alpine moraines record one or two late-glacial advances, an earlier one that predates YD and a later that is synchronous with it (e.g., Menounos and Reasoner, 1997). These inconsistent results suggest either that current age constraints are in error, or more likely, that the American Cordillera experienced rapid yet localized variations in temperature and moisture delivery, possibly related to an unstable Pacific storm track.

88-5 BTH 22 Teller, James T.

GLACIAL LAKE AGASSIZ: A 5000-YEAR HISTORY OF CHANGE

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Lake Agassiz was the largest lake in North America during the last period of deglaciation, extending over a total of 1.5 million km^2 before it drained about 7.7 ^{14}C ka (8.4 cal ka). New computer reconstructions, controlled by large beaches, isostatic rebound data, the margin of the Laurentide Ice Sheet, outlet elevations, and modern DEM topographic data, show how variable the size and depth of this lake were during its 4000 ^{14}C yr (5000 cal yr) history. Abrupt draw downs of 8-110 m in the lake surface occurred on at least 18 occasions, when new outlets were opened, reducing the extent of the lake and sending large outbursts of water to the oceans. These outbursts abruptly added 1600-9500 km^3 to the baseline overflow from the lake, and were routed to 3 different ocean basins: the Gulf of Mexico, Arctic, and North Atlantic. After each draw down, the lake transgressed back over the newly exposed lake floor, deepening the water everywhere to the south of the isobase that extended through the outlet. The final drainage of Lake Agassiz abruptly released 163,000 km^3 into the Hudson Bay basin and the North Atlantic. Three of the largest outbursts correlate closely in time with large δ^{18}O excursions in the isotopic records of the Greenland ice cap, suggesting that those freshwaters impacted on thermohaline circulation and, in turn, on climate.

88-6 BTH 23 Yu, Zicheng

SPATIAL PATTERN OF DEGLACIAL CLIMATIC OSCILLATIONS AND VEGETATION RESPONSES FROM ATLANTIC SEABOARD TO GREAT LAKES REGION IN EASTERN NORTH AMERICA: EVIDENCE FROM LACUSTRINE STABLE-ISOTOPE AND POLLEN RECORDS

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Large and abrupt climatic oscillations occurred during the last deglaciation evident in ice, lacustrine and marine records from different geographic regions. Stable isotopes retrieved from these records could potentially provide a common proxy in correlating these records and detecting temporal and spatial patterns, which are critical in understanding the nature and regional gradients of climate changes and thus their forcing mechanisms. Here I provide new isotopic and pollen results from the Mid-Atlantic region of USA to expand the existing late-glacial isotopic records from the Great Lakes region toward the Atlantic Seaboard. White Lake, a marl lake in northwestern New Jersey, provides high-resolution sedimentary records since ice retreat (as early as 20,000 cal BP). Preliminary isotope results of marl bulk samples (contain >90% carbonates) from this site show >3‰ shift in oxygen isotopes between -8 and -4‰ during the late glacial and early Holocene, indicating distinctive multiple oscillations at millennial and centennial scales. Pollen stratigraphy suggests the timing of these shifts representing the Bölling-Alleröd warm period, including three short-lived cooling events (intra-Bölling cold period, Older Dryas, and intra-Alleröd cold period), the Younger Dryas and Preboreal Oscillation. Oxygen and carbon isotopes show strong covariation during these climate events. Pollen sequence from this site is similar to previously published extensive pollen records from this region, which indicate the Younger Dryas event as a return of boreal taxa (including *Abies* and *Alnus*) after establishment of a mixed deciduous-coniferous forest containing *Quercus*, *Fraxinus* and *Ostrya/Carpinus*. Combined isotope (as an independent climate indicator) and pollen data from the same sites shed new light into understanding the nature of late-glacial vegetation change in this region and sensitivity of upland vegetation to abrupt climate changes. Close-interval AMS dating of this record and others in this region is ongoing, and isotope analysis of shells from ostracodes calcified during different seasons would provide insight into potential change in seasonality associated with these climatic oscillations.

88-7 BTH 24 Juan, Xu

COMPARATIVE RESEARCH OF THE CLIMATIC CHANGES IN THE ARCTIC AND THE OTHER REGIONS IN THE NORTHERN HEMISPHERE DURING THE TRANSITION FROM THE LAST GLACIAL MAXIMUM TO THE PRESENT INTERGLACIAL (HOLOCENE)

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The climatic changes after the last glaciation have attracted many scientists attention. In the unique geographical region, as a super air-condition, the climate changes of Arctic may influence the other regions in the world, especially the regions of the Northern Hemisphere, because they belong to the same atmospheric circulation system of the Northern Hemisphere. Many scientists are making effort to find out the relationship of climatic changes between the Arctic areas and others in the Northern Hemisphere and some achievements are gained(1 3 4). The transition from the last glacial maximum to the present interglacial (Holocene) has great importance in understanding how Earth's climate system can abruptly switch from one state to another(2). So here we select the transition as a representative period to study the climatic changes. The purpose of our research in this paper is to compare the climatic changes in the Arctic with those in other regions of the Northern Hemisphere, mainly in the Northern America, Europe and China. With the climate proxy data, including isotope of oxygen (18 O), paleobiology, pollen records, geochemistry element data, I will use methods of Singular Spectrum Analysis£¬Similarity Analysis£¬Cluster Analysis, Factor Analysis and Space Optimum Cutting Method to find the correlation and similarities between the Arctic and the other regions of the Northern Hemisphere and to find out which region is most sensitive to the climatic changes of the Arctic. Establishing and comparing the geographic extent, sequence, and magnitude of climate oscillations in this period is essential for understanding the mechanisms and causes of abrupt short-term climatic changes. This research was financially supported by funding from National Natural Science Foundation of China (49971078).

88-8 BTH 25 Yokoyama, Yusuke

LAST GLACIAL MAXIMUM SEA-LEVEL OBTAINED FROM BONAPARTE GULF OF AUSTRALIA USING MICROPALAEONTOLOGICAL EVIDENCE

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The region north of Australia, far away from former ice sheets and in a tectonically-stable margin, is ideally suited for sea-level reconstructions as glacio-hydro-isostatic effects are minimal. Thus, examination of ostracod and foraminifer remains, recovered from gravity core RS176/GC5 from Bonaparte Gulf, and which is located at 118m water depth, has permitted to reconstruct in detail

the sea-level regression and transgression that coincided respectively with the on start and end of the Last Glacial Maximum (LGM). Our data further confirms that the lowest sea-level was locally at about 120m below present days sea-level. We provide further evidence of sea-level rise after 19,000 cal years BP of the order of 10 meters. Glacio-hydro-isostatic modeling was also conducted using these observations to draw palaeo-shore line maps. These maps are clearly demonstrated the drastic environmental transitions after the LGM through the Holocene.

88-9 BTH 26 Augustinus, Paul C.

LATE GLACIAL ENVIRONMENTAL CHANGE RECORDED IN A NORTHERN NEW ZEALAND MAAR CRATER LAKE

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Onepoto maar crater is situated in Auckland City, northern New Zealand, and contains an almost continuous and high-resolution record of lacustrine sedimentation spanning to at least 250 ka. The section of interest here covers the period from ca. 28 to 8 ^{14}C kyr BP during which ca 4 m of laminated organic-rich sediments accumulated in the deep paleolake. Tephra from the central North Island are present throughout the sequence, and provide a chronostratigraphic framework underpinned by AMS ^{14}C ages. Environmental changes within the lake and catchment are interpreted from variations in a range of physical, chemical, and biological proxy indicators including: grain size, major oxide and trace element geochemistry, total organic matter content, elemental carbon/nitrogen ratios, carbon and nitrogen isotopes, magnetic susceptibility, diatom assemblages and biogenic silica content. These proxies have allowed us to infer changes in the extent and productivity of vegetation in the lake and catchment, as well as changes in the source of sediments.

Elements of the bulk organic matter and geochemical content of the sediments preserved a high-resolution record of vegetation response to climate perturbations, even during climatic events that were probably insufficient to induce a major changes in the vegetation cover. There are indications of an interval of low plant productivity and erosion commensurate with cool and dry conditions from ca 27 to 14.7 ^{14}C ka BP; following which climate amelioration with increasing plant productivity (both aquatic and terrestrial) was accompanied by reduced input of terrigenous material. A subsequent marked decline in biomass productivity and enhanced terrestrial input after ca 11.4 ^{14}C ka BP suggests the resumption of cooler and/or drier conditions between ca. 11.4 to 10 ^{14}C ka BP. Finally the onset of early Holocene warm, wet conditions was marked by high aquatic and terrestrial productivity that is displayed in most of the proxies. The details of the paleoenvironmental interpretation will be discussed as will the implications for late glacial paleoclimate in the SW Pacific.

88-10 BTH 27 Hoek, W.Z.

DETAILED CORRELATION OF RECORDS IN THE NORTH-ATLANTIC REGION DURING THE LAST GLACIAL-INTERGLACIAL TRANSITION

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Correlation of records covering the Last Glacial-Interglacial Transition can be established in different ways. Based on a combination of different lines of evidence the high resolution terrestrial records from the North Atlantic Seaboard can be correlated in detail, not only to each other, but also to the Greenland Ice-cores. Based on this correlation, it can be concluded that events recorded in the ice-core and terrestrial archives appear to be more or less synchronous, which implies an intimate link between both environments through atmospheric, climate, coupling. On the other hand, the climate system is influenced by ocean processes. The influence of the Atlantic on the terrestrial climate can be exemplified by analysing the spatial effects of this strong climate signal during the Younger Dryas (GS-1) in NW Europe. Marine records from the North Atlantic indicate important changes in sea-ice distribution and associated circulation patterns during the LGIT.

In order to test current ideas about 'leads' and 'lags' in the North Atlantic climate system a detailed correlation between records from the different environments is imperative. The majority of records for the LGIT obtained from marine and terrestrial sequences have been dated using 14C and can be correlated chronostratigraphically. However, fossils obtained from marine sequences are subject to an 'apparent age', or marine reservoir effect, caused by a.o. the slow mixing of ocean waters and the upwelling of C-14 depleted waters. Furthermore, it is now clear that the marine reservoir effect has not remained constant throughout the LGIT, neither in time, nor space. At present, this remains one of the major limitations on the correlation of marine and terrestrial records, for the uncertainties associated with age estimates based on marine fossils can be well in excess of the analytical precision of the 14C dates themselves.

Time-parallel events in the geological record, which provide important 'tie-lines' between marine, terrestrial and ice-core sequences, offer an alternative basis for the dating and correlation of events during the LGIT. Furthermore, the event-stratigraphy approach can be used to get a better grip on the marine reservoir ages, and thus can help to improve the value of existing C-14 chronologies and future land-ocean correlation.

88-11 BTH 28 Schaub, Matthias

RECORDS OF LATE-GLACIAL PIONEER FORESTS ON THE SWISS PLATEAU PROVIDE A HIGH RESOLUTION ARCHIVE

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Lateral melt water channels were formed along the margins of the Alpine glacier lobes on the Swiss plateau after the last glacial maximum (c. 16 ka BP). As soon as these outlets became inactive, landslide, solifluction, and surface water processes started to fill the channels with loamy alluvia. Pioneer forests (birch, pine) established themselves in response to the abrupt warming at the beginning of the Late-glacial. While the pioneer vegetation developed, continuous sedimentation processes led to the tree stumps being buried in sediments some 10 m thick, with subfossil pines ranging in age between 12,350 and 9,400 14C BP. This process ended when the Boreal vegetation began to migrate to higher elevations, suppressing the Late-glacial and Preboreal pioneer forests.

The Bølling/Allerød forest is represented in the floating chronologies obtained from Daettnau, while the ages of the subfossil forests in the Zurich area range in age between 11,800 and 9350 14C BP, spanning the Allerød, Younger Dryas and Preboreal. The chronologies derived for the later half of Younger Dryas and the Preboreal have been matched with the absolute pine sequences from Hohenheim, extending these back to 12,454 cal BP. Two construction sites, Gaenziloo and Landikon, excavated for the new highway tunnel through the Uetliberg in Zurich, provided a total of 144 fossil pine stumps. The resulting floating chronologies cover the main part of the Allerød from c. 11,800 to 10,850 14C BP. A 14C plateau of >200 years at 11,100 14C BP complicates attempts to develop a continuous Allerød chronology. Tree finds are less frequent but continue into the Younger Dryas. From the early part of the YD until the beginning of the absolute pine chronology, only 9 tree fossils have been recovered. Six of these form a floating chronology of some 189 years, while 3 single trees with ring counts of 245, 144, and 145 dendro-yr, and which do not cross-match, span an interval of at least 430 dendro-years.

88-12 BTH 29 Rundgren, Mats

HOW VARIABLE WERE ATMOSPHERIC CO_2 LEVELS DURING THE LAST DEGLACIATION? EVIDENCE FROM STOMATAL INDEX MEASUREMENTS OF A SWEDISH HIGH-RESOLUTION LEAF RECORD

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Data from ice cores suggest that Lateglacial and early Holocene atmospheric CO_2 variations were rather conservative, the most important change being a gradual Younger Dryas increase. By contrast, palaeo-CO_2 records based on the inverse relationship between CO_2 partial pressure and stomatal frequency of terrestrial plant leaves reflect a more dynamic CO_2 evolution. If correct, stomatal-based CO_2 estimates suggest that the global carbon cycle experienced significant reorganization during the last deglaciation.

Here we present a Lateglacial and early Holocene CO_2 record based on stomatal index data from leaves preserved in the sediments of Lake Madtjärn, a small lake in southwestern Sweden. Based on an extensive radiocarbon dating programme in combination with lithostratigraphic and palaeobotanical investigations, it was possible to correlate our CO_2 record to the INTIMATE event stratigraphy.

Three independent CO_2 records constructed from stomatal index data of Salix polaris, Salix herbacea and Betula nana leaves were combined to form a high-resolution reconstruction for the period 12,800-10,800 cal yr BP. Atmospheric CO_2 concentrations were found to have decreased rapidly from c. 260 ppmv to 210-215 ppmv within 200 years during the Allerød (GI-1)-Younger Dryas (GS-1) transition. After 100-200 years, CO_2 concentration started to gradually increase to 270-290 ppmv at the end of the Younger Dryas stadial (GS-1). CO_2 concentrations were relatively stable during the early Holocene, except for a short-lived period of lower (240-250 ppmv) values c. 11,350-11,200 cal yr BP.

The CO_2 record from Lake Madtjärn resembles in many respects the GRIP oxygen isotope record, suggesting that atmospheric CO_2 may have played an important role in climate dynamics during the last deglaciation. Our CO_2 record also partly resembles previous stomatal-based reconstructions, and the overall deglacial trend is almost identical to that seen in ice-core records. The amplitude of change is, however, markedly higher in the Swedish stomatal-based record compared to the ice cores. This difference may partly be accounted for by the inherent smoothing of ice-core CO_2 records caused by diffusion, but a major part of the difference in amplitude between ice-core and stomatal-based CO_2 records still remains to be explained.

88-13 BTH 30 Finsinger, Walter

A MULTIPROXY, HIGH-RESOLUTION RECORD OF LATE GLACIAL CLIMATE CHANGE IN NORTHWEST ITALY

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A lacustrine sequence from Lago Piccolo di Avigliana, Piemonte, Italy, has been studied using pollen, loss-on-ignition, stable isotopic, and microtephra analysis. The data provide evidence of climate changes during the last glacial Late Glacial south of the Alps, a region whose climate is influenced at present by the Mediterranean Sea and by its position in regard to the Alpine mountain chain. Previous attempts to prove the impact of climatic shifts by means of oxygen isotopes (δ^{18}O) in this region were not completely successful (for hydrological reasons): only the Bølling warming could be demonstrated. In contrast, δ^{18}O measured on bulk carbonates at our new site reveals a similarity with classic climate sequences of Central European records (e.g. Gerzensee) or ice-core records (GRIP/GISP), where (i) major climatic events such as the rapid warming at the Oldest Dryas/Bølling transition and the onset and end of the Younger Dryas were observed, as well as (ii) minor events like the Gerzensee Oscillation, were recorded. Chronology is given by AMS ^{14}C datings of terrestrial macrofossils, one tephra layer (LST), and regional pollen correlation. Correlation of our δ^{18}O record with other sequences where the LST was found is attempted, and synchronicity of the Gerzensee Oscillation could therefore reliably be tested.

The δ^{18}O record is taken as a signature of climate forcing against which the response of vegetation can be studied. During the Bølling warming, δ^{18}O values, organic matter, and carbonate content increased while *Betula* and subsequently *Pinus* forests established. During the Allerød and before the LST was deposited, *Quercus* expanded but was soon reduced in response to the Younger Dryas cold reversal. The subsequent gradual reduction of δ^{18}O values during the early Holocene suggests either a change in seasonality of rainfall or a change in source of moisture.

In conclusion, the similarity between δ^{18}O records at distant sites suggests that during the Late Glacial the Southern Alps and the North Atlantic may have been responding more or less synchronously to common forcing mechanisms. However, the contemporaneity of these climate shifts with climatic events observed in the GRIP ice-core record is difficult to establish until independent correlation proxies such as tephra layers are used to link sedimentary sequences.

88-14 BTH 31 Whitehouse, Nicki J.

THE LAST GLACIAL-INTERGLACIAL (LGIT) CHANGE IN IRELAND: NEW EVIDENCE FROM COLEOPTERAN RECORDS

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The LGIT was a period characterised by several rapid, extreme shifts in climate across the North Atlantic region. Lowe et al (1999) rightly point out problems associated with identifying the synchroneity of events and the important role of quantified climate proxies in determining the magnitude of climate shifts. For instance, using quantified temperature reconstructions of the mean warmest month (TMAX) from Coleopteran assemblages, Coope et al (1998) reported significant differences in the overall trend and timing of temperature variations across northern Europe during the LGIT. Significantly, though, there was little representation from Ireland, at the extreme western end of the transect.

Ireland's contribution to this debate has not been fully realised, despite being uniquely placed to record changes in the location of the Polar Front and associated changes in climate on the most western extreme of a transect across northern Europe. The prevailing westerly airflow combined with the strongly controlled maritime climate and an absence of any significant ice cap at

the time of the LGIT allow climatic changes to be identified and quantified free from any effects of ice and continentality in the east. The LGIT is well documented, with numerous high-resolution deposits of suitable age and an established tephrostratigraphic record for the Holocene, suggesting the good potential for a late glacial tephra chronology.

We present results from recent investigations of Irish late glacial deposits and a new, Coleopteran-inferred temperature curve for Ireland. We focus on the findings from a high-resolution site on the east coast, Roddans Port, Co. Down. The tephrostratigraphic record for the site is being presented separately. We compare the results from this site with other Irish investigations being carried out at Ballybetagh Bog (Co. Wicklow) and Craddenstown (Co. Louth), and with other proxies. Finally, we discuss the significance of this work within the wider context of the North Atlantic region.

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88-15 BTH 32 Lohne, Oystein S.

THE MAJOR YOUNGER DRYAS GLACIER ADVANCE IN WESTERN NORWAY STARTED ALREADY IN THE ALLERØD - ACCORDING TO SEA-LEVEL CHANGES

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Western Norway experienced large changes during the Lateglacial period. The general ice-front recession accompanied by a lowering of the relative sea-level due to glacio-isostatic recovery, were interrupted by a major ice sheet readvance (> 50 km) and a relative sea-level rise (c. 10 m amplitude) (Bondevik & Mangerud 2002; Lohne et al. in prep.). Both the transgression and the glacier advance culminated simultaneously in the very late Younger Dryas (YD). The coincidence of these maxima is striking and according to geophysical modelling the transgression was a result of halting or reversing of the isostatic uplift and rising sea-level caused by the advancing glacier combined with rising global sea-level.

Due to the eroding nature of a glacier it is difficult to date the start of a glacial advance. However, as indicated by geophysical modelling the regional relative sea-level change is tightly connected to the glacier fluctuations. In a detailed sea-level curve from an area adjacent to the YD end moraine south of Bergen, the sea-level fell after the deglaciation (12 500 ^{14}C BP/14 450 cal yr BP), and reached a low stand at ca. 11 600-11500 ^{14}C BP/13 400-13 300 cal yr BP (matched to the Cariaco calibration curve). Subsequently the relative sea-level started to rise and, as mentioned, the transgression culminated in the late YD. Hence, the sea-level record suggests significant glacial loading of the lithosphere starting ca. 13 300 cal yr BP, well before the distinct climatic deterioration at the AL/YD transition.

Generally the AL climate in Western Norway was cool and oceanic, with a relatively high precipitation. Chronologically the suggested glacial build-up coincides with the Inter-Allerød Cold Period. Even though this climatic fluctuation is recorded as a minor signal in Western Norway, it may have increased the length of the accumulation season sufficient to exceed the summer melting, resulting in a reactivation of the ice sheet.

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88-16 BTH 33 Voelkel, Joerg

THE AGE OF PERIGLACIAL SLOPE DEPOSITS AND SOILS OF LATE GLACIAL TIME IN THE CENTRAL EUROPEAN HIGHLANDS

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The Central Highlands of Germany were largely unglaciated during the Würm, and were subject to humid-cold periglacial climate. Extensive sheets of periglacial slope deposits partially fill the valley bottoms and mantle the mountains, foreland hills. Genesis and youngest age of the periglacial slope deposits is used as an important palaeoclimatic indicator. Although there is general agreement on the tripartite division of their lithostratigraphy, there is debate on the actual age of these deposits. The debate comes about because of conflicting interpretations of the efficacy of the Laacher See Tephra as a chronological marker. When the Plinian eruption of the Laacher See volcano occurred in Alleröd time its tephra plume extended over parts of the Central Highlands. Today, the tephra is often found as scattered shards intermingled with the periglacial deposits and, hence, some authors have assigned the periglacial slope deposits to a Younger Dryas age. The fact that the Laacher See tephra is found mixed with the periglacial slope deposits is, from the stratigraphical point of view, not a sufficient reason to conclude that the deposits are of the same age. It is in this context that our dates from several bogs whole over the Central European Highlands are critical in constraining the age of the periglacial slope deposits. In the case of Bavarian Forest peats just above the underlying periglacial slope deposits yielded radiocarbon dates which date the Upper Head, at a minimum, Older Dryas which is also consistent with palynological assignation of those bogs to the chronological Pollen Zone Ia. In the Fichtelgebirge the minimum age of the Upper Head is also Older Dryas, dated by radiocarbon. Palynological work assigned these bogs to the Alleröd. In the Harz, all the palynological data show that the bogs were initiated during the Younger Dryas itself. Therefore, the Upper Head below the bogs has to be older than Alleröd. In the Rhön bogs, the Laacher See Tephra is either found within the peat or lying as an undisturbed layer on the top of the Upper Head. The Rhön bog itself was growing during the Bölling. Hence, nowhere in our study sites can the Upper Head be of Younger Dryas age as presumed in the literature since 40 years.

SESSION NO. 89, 1:30 PM

Wednesday, July 30, 2003

S24. Environmental Catastrophes and Recovery in the Holocene (Posters) (*Holocene Commission; Neotectonics Commission, Commission on Sea-Level Changes and Coastal Evolution*)

Reno Hilton Resort and Conference Center, Pavilion

89-1 BTH 34 Smith, David E

THE HOLOCENE STOREGGA SLIDE TSUNAMI IN THE UNITED KINGDOM: AGE, MAGNITUDE AND IMPACT

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The Holocene Storegga submarine slide occurred on the continental margin off western Norway about 8000 calendar years BP, causing a tsunami which is known to have reached coastlines in Norway, possibly Iceland, the Faroes and the UK (mainly Scotland). The UK evidence consists of largely comparable deposits from 33 sites, involving 47 radiocarbon dates with pollen, diatom and particle size determinations. An age of around 7000-7100 radiocarbon years BP or 7800-8000 calendar years BP for the event is preferred. the magnitude was considerable. Run-up of the tsunami of over 5m and probably several metres above that is inferred from the altitude of the sediment and its particle size characteristics. At least two waves are indicated by the particle size graphs. The impact involved erosion of dune and shingle barriers at several locations and widespread inundation inland. Using altitudes obtained on the shoreline reached at the time of the tsunami, a new isobase map of Scotland is shown, using a statistical technique new to sea level studies.

89-2 BTH 35 Tooley, Michael

EVIDENCE FOR HOLOCENE RELATIVE SEA-LEVEL CHANGES AND THE STOREGGA TSUNAMI DISCLOSED IN MARINE DEPOSITS IN THE FIRTH OF FORTH, SCOTLAND, UK

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A number of exposures up to 7m high along the banks of the Cocklemill Burn in Fife on the north shore of the Firth of Forth, Scotland, UK, together with supplementary boreholes disclose a record of relative sea-level change in the area for the early to late Holocene, based upon detailed sedimentological, macrofossil, radiocarbon and luminescence dating evidence.Underlying limnic peat accumulated on a surface of sand during the early Holocene before being replaced by marine sands which contain a record of sedimentation into the late Holocene. The marine sands contain a coarse sand, gravel and shell hash layer catastrophically deposited and attributed to the early Holocene Stroegga tsunami, the only evidence of this nature for this tsunami so far reported. The relative sea-level changes and tsunami are considered in their regional context.

89-3 BTH 36 Sommerville, Anne A.

OSL DATING OF INCREASED SAND BLOW ACTIVITY IN THE ORKNEY ISLANDS, SCOTLAND: A RESULT OF VOLCANIC ERUPTIONS IN ICELAND?

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OSL dating has successfully dated periods of wind blown sand activity at archaeological sites in the Orkney Islands, Scotland which conform to periods of Holocene climate deterioration elsewhere. A site at Tofts Ness, Sanday was settled from the Neolithic but was abandoned in the late Neolithic/ early Bronze Age for approximately 1000 years before being resettled in the late Bronze Age and then permanently abandoned in the Iron Age. Sand layers lying above the late Neolithic soils have been dated by OSL to about 4000 BP and this correlates well with increased sand blow activity and abandonment of the World Heritage site of Skara Brae, also in the Orkney Islands. OSL dating of wind blown sands near to Tofts Ness at Lopness, suggests that sand dunes developed about 3000 BP, this age constrained by midden deposits and a Bronze Age burial underneath.

The climate impact of the Icelandic volcanic eruptions of Hekla 4 and 3 has been reported from archaeological sites elsewhere in Scotland and is thought to have resulted in the abandonment of settlements. We suggest that the dating of climate deterioration and increase in dune-building activity in Orkney also correlates well with the Hekla 4 and 3 eruptions, this being the first evidence to link the Icelandic eruptions to events in the Orkney Islands.

89-5 BTH 38 Lavrushin, Yu.

CATASTROPHIC LATE PLEISTOCENE AND HOLOCENE NATURAL EVENTS AND THEIR ECOLOGY RESULTS

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There are some important natural catastrophic events within European part of Russia: they are landscape's changes in the north of arid zone; desertification phenomenon; dust storms and ash falls; glacial catastrophic events during degradation stage in the north (serdges, lateral faults into glacier); hydrological events (Caspian sea level changes, lake's level changes; flooding events within river plain); sedimentary events in the glacial shelves, in the river and lakes with formation of glacial turbidity structures, gravity stream formations, suffusion-karst phenomenon, and paleoseismicity events; critical stages of land fauna evolution. Most of these events influenced on the primitive human cultures evolution and on primitive people society migration. Recognition the rhythmic of extremely events and their duration and reasons of their origin help to made prognoses scenarios of formation and evolution these processes in the future. It is very important to

account that catastrophic events are characterized by as linear and nonlinear regimes. Extremely natural events had occurred during as cold as warm period. Their influences on people's popular distribution are demonstrated in this report. (project 3.8. DSG RAS)

SESSION NO. 90, 1:30 PM

Wednesday, July 30, 2003

S26. Neglected Environmental Proxy Archives: Continental Shelves, Karst, and Drylands (Posters)

Reno Hilton Resort and Conference Center, Pavilion

90-1 BTH 39 Thomas, David S.G.

CHANGES: CARBON, HYDROLOGY AND GLOBAL ENVIRONMENTAL SYSTEMS. UNLOCKING UNDER-RESEARCHED ENVIRONMENTAL ARCHIVES

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CHANGES –Carbon, Hydrology and Global Environmental Systems- is a collaborative research initiative, supported by ICSU, IUGS and UNESCO, between four IGCP projects that focus on the records of environmental change from drylands (IGCP 413), karst terrain (IGCP 448), the continental shelves (IGCP 464), and the archives of climatic change held within past carbon cycle fluxes (IGCP 459). The principal aims of CHANGES are to • Co-ordinate specific strengths within the independent IGCPs ; • Synthesize existing data and data-bases ; • Identify the global role of each environment with respect to the dynamics of carbon, water and the 'greenhouse' gases. The overall purpose of CHANGES is to highlight the significance of these environments in better understanding the dynamics of terrestrial responses to global climate change. With regard to other environments, those in the CHANGES remit are often under-researched, yet they often contain important sedimentary, biological and geomorphological proxies of Quaternary environmental changes that can contribute to enhancing global interpretations of environmental dynamics.

CHANGES aims to contribute to the realisation of their potential as data sources that enhance understanding of global climate system dynamics during the Quaternary, and into the future. This is being facilitated through a range of actions including the development of an interactive data base that acts as an archive of peer- reviewed palaeoenvironmental records. Data collection and analysis is currently focussing on three key time slices: – The last glacial maximum – The Holocene climate optimum – 1000 BP

At the INQUA congress the rationale, development and content of the data base will be demonstrated, and future research plans explained.

90-2 BTH 40 Yim, Wyss W.-S.

PEDOGENESIS OF SUB-AERIALLY EXPOSED CONTINENTAL SHELVES DURING GLACIAL PERIODS AND THE PRODUCTION OF ATMOSPHERIC GREENHOUSE GASES

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The pedogenesis of sub-aerially exposed continental shelves is suggested to have played an important role in the production of atmospheric greenhouse gases causing a change in the earth's climate. During glacial periods including the Last Glacial Maximum (LGM), coral reefs contracted towards the equator. Both fossilized coral reefs and carbonate platforms became sites of karstification resulting in the release of carbon dioxide into the atmosphere through weathering. In muddy inner continental shelves such as the northern South China Sea off Hong Kong, the subaerial exposure of seafloor muds of marine isotope stage (MIS) 5, 7, 9 and 11 ages resulted in the release of greenhouse gases. Carbon dioxide was produced by acid-sulphate soil development through sulphuric acid reaction with biogenic carbonates while methane was generated through the bacterial decomposition of fossilized plant matter. The release of these greenhouse gases may be the triggering mechanism needed for switching the earth from a full glacial mode back into an interglacial mode (Yim et al., 2002). Such a mechanism is supported by the dramatic increase in carbon dioxide and methane content in the Vostok ice core following the glacial periods of MIS 2, 6, 8, 10 and 12 (Petit et al., 1999). The presence of methane trapped within pre-Holocene shelf sediments is supported by seismic profiles showing areas of the seabed affected by acoustic turbidity while microfabric studies of palaeo-desiccated crust developed in the upper part of MIS 5 muds (Tovey and Yim, 2002) also supported the conclusions drawn.

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90-3 BTH 41 García-Gil, Soledad

SHALLOW GAS FLUX RATES FROM THE RÍAS BAIXAS SEABEDS (NW SPAIN)

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The presence of shallow gas in marine sediments has a significant effect in their geoacoustic behaviour. Gas seepages affect seawater chemistry and have a poorly assessed effect on atmospheric carbon and methane levels.

The Rías Baixas of Galicia (Ría de Vigo, Pontevedra, Arousa and Muros) are located on the passive Atlantic margin of southwestern Galicia (NW Spain).

Objective layout grids of shallow seismic (Sparker, Uniboom, 3.5 kHz profiler), Echo sounder and Side scan sonar have been acquired from 1991 until 2001 in the Rías Baixas (Ría de Vigo, Pontevedra, Arousa and Muros). Detailed interpretations of the whole records have been allowed mapping of shallow gas accumulations and gas escape features in the four rías. X-ray photographs of gravity cores and vibrocores have been used as semi-direct evidence of the presence of gassy sediments.

Mapping of fluid escape areas shows that these are located either above the shallower gas accumulations or in the outermost zones of the gas accumulations fields, as well as at intersections of the main fault systems.

The spatial distribution of the gas escapes; gas accumulations and their vertical variations are interpreted as evidence of a sedimentary facies control, its permeability and the quantity of gas within them.

GC-MS analysis of direct gas samples shows the presence of methane in the shallow gas of the rías.

Quantitative data on gas flux rates from seabed seepages has been performed in the Rías. Calculations in the rías indicate mean densities of: 1.7 acoustic plumes km–2 from the Ría de Vigo; 7.9 acoustic plumes km–2 from the Ría de Pontevedra ;10.9 acoustic plumes km–2 from the Ría de Arousa and 7.4 acoustic plumes km–2 from the Ría de Muros.

Applying a similar calculation to that used by Judd et al. (1997) to estimate the flux of gas to the water column, we obtain a result of 206.25 Tm(C)/yr to 5907 Tm(C)/yr towards the water column in the Ría de Vigo; 45 Tm(C)/yr to 1289 Tm(C)/yr in the Ría de Pontevedra; 670 Tm(C)/yr to 19188 Tm(C)/yr in the Ría de Arousa and 74 TmC/yr to 2112 Tm (C)/yr in the Ría de Muros.

Assuming that a 30 % of gas is dissolved in the water column a total of 144 Tm(C)/yr to 4135 Tm(C)/yr get to the atmosphere in Ría de Vigo; 31.5 Tm(C)/yr to 902 Tm(C)/yr in the Ría de Pontevedra ;469 Tm(C)/yr to 13431 Tm(C)/yr in the Ría de Arousa and 51.625 Tm (C)/yr to 1478.54 Tm (C)/yr escape to the atmosphere in the Ría de Muros.

90-4 BTH 42 Chiocci, Francesco L.

GLACIAL/INTERGLACIAL CYCLE OF ORGANIC CARBON RELEASE AND SEQUESTRATION IN MID-LATITUDE SHELVES

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During the Quaternary glacial/interglacial cycles, the continental shelves experienced very dramatic environmental changes, passing from submergence to emergence i.e. from submarine deposition to subaerial exposure and erosion. So far the main contribution that such changes will produce on carbon cycle was identified in tropical environments due to the downwards displacement of carbonate factory and carsification of emerging reefs. In mid-latitude shelves however, a relevant role can be played by organic carbon being sequestrated in fine-grained sediment during sea level highstand and being released during sea level lowering and lowstand. An evidence of large amount of organic carbon within highstand deposits (prodelta and shelf mud) comes from high-frequency reflection seismics. In fact organic carbon discharged from rivers is buried within sediments where methane is usually generated. If methane concentration exceeds methane solubility, gas bubbles will form, hindering seismic wave penetration on sediment Shelves in both passive and active continental margins are suitable for storage of organic carbon, as passive margins host large river deltas whilst active margins are characterized by very narrow shelves with high sedimentation rates. However the highstand deposits have a very low preservation potential during a whole glacio-eustatic cycle. In fact margin architecture of mid-latitude shelves is essentially made up of forced regression and lowstand deposits, very different in geometry and seismic facies from present-day (highstand) shelf deposits. This fact is due to the fast sea level changes that cause the highstand deposits to be exposed to subaerial (and shoreline) erosion shortly after their deposition, so that they can be easily removed. Therefore the organic carbon trapped on highstand sediments will be released directly to the atmosphere during each glacial lowering of sea level. It is relevant to notice that such a phenomenon (release during glacial/lowstand, sequestration during interglacial/highstand) contrasts with the observed decrease of atmospheric methane concentration during glacial time. However it has to be taken into account as it may interfere with the other processes responsible of methane release or sequestration.

90-5 BTH 43 Chivas, Allan R.

AN INVESTIGATION OF CLIMATE HISTORY, SEA-LEVEL CHANGE, AND GEOLOGICAL PROCESSES IN MODERN TROPICAL EPEIRIC SEAS: APPLICATION TO GLOBAL CHANGE AND ANCIENT ANALOGUES

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As part of the IODP, we proposed drilling in the shallow epeiric seas of Australasia (Southeast Asia and northern Australia) using a Mission-Specific Platform. Despite the array of scientific opportunities afforded by tropical epeiric seas, a systematic study of these epeiric seas and the adjacent lands has yet to be conducted. The region of shallow cratonic seas spans the range of climates from the rain forests of the equatorial perhumid (everwet) tropics to the savannas of the semiarid tropics (seasonal). There are two goals of this proposal, 1) establish the long-term (Plio-Quaternary) history of climate and sea-level changes and the relation of this history to atmospheric processes where the greatest ocean-atmosphere transfer of heat and moisture occurs, and 2) develop a comparison between the physical and chemical sedimentary processes in modern tropical epeiric seas with the widespread cratonic seas of the pre-Neogene. In addition, a wide spectrum of associated research topics can be addressed, based on well-preserved strata that range from highstand shallow-water marine deposits to lowstand paleosols, riverine, and lacustrine sediments. The key investigative value of these sediments is their potentially complete preservation based on seismic records from the Gulf of Carpentaria and field observations in the epeiric seas of the Carboniferous. The preservation of both lowstand and highstand lithologies results from low energy in broad expanses of advancing and retreating shallow water, such as a tide over a mud flat. The effect is that complete transgressive/regressive cycles occurred without significant erosion or evidence of a lag deposit, thus preserving the marine and nonmarine strata, including paleosols. To fully understand the atmospheric, oceanic, and geologic processes active in an epeiric system, it is recommended that the study also include an onshore component.

90-6 BTH 44 Yim, Wyss W.-S.

POTENTIAL OF SURVEYING WORK OF SUBMARINE PIPELINES AND CABLES FOR STUDYING THE LATE QUATERNARY EVOLUTION OF CONTINENTAL SHELVES:

YIM, Wyss W.-S.[1], RIDLEY THOMAS, W.N.[2], HALE, R.E.[2], HUANG, G.[3], FONTUGNE, M.R.[4], PATERNE, M.[4], and PIRAZZOLI, P.A.[5], (1) Department of Earth Sciences, The University of Hong Kong, Pokfulam Road, Hong Kong SAR, China, wwsyim@hku.hk, (2) EGS (Asia) Limited, 9/F South, Somerset House, Taikoo Place, 979 King's Road, Quarry Bay, Hong Kong SAR, China, (3) Guangzhou Institute of Geography, 100 Xian Lie Road, Guangzhou, 510070, China, (4) Laboratoire des Sciences du Climat et de l'Environnement, UMR CEA/CNRS, 91198 Gif-sur-Yvette cedex, France, (5) Laboratoire de Geographie Physique, CNRS, 1 Place Aristide Briand, Meudon-Bellevue, 92190, France

For sustaining the continuous economic growth in the world, the installation of submarine pipelines and cables are needed. In this paper, the potential of using surveying work of submarine pipelines and cables for studying the Late Quaternary evolution of the northern South China Sea continental shelf is highlighted. The surveying work of submarine pipelines and cables commonly involves: (1) Geophysical surveys including side-scan sonar, multi-beam swath mapping and seismic profiling. (2) In-situ cone penetration testing of the strength of seafloor materials. (3) Coring of the seabed using a vibrocorer or gravity corer at ca. 2-km intervals for pipeline surveys and at ca. 10-km intervals for cable surveys. If the seabed is indurated, a grab sampler or a dredge is often used to provide confirmatory information. In the northern South China Sea continental shelf off Hong Kong, the surveying work of a submarine pipeline including vibrocores along a 93-km transect and the surveying work of a submarine cable with gravity cores or grab samples along a 440-km transect were studied. Seismic profiling information was interpreted to provide information on the Holocene-Pleistocene boundary and seafloor areas affected by acoustic turbidity was mapped. The core samples obtained were logged, measured for magnetic susceptibility and subsamples were taken for radiocarbon dating in order to permit the reconstruction of sea-level position during the post-glacial transgression. A call is made to researchers in different countries to lobby their respective governments to ensure that similar opportunities in other continental shelves are used for undertaking research work. Such work is seen to be needed to throw light on the contribution of sub-aerially exposed continental shelves to the global carbon cycle.

90-7 BTH 45 Yuan, Dao-Xian

KARST PROCESSES AND THE CARBON CYCLE

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The IGCP379 has been involved in global change study in two ways: assessing the modern contribution of karst processes to the content of CO2 in the atmosphere,and collecting karst records as paleoenvironmental proxies.

It is straightforward from the basic chemical reaction of karst processes that it can be both a sink or a source of CO2 in atmosphere. With every tonne of limestone dissolution,120 kg of carbon must have been taken as CO2 from the atmosphere; or in contrary,the same percentage of emission will take place when carbonate rock is deposited.

Some basic points regarding karst processes in global carbon cycle have been reached in IGCP 379's five year international collaboration:(1) carbonate rocks,the world biggest carbon reservoir which covers 99.55% of the world's total,are still active in global carbon cycle. According to monitoring,the variation of CO2 taken from atmosphere by limestone dissolution can be monthly and daily in the time scale,or even daily or hourly in CO2 emission;(2) Biogenic processes play a major role in limestone dissolution. These two changes occur almost synchronically. It is hard to take the limestone dissolution as a slow,merely inorganic chemical process,and seperate it from terrestrial biosphere as a long-term cycling; (3)the limestone denudation acts basically as a sink of atmospheric CO2. IGCP 379 has estimated the global annual removal of carbon from the atmosphere by karst processes as 6.08 hundred million tonnes annually,i.e, one-third of the missing sink in the current global carbon cycle model. The emission of CO2 from plate margin is considered as a source of atmospheric CO2.

The major contribution which Geology has ever made to global change study is providing information on paleoclimatic changes. The General Circulation Model was tested by records from deep sea sediments,corals,ice cores,lake deposits,and loess. Karst records are advantageous in this direction to some broad area of carbonate rocks without other paleoenvironmental proxies. IGCP379 members have worked on 34 sites for paleoclimatic reconstruction,which cover almost all the continents. For instance, with a 210cm long stalagmite taken from the DongGe Cave, Libo county,Guizhou province,south China,the paleoclimatic change from MIS 6 to 5c was reconstructed at an average resolution of 620 year. The end of Penultimate Glaciation was determined.

90-8 BTH 46 Smalley, Ian J.

RECORDING PALAEO-EVENTS IN THE CENTRAL ASIAN DRYLANDS- THE PERIMONTANE AND PERIDESERT LOESS REGIONS INTERACT

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The thick loess in Uzbekistan could one day rival the deposits in north China as an accessible store of environmental proxy archives. Thick loess deposits contain many palaeosols and other indicators of Quaternary climate change, but it is useful if the sedimentological setting is both simple and fairly well understood. The nature of a loess deposit does have some influence on its use as a 'climate register'. While Central Asia was part of the USSR there were many opinions in favour of the eluvial/ in-situ/ soil formation theory of loess development(the famous Berg theory) and this top-down approach is impossible to reconcile with 100m thick deposits and multiple palaeosols (and observed hydrocollapse). Many Central Asian investigators, particularly in Uzbekistan, retained the loess ideas of A.P.Pavlov(c.1900) which essentially divided loess into deluvial (slope) loess and proluvial (plains) loess. Direct deposition from water was required, and there are deposits, e.g. associated with the Chirchik river, that appear to be water-laid. Obruchev, by 1952, had reconciled aeolian deposition with the Pavlov scheme- but more progress in this direction is required. The PTD scheme allows loess particles to originate in the Tien Shan and eventually form airfall deposits. It is possible that the D1 deposits in the current scheme are what Pavlov would call 'deluvial' loess, and that the D2 deposits are 'proluvial' loess. A good case can be made for the D3 deposits being aeolian, and the D4 deposits the result of wind erosion. Once the true nature of the thick deposits has been determined, valuable palaeoclimatic data can be obtained. The 'desert' loess problem is very visible here because the desert edge is very close to the Tien Shan; there are important Quaternary processes still to be investigated in the overlap region.

90-9 BTH 47 Markovic, Slobodan B.

STRATIGRAPHY OF THE DANUBE LOESS

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Loess-paleosol sequences in the middle and lower reaches of the Danube river basin contain the longest and most complete climate records in central Europe from the last two million years. The Danube loess belt covers about 200.000 km2 in 11 countries: Germany, Austria, Czech Republic, Slovakia, Hungary, Croatia, Serbia and Montenegro, Rumania, Bulgaria, Moldova and Ukraine. Local loess-paleosol stratigraphic schemes have been defined in all these countries separately. The most important sites have been described at Krems, Stranzendorf, Cerveny Kopec, Paks, Stari Slankamen, Koriten and Novaya Etuliya (Map 1). Most of them reach into the geomagnetic Matuyama Epoch. Based on paleomagnetic, soil-stratigraphic and other paleoenvironmental data it is possible to correlate the sites and reconstruct the approximate climate development in the basin. Major environmental shifts affected the area in the middle Brunhes about 450,000 years ago and in the Upper Matuyama, about 800,000 years ago. We compare the combined Danube loess stratigraphic model (marked by a prefix D) with the record of the Chinese loess plateau and with the oxygen isotope variations recorded in deep-sea sediments (Table 1).

Table 1. Danube loess -stratigraphic model of the last approximately one million years and its relation to the Chinese loess, marine isotope stratigraphy (MIS), glacial cycles and local subdivisions at CK-Cerveny Kopec; K-Krems;P-Paks; SS-Stari Slankamen; KO –Korite and; NE- Novaya Etulia. Reversely magnetized units shaded.

Danube loess	Chinese loess	MIS	Glacial cycle	CK	K	P	SS	KO	NE
D S0	S0	1	A	A	KR1		SL S0		
D L1	L1	2-4	B	B3			SL L1		
D S1	S1	5		B2,B1		MF2	SL S1	S1	PK2
D L2	L2	6	C	C3			SL L2		
D S2	S2	7		C2,C1		BD	SL S2	S2	PK3.1
D L3	L3	8	D	D3			SL L3		
D S3	S3	9		D2,D1		BA	SL S3	S3	PK3.2
D L4	L4	10	E	E3			SL L4		
D S4	S4	11		E2,E1		MB	SL S4	S4	PK3.3
D L5	L5	12	F	E3			SL L5		
DS5	S5	13		E2,E1		Phe	SL S5		PK4
		14	G	G3					
		15		G2,G1		Mtp			
D L6	L6	16	H	H3			SL L6		
D S6	S6	17		H2,H1		hs2	SL S6	S6	PK5
D L7	L7	18	I	I1b			SL L7		
D S7	S7	19		I1a	KR4	PD1	SL S7		PK6
D L8	L8	20	J	J3			SL L8		
D S8	S8	21		J1	KR5	PD2	SLS8		PK7
D L9	L9	22-24	K	K3					incipient soil
D S9	S9	25		K1,K2	KR6				
D L10	L10	26	L						
D S10	S10	27		L1,L2					PK8

[1]*Financial support from the INQUA Excutive Commitee*

90-10 BTH 48 Borgatti, Lisa

LANDSLIDES: A NEGLECTED ENVIRONMENTAL PROXY ARCHIVE?

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To answer the questions concerning how and why climate has varied on different time-scales over the Quaternary, the key is to improve the documentation and understanding of natural variability for periods extending back beyond the instrumental record. Knowledge of past climate changes has to be gained from well-calibrated proxy data derived from natural archives. In an ideal situation such archives provide accurate records of climate history, can be dated with annual precision on a calendar year time-scale and can be correlated through time. Actually, no single archive encompasses such properties and information from different sources are to be merged in paleoclimatic reconstructions. Among these sources, however, landslides and in particular the temporal concentrations of instability events have been by now neglected, though they could improve significantly the insight of the environmental context as a whole. It should not be omitted that, even when the geomorphological evolution of a slope can be described by way of surveys, radiometric dating, cross-sections etc., its entire history may not be feasible and there can still be lacks in space and time due to the inherent mechanisms of landslide processes and to their episodic behaviour. Nevertheless, if landslides are regarded as proxy, these constraints can be overcome starting from the assessment of a site susceptibility to instability and the evaluation of the paleoclimatic significance of the landslides considered. Actually, the variation of stability conditions through time depends on the slope response to different potential causes, both external, such as climatic and seismic ones, and internal, such as geological, structural, hydrogeological etc. When climate is considered to be the main cause of instability, concentrations of events become significant in a paleoclimatic perspective, if a sufficient number of landslides have been recorded. Therefore, though the records of landslide activity are not likely to be considered as comprehensive proxy archives sensu stricto, still they can give a significant contribution to the establishment of a paleoclimatic multi-proxy database when the environmental context is analysed with a multidisciplinary approach.

90-11 BTH 49 Hetherington, Renee

LOST LANDSCAPES: A PALEOGEOGRAPHIC RECONSTRUCTION OF THE QUEEN CHARLOTTE ISLANDS ARCHIPELAGO, WESTERN CANADA 8.7 TO 14.2 KA BP

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The Americas' first humans are thought to have migrated down the west coast of North America subsequent to the last glacial maximum (LGM). However no evidence dating prior to 10.3 ka BP has yet been found along the British Columbia (BC) mainland - Alaska coast. Is this a conse-

quence of a lack of early archaeological sites, or is it because coastlines have shifted making site identification difficult.

A series of paleogeographic maps and isostatic crustal displacement maps chart the sequence of evolving landscapes and display temporal changes in the magnitudes and extent of crustal flexure which resulted in a lack of uniformity in relative sea levels across the Queen Charlotte Islands (QCI) region. These maps were derived from the integration of the following data sets: habitat characteristics and age of molluscs collected from submarine cores, submarine grab samples, and raised beaches; sedimentological analysis of cores and raised beaches; seismic reflection and sidescan sonar records; and bathymetry.

An estimated 690 m of glacial ice began retreating from Dixon Entrance after 14.5 ka BP and prior to 12.6 ka BP, permitting over 100 m of uplift in northern Hecate Strait. A forebulge persisted in Hecate Strait and QC Sound from 13.2 until after 9.7 ka BP implying fixed glacial ice on the BC mainland until ~10 ka BP. Paleogeographic reconstructions show two emergent ice-free terrains extending across the continental shelf (100-150 km) that could have been inhabited by plants and animals, including coastally migrating early humans. Ice-free terrain, present by 13.7 ka BP, were intermittently connected via a landbridge to the Queen Charlotte Islands and the BC mainland. Edible molluscan resources were available from at least 13.2 ka BP. Malacological evidence supports paleoceanographic and palynological studies of a late-glacial Younger Dryas cooling event around the southern limits of Hecate Strait and QC Sound, potentially requiring early peoples to migrate greater distances to collect coastal resources and/or increase their reliance on land-based resources. Early coastlines that have not been drowned and which may harbour early archaeological sites are identified along the western QCI and the BC mainland.

SESSION NO. 91, 1:30 PM

Wednesday, July 30, 2003

S29. Quaternary History of the Antarctic Ice Sheets from Geochronology of Marine and Terrestrial Glacial Deposits (Posters)

Reno Hilton Resort and Conference Center, Pavilion

91-1 BTH 50 Heroy, David Carlson

LAST GLACIAL MAXIMUM (LGM) ICE SHEET RECONSTRUCTION AND GLACIAL RETREAT HISTORY OF ANTARCTIC PENINSULA

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Recent models of maximum extent of ice during the Last Glacial Maximum (LGM) differ widely in terms of thickness and location of grounded ice in the Antarctic Peninsula region, largely due to a lack of adequate ground truth. In addition, the controls and timing of ice sheet retreat are poorly constrained. During the 2002 cruise of the Nathaniel B. Palmer we obtained multibeam swath bathymetry, high-resolution chirp sonar, deep tow side scan sonar, 62 sediment cores, and ~ 2200 km of seismic data to augment existing seismic and core datasets. Examination of these data reveals geomorphic evidence of grounded ice extending to the shelf break in many areas. Geomorphic evidence for a much expanded ice sheet includes mega-scale glacial lineations, grooves, drumlins, and line-sourced shelf break gullies. Mega-scale glacial lineations are draped with a thin veneer of glacial marine sediments imaged by chirp sonar, suggesting that these features were formed during the most recent glacial maximum. This interpretation is supported by sediment cores, which sampled diamicton covered by ice sheet proximal gravely mud, draped with laminated glacial marine sediments. Further, radiocarbon dating of foraminifera tests reveals ice retreat from the outer shelf by 14,000-13,000 yr BP. This compares favorably with LGM retreat dates from the inner shelf at Palmer Deep by 13,000 yr BP, supporting the hypothesis of rapid retreat in the region.

91-2 BTH 51 Smith, J.

HOLOCENE HISTORY OF GEORGE VI ICE SHELF, ANTARCTIC PENINSULA: INFERENCES FROM LAKE SEDIMENTS

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The recent collapse of several Antarctic Peninsula ice shelves has highlighted the need for a long-term perspective on ice shelf stability. An opportunity to obtain a highly detailed late-Quaternary history of one ice shelf is provided by Moutonnée Lake. Moutonnée Lake (ML) is a large, 50m deep epishelf lake impounded on the eastern side of Alexander Island by George VI Ice Shelf, which flows across George VI Sound from the Antarctic Peninsula. Detailed water chemistry measurements have shown ML to be clearly stratified. A distinct halocline occurs at 30m, where modern freshwater overlies marine water. Our hypothesis is that any changes in the stability of the ice shelf should leave distinct biological, chemical and lithological signatures in the lake sedimentary record. Biologically, ice shelf loss would see the present stratified water column replaced by a purely marine one. Significant changes in sedimentation are also likely to follow any change in the configuration of George VI Ice Shelf. Outcrops of igneous and metamorphic rocks with distinctive chemical and isotopic signatures are found on the western coast of the Antarctic Peninsula. These differ from the rocks of Alexander Island, which are predominantly sedimentary in origin. Restricted ranges of igneous and metamorphic clasts, transported through George VI Ice Shelf to Alexander Island, and deposited with locally derived sedimentary clasts, would be replaced, during periods of ice shelf loss, by a wide lithological assemblage dominated by ice-rafted debris and locally derived sedimentary clasts. To test this hypothesis, high-resolution studies have been performed on two sediment cores extracted from ML. Analyses have included physical (MS, LOI and CaCO3), biological (diatom and foraminifera) and isotopic measurements performed on both bulk sediment samples and individual foraminifera. Results demonstrate the existence of two distinct zones, where marine organisms (foraminifera and marine diatoms) and local sedimentary clasts dominate. Both zones coincide with elevated d13C values, interpreted here as enhanced marine activity. Taken together these data imply that George VI Sound has been free of the ice shelf on at least one occasion during the Holocene. Chronological control will be provided by 11 AMS 14C dates performed on individual foraminifera.

91-3 BTH 52 Bentley, Mike

ENVIRONMENTAL HISTORY OF SOUTH GEORGIA, SUB-ANTARCTIC SINCE THE LAST GLACIAL MAXIMUM

BENTLEY, Mike[1], ROSQVIST, Gunhild[2], DAVIES, Sarah[3], EVANS, David[4], HANSOM, James[4], GORDON, John[5], MORETON, Steve[6], HUBBARD, Alun[7], and HAYNES, Valerie[8], (1) Dept of Geography, Univ of Durham, South Rd, Durham, DH1 3LE, United Kingdom, m.j.bentley@durham.ac.uk, (2) Department of Physical Geography and Quaternary Geology, Stockholm Univ, S-106 91, Stockholm, Sweden, (3) Institute of Geography and Earth Science, Univ of Wales, Llandinam Building, Aberystwyth, SY23 3DB, United Kingdom, (4) Department of Geography and Topographic Science, Univ of Glasgow, Glasgow, G12 8QQ, United Kingdom, (5) Earth Science Group, Scottish Nat Heritage, 2 Anderson Place, Edinburgh, EH6 5NP, United Kingdom, (6) NERC Radiocarbon Laboratory, Scottish Enterprise Technology Park, East Kilbride, United Kingdom, (7) School of Geosciences, Univ of Edinburgh, Drummond St, Edinburgh, EH8 9XP, United Kingdom, (8) Department of Environmental Science, Univ of Stirling, Stirling, FK9 4LA, United Kingdom

We report here the preliminary findings of an integrated study on the environmental history of the island of South Georgia. Fieldwork was carried-out in December 2002 – February 2003. The island lies just south of the Antarctic Polar Frontal Zone (or Antarctic Convergence), a key climatic boundary between southernmost South America and the Antarctic. As such, the island provides a key site for studying the relative phasing of environmental change in Antarctica and the rest of the world. Recent work (Rosqvist et al., 1999) has suggested that LGM ice sheet extent in South Georgia may have been restricted to the inner fjords and that substantial deglaciation may have occurred as early as 18,000 calendar years ago. This is a substantially more restricted glaciation than the continental shelf edge extent suggested by earlier workers. Moreover, the relative early timing of deglaciation suggests that the island was responding to 'early' warming in Antarctica, rather than the later warming shown by deglaciation and vegetation response in southern South America.

We are using a combined geomorphological-limnological-modelling approach to test these hypotheses and to understand post-glacial environmental change on the island since the Last Glacial Maximum. There are three linked foci of our work. First, we have carried-out geomorphological mapping of glacial and marine limits at several sites and will date (C-14 and cosmogenic isotopes) these to test the restricted glaciation hypothesis. Second, we have cored several lakes to determine basal dates for deglaciation, as well as Late-glacial to Holocene climate change. The third focus is concerned with understanding the controls on glacier behaviour on South Georgia. For this we are determining detailed historical glacier chronologies and comparing to meteorological records, as well as carrying-out computer modelling of the response of South Georgia glaciers to climate change. The modelling effort will also be tied to the palaeo-glacier chronologies to aid inference of past climate change during the glacial-interglacial transition.

Rosqvist, G. , Rietti-Shati, M. and Shemesh, A. 1999. Late glacial to middle Holocene climatic record of lacustrine silica oxygen isotopes from a Southern Ocean island, Geology, 27(11), 967-970.

91-4 BTH 53 Rosqvist, Gunhild C

MILLENNIAL-SCALE CLIMATE CHANGES ON SOUTH GEORGIA, SOUTHERN OCEAN

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The location of South Georgia (54°S, 36°W) makes it a suitable site for the study of the climatic connections between temperate and polar environments in the Southern Hemisphere. Because the mass-balance of the small cirque glaciers on South Georgia primarily responds to changes in summer temperature they can provide records of changes in South Atlantic Ocean and atmospheric circulation. We use greyscale density, weight loss-on-ignition and grain size analyses to show that the proportion of glacially eroded sediments to organic sediments in Block Lake was highly variable during the last 7400 calendar year B.P. We expect that the glacial signal is clearly detectable above noise originating from non-glacial processes and assume that an increase in glacigenic sediment deposition in Block Lake have followed Holocene glacier advances. We interpret proglacial lake sediment sequences in terms of summer climate warming and cooling events. Prominent millennial-scale features include cooling events between 7200-7000, 5200-4400, and 2400-1600 cal yrs B.P. and after 1000 cal yrs B.P. Comparison with other terrestrial and marine records reveals that the South Georgian record captures all the important changes in Southern Hemisphere Holocene climate. Our results reveal a tentative coupling between climate changes in the South Atlantic and North Atlantic because the documented temperature changes on South Georgia are anti-phased to those in the North Atlantic.

91-5 BTH 54 Keller, Randall

POTENTIAL FOR TEPHROCHRONOLOGY OF MARINE SEDIMENT CORES FROM BRANSFIELD STRAIT AND THE NORTHWESTERN WEDDELL SEA

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For marine sediments around the Antarctic Peninsula, there is a critical need for chronostratigraphic tools alternate to 14-C dating. In the South Shetland Islands and Bransfield Strait (northern Antarctic Peninsula) there are at least four subaerial volcanic centers that are capable of producing Quaternary ash layers. We have undertaken a reconnaissance electron microprobe survey of individual shards in ash layers in sediment cores from Bransfield Strait to assess the potential for tephrochronology of the cores and to document Quaternary volcanic activity in the area. We are concentrating on ash layers that primarily consist of glass shards and angular mineral fragments, and avoiding those that contain evidence for substantial disturbance or reworking, such as abundant microfossils and rounded lithic fragments.

Almost all of the analyzed ash layers match rock compositions on Deception Island, a caldera-topped volcano that is the largest in the region, and the only one known to have been historically active. At least one of the Deception ashes extends as far as 190 km to the ESE, where it is found in a core from the Vega Drift (northern Prince Gustav Channel, Weddell Sea). That Vega Drift ash layer has an approximate age of 6500 years before present, based upon interpolation between radiocarbon dates of fossil shells found elsewhere in the same core (see Domack et al., this session). This widespread ash layer may be useful for stratigraphic correlation throughout the northern Antarctic Peninsula region.

Two ash layers in a core in northeastern Bransfield Strait are distinctly different in composition from the Deception Island ashes, but are similar to published analyses from the Penguin Island and Melville Peak volcanoes, both located about 30 km northwest of the core location. These two ash layers are the first known evidence for the timing of eruptions at Penguin and Melville. We do not have radiocarbon dates from this core, but based upon preliminary correlation with the dated

core from the Vega Drift, the Penguin and Melville eruptions may have been on the order of several thousand years ago, and may provide useful stratigraphic markers on a more local scale.

91-6 BTH 55 Todd, Claire E.

EXPOSURE DATING OF GLACIAL ERRATICS FROM THE SOUTHERN ELLSWORTH MOUNTAINS, ANTARCTICA

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Dating of glacial deposits in Marie Byrd Land, central West Antarctica and the Ross Sea indicates that the West Antartic Ice Sheet (WAIS) reached its maximum size thousands of years after the Northern Hemisphere ice sheets and that deglaciation continued into the Holocene. However, there is little evidence to constrain the timing of deglaciation elsewhere in West Antarctica. We are dating erratics from the Marble Hills in the southern Ellsworth Mountains to investigate the deglaciation history of the Weddell Sea sector of the ice sheet.

Glacial erratics, spanning altitudes from 1390 to 980 meters, were collected from surfaces overrun during the last glacial maximum and exposed as the ice sheet thinned. The apparent ages of three samples analyzed predate the last glacial maximum. We interpret these results as evidence of recycling and prior exposure. A fourth sample collected ~160 meters above the ice margin yielded an age of 4100 ± 300 years, indicating significant late Holocene ice retreat. This preliminary result may suggest delayed deglaciation as seen in the Ross Sea sector of the WAIS. Analysis of the remaining samples, currently in progress, will provide a representative thinning history for ice flowing into the southern Weddell Sea.

91-7 BTH 56 Cowdery, Seth G.

PLIOCENE-PLEISTOCENE GLACIAL HISTORY OF MARIE BYRD LAND, WEST ANTARCTICA, FROM COSMOGENIC NUCLIDE MEASUREMENTS ON BEDROCK

COWDERY, Seth G. and STONE, John O., Department of Earth and Space Sciences, Univ of Washington, Box 351310, Seattle, WA 98195-1310, scowdery@u.washington.edu

Cosmogenic nuclides are produced at the Earth's surface in specific ratios to one another, but decay at different rates. Disequilibrium between nuclides measured in a single sample indicates a complex history of burial and exposure. Although the specific number, timing, and duration of burial and exposure events generally cannot be determined, minimum cumulative burial and exposure times can be calculated.

We have measured cosmogenic Al-26 and Be-10 in quartz from bedrock surfaces throughout the Ford Ranges, in West Antarctica. With the exception of heavily scoured surfaces at low altitude (where overriding ice was thickest), bedrock surfaces have apparent exposure ages much older than the last deglaciation and show disequilibrium between Al-26 and Be-10. We interpret these results in terms of exposure during interglacial periods and episodic overrriding by cold-based, weakly erosive ice, as follows: (1) Mountaintop surfaces show evidence of longer cumulative exposure and shorter cumulative coverage by ice than surfaces at lower altitude, as expected. (2) Samples from inland sites and higher altitudes, where overriding ice was thinnest and coldest, record the longest cumulative exposure and burial histories. (3) The oldest surface encountered so far records a minimum of 3.5 million years of cumulative burial by ice, compared to a minimum of 130,000 years of cumulative exposure. (4) The Al-26 exposure age of this surface is so short that it cannot have been exposed for more than 10,000 years within the past million years. (5) Observation (4) above suggests that the present deglaciation of West Antarctica is among the most extensive to have occurred in the mid- to late-Quaternary. (6) Bedrock weathering, including surficial oxidation, salt and gruss accumulation, is the result of repeated exposures separated by periods of non-erosive or weakly-erosive ice cover. Heavy weathering of bedrock cannot be taken as evidence of prolonged ice-free conditions. This research is supported by LLNL-CAMS and NSF award OPP-0229915.

91-8 BTH 57 Mackintosh, Andrew

LATE QUATERNARY FLUCTUATIONS OF THE EAST ANTARCTIC ICE SHEET IN THE FRAMNES MOUNTAINS

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An understanding of past changes in the East Antarctic Ice Sheet is essential for predicting future changes and sea level. The ice sheet has a response time of thousands of years and has not fully adjusted to late Quaternary and Holocene climatic and sea level changes. Ice sheet models are the best tools for understanding time-dependent, continental-scale ice fluctuations. However, the models must explain past changes before they can be considered reliable. Unfortunately, terrestrial field evidence is geographically sparse, and provides a weak horizontal and poorer vertical constraint of past ice extent. Here we present new data from the Framnes Mountains, that stretch from the coast near Mawson Station, to ~50 km inland. 10Be and 26Al analyses were performed on subglacially rounded erratic boulders from summits up to 500 m above the present day ice sheet surface, thus providing a direct constraint on ice volume changes through time. Three former ice levels are identified – 1) Glacial erratics from the last local glaciation show ice sheet thickening of 300-400 m, leaving some summits ice-free throughout this period. 2) Moraines ~200 m above the contemporary ice mark a break in retreat or perhaps a local readvance, and 3) Boulders deposited recently within 100 metres of the present ice sheet indicate relative stability of the ice edge. The cosmogenic dates, due in late 2003, will reveal the timing of these events. If the landforms date from the last global glaciation, our evidence will indicate that the c. 1000 m of ice thickening suggested by some ice sheet models did not occur in this area. Models must address these issues before they are used to assess the future stability of the ice sheet in a warmer world.

91-9 BTH 58 Oberholzer, Peter

CONSTRAINTS TO THE AMPLITUDE OF PLEISTOCENE ICE LEVEL VARIATIONS IN THE TRANSANTARCTIC MOUNTAINS FROM GLACIAL GEOMORPHOLOGIC MAPPING AND SURFACE EXPOSURE DATING

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Did the volume of the Antarctic ice cover fluctuate synchronously to the past climate changes that occurred in the northern hemisphere? Or have the southern ice sheets remained unaffected by these partly abrupt warming and cooling events? The glacial deposits at the margin of the East Antarctic Ice Sheet (EAIS) reflect volume changes of the inland ice in the past. We have mapped glacial landforms on nunataks and in other ice-free areas along the Transantarctic Mountains within an project ongoing since 1996. The result is a series of 1:250,000 scale geomorphological and glaciological maps showing in detail the distribution of glacier and sea ice features, glacial, periglacial, aeolian and weathering landforms and deposits. At least five glacial drifts at different elevations have been differentiated and correlated over large areas. In addition, we have dated erosional and depositional glacial features at selected sites by surface exposure dating with in-situ produced cosmogenic He-3 and Ne-21. At the Ricker Hills, situated 100 km inland west from the Ross Sea coast, we obtain new exposure ages ranging between 160 and 680 ka. The combination of mapping and dating allows the conclusion that the EAIS did undergo surface level changes throughout the Pleistocene, but that these have been of limited amplitude, up to 500 m on Ricker Hills. This agrees with findings from further north in Northern Victoria Land. More datings from the same and other sites are in progress.

91-10 BTH 59 Hallet, Bernard

MICRO-RELIEF AND DEBRIS COVER DEVELOPMENT IN POLYGONAL PATTERNED ICE IN ANTARCTICA: A MODELING PERSPECTIVE

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Contraction cracks are ubiquitous in the Dry Valleys of Antarctica where they define extensive areas of polygonal patterned ground. Despite the hyper-arid conditions of the region, the contraction cracks reflect extensive ground ice and, in places, massive subsurface ice beneath a debris mantle. The micro-relief and characteristic of the debris layer provide useful clues about the nature of the subsurface, and because they can be detected remotely, they are likely to be of interest in studies of permafrost regions not only on earth but also on Mars.

Herein, we describe a modeling approach aimed at better understanding the micro-relief and debris cover that develop over a long time above massive debris-rich ice that is actively sublimating. Any reasonable quantitative description must account for the progressive growth of sand-wedges or ice-wedges at sites of contraction cracking, extensive sublimation of the ice and surface accumulation of debris formerly contained in the ice, modulation of ice sublimation rate by the protective debris cover, and lateral motion of the debris driven by surface slope as the micro-relief develops. The model unifies these processes to produce a slowly evolving micro-topography and a debris-layer thickness distribution that are comparable to those in actual polygons. It also calculates deformation fields in the ice and debris that are consistent with the spatially varying sublimation rate, steeply dipping foliation commonly seen in the ice at the periphery of polygons, and exposure age histories obtained from vertical profiles of cosmogenic isotopes in the debris cover, as well as in the ice. Our model results help define the time scale over which the ground surface would be completely reworked, which has rich implications for the age and interpretation of landscape surfaces in Antarctica.

91-11 BTH 60 Dickinson, Warren W.

TEMPERATURE CONTROL ON POLYGONAL GROUND, TABLE MOUNTAIN, ANTARCTICA

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We present the results of 14 months high-precision ground temperature measurements at two sites in cold, dry permafrost at Table Mountain in the McMurdo Dry Valleys, Antarctica. The scale of polygonal ground differed by a factor of 3 at each site and sediment composition was significantly different. Temperature was recorded with thermistor arrays at depth intervals of 13.5cm and time intervals of 4 hours from the surface to a depth of 2 meters. We find that the thermal dynamics are well described by one-dimensional linear heat flow with no latent heat effects and resolve a composition- and temperature- dependent thermal diffusivity. Effects normally associated with liquid water in permafrost can be ignored because the temperatures in the ice-cemented ground are always below minus 10 degrees C.

The diffusivity (D) is 2-3 times higher than for freeze-thaw permafrost and has a range of 1-3 x10-6 m2/s. The diffusivity is 18±9% higher in the winter than in the summer, close to that expected from the temperature dependence of the ice-cement thermal conductivity and heat capacity. We estimate the heat capacity (C) of core samples from the installation holes to be 2.0±0.2 MJ/m3 and calculate thermal conductivity profiles with a range of 2-6 W/m°C, that agree with a separate quasi-static analysis. The diffusivity and conductivity profiles correlate very well with the composition and ice content of the recovered cores. Our measurements and analysis provide new precision and accuracy for determining non-constant thermal properties. The graphical analysis is a new approach to the simple extraction of thermal properties from temperature profiles and is more robust than other similar methods.

91-12 BTH 61 Lederer, Jason R.

PROVENANCE OF ROSS SEA TILL

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The coarse sand fraction of till samples from cores retrieved beneath the Whillans Ice Stream and Ice Stream C in West Antarctica and samples collected from six locations in East Antarctica have distinct petrologic signatures. Thirty-three samples of Last Glacial Maximum (LGM) till from across the Ross Sea exhibit compositional similarities to the East and West Antarctic source terranes.

The coarse sand fraction of East Antarctic till is dominantly composed of angular intermediate to mafic lithic fragments, fine-grained quartz-rich detrital sediments, rounded quartz, rounded metamorphosed carbonate lithic fragments, angular pyroxene, and rounded feldspar grains. Adjacent western Ross Sea till exhibits compositional similarities with East Antarctica tills with the exception that several western Ross Sea samples containing higher percentages of felsic and sedimentary lithic fragments.

The coarse sand fraction of West Antarctic till is dominantly composed of rounded quartz grains, rounded feldspar grains, sedimentary lithic fragments containing primarily quartz, and felsic lithic fragments containing predominantly quartz and phyllosillicates (biotite and chlorite). Adjacent eastern Ross Sea tills exhibit compositional similarities with West Antarctic till.

The central Ross Sea till exhibits compositional similarities to both the East and West Antarctic source terranes. The coarse sand fraction includes: rounded quartz; rounded feldspar; angular felsic - mafic lithic fragments; quartz-rich detrital sediments; rounded limestone, some of which contain ooids; angular pyroxene; and extrusive lithic fragments. Although absent in the source terrane

till samples, oolitic limestone has documented occurrences in the Holyoake Range, which flanks the Nimrod Glacier in East Antarctica. Expansion of the East Antarctic ice sheet into the central Ross Sea is also supported by the presence of mafic lithic fragments, which are unique to the East Antarctic tills. These qualitative observations linking Ross Sea till to source terrane samples are also supported by cluster and discriminant analysis. Therefore, we conclude from the sand petrography of Ross Sea till that both the East and West Antarctic ice sheets contributed to the expansion of LGM-age ice into the central Ross Sea.

91-13 BTH 62 Hall, Brenda L.

CHRONOLOGY OF PROGLACIAL AND LATERAL LAKES IN THE DRY VALLEYS

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An understanding of lake sediments is key to interpreting the late Quaternary glacial history of the Dry Valleys. This is illustrated by the fact that almost all chronologic information for this area comes from algae or precipitates that formed in proglacial or lateral lakes. In addition, proglacial lakes can transport glacial sediments tens of kilometers beyond the grounding line by a process known as the lake-ice conveyor. Conveyor sediments make up a unique landform assemblage, the identification of which is necessary to interpretations of former glacier extent and chronology.

During the last glacial maximum (LGM), lakes several hundred meters deep filled the Dry Valleys. AMS radiocarbon and TIMS uranium-thorium dates of algae and carbonate precipitates indicate that all lakes were significantly higher than at present by 20,000 14C yr B.P. Many of these lakes afford important information on the extent, thickness, and dynamics of the Ross Sea ice sheet, as well as of local glaciers. For example, the presence of lacustrine sediments to 350 m elevation in Taylor Valley requires thick grounded Ross Sea ice in the valley mouth in order to dam the lake. In nearby Wright Valley, Glacial Lake Wright reached 566 m elevation, indicating that the Wilson Piedmont Glacier must have been at least 100 m thicker at the LGM than it is today. Otherwise, the lake would have drained. Conversely, the presence of lacustrine sediments of infinite age thrust up within Victoria Lower Glacier suggests that the glacier is now at its maximum extent in at least the last 50,000 years. Current work is focusing on developing a chronology of lake-level fluctuations and on improving understanding of any lake-bottom radiocarbon reservoir effects.

91-14 BTH 63 Hodgson, Dominic A.

LATE QUATERNARY INTERGLACIAL AND SUBGLACIAL ENVIRONMENTS IN AN EASTERN ANTARCTIC OASIS

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Information on late Quaternary environments in Antarctica is primarily derived from ice cores from the interior and marine sediment cores from the continental shelf. Ice cores permit temperature reconstructions derived from changes in atmospheric composition and marine cores can document changes in biological production. However, there is limited information on environmental changes in terrestrial and freshwater environments of the late Quaternary era in Antarctica due to removal of stratigraphic records by glacial erosion. Recent evidence suggests that some east Antarctic coastal oases had limited ice cover through the Last Glacial Maximum. In one of these oases, the Larsemann Hills, a sediment core was collected from a 38 m deep lake and studied for geochronology, sedimentology, biological and biochemical markers. Results suggest that the first sediments were deposited during the Eemian interglacial. Diatoms and pigments reveal a productive biological community consistent with warmer conditions at this time. This was followed by a subglacial period resulting in almost complete suppression of biological activity in the lake. Whilst we cannot exclude that life persisted under these subglacial conditions, it would have done so under an extremely impoverished light, oxygen and nutrient regime. Just over 4500 years ago the lake re-emerged from under the ice and biological production resumed but with a lower biological diversity, lower rates of pigment production and a different species assemblage compared with the preceding interglacial. This suggests cooler conditions during the Holocene than the Eemian interglacial and a high degree of species turnover. The sediment sequence gives scientists an opportunity not only to compare environments of the last two interglacials but also to examine the biological consequences of a lake becoming subglacial.

91-15 BTH 64 Miura, Hideki

LATE QUATERNARY ICE HISTORY ALONG THE SOYA COAST, LUTZOW-HOLM BAY, ANTARCTICA

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The paleoenvironment during the late Quaternary along the northern Soya Coast, Lutzow-Holm Bay, can be estimated on the basis of the raised beach stratigraphy, AMS ^{14}C ages and oxygen isotopic ratios of the fossil shells. The AMS ^{14}C dating revealed that the ^{14}C ages of *in situ* fossil shells are clearly classified into two groups: the younger group is 3,000-8,000 yrs BP, in the Holocene, and the older is 30,000-46,000 yrs BP, in the late Pleistocene, probably the last interstadial, without the reservoir corrections. The locality containing the late Pleistocene *in situ* fossils is confined to the northernmost part of the Soya Coast region. This fact indicates that marine transgression occurred twice during the late Quaternary in that region. In the northernmost part of the Soya Coast region, extremely fragile shells of *Laternula elliptica*, dated in the last interstadial, retain their living form in situ in the raised beach sediments without removal or shattering by the ice sheet. This fact indicates that the East Antarctic Ice Sheet had retreated at least from the Ongul Islands and the northern part of Langhovde by the last interstadial, and did not advance over the Ongul Islands and the northern part of Langhovde again, even during the LGM. It is not clear whether the southern part of Soya Coast was free from the East Antarctic Ice Sheet during the interstadial or not. However, most ice-free rocks on the southern part of the Soya Coast had become free from the East Antarctic Ice Sheet by the middle of the Holocene. The values of ^{18}O (PDB) for the Holocene and last interstadial shells of Ongul Islands range from about 3.9 to 4.6 ñ; on the other hand the values for the last interstadial shells of Langhovde range from about 2.9 to 3.8 ñ. The difference of oxygen isotopic ratio is considered to mostly depend on ^{18}O-depleted melt water from the Antarctic ice sheet. This also suggests that the ice margin of the East Antarctic Ice Sheet had been located at the northern part of Langhovde during the last interstadial.

SESSION NO. 92, 1:30 PM

Wednesday, July 30, 2003

T1. Quaternary Sea Level Changes and Their Physical Biological and Oceanic Impacts (Posters) (*Commission on Sea-level Change and Coastal Evolution*)

Reno Hilton Resort and Conference Center, Pavilion

92-1 BTH 65 Kumaresan, Anbarasu

QUATERNARY SEA LEVEL CHANGES ALONG THE COAST OF TAMILNADU,INDIA

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Introduction : East coast of India –emergence type – mostly littoral low lands- living corals in two places – suitable for the study of sea level changes.

Study area : Tamilnadu- southern part of east coast of India

Geomorphology: Width of the Coastal plains ranges from few meters to 80 Km- beaches, beach ridges, cheniers, terraces, mudflat, lagoons, raised corals, spits and bars etc. Tectonism: Evidences for neotectonism are present in the form of cymatogenic downwarping

Sea level indicators :

Geomorphic -

Beach ridge plains around Vedaranyam – 1,25,000 years BP (TL Date) Beach ridge plains around Chidambaram -Marine terraces around Pondicherry-Raised corals in Rameshwaram island- Barrier ridges around Marakkanam - 6000yearsBP

Archealogic - Submerged Roman fort in Arikamedu – 1,850 - 1,700 BP Submerged town of Kaveripatnam - 1,900 - 1,700 BP Quaternary sea level history:

Events Age Indicator

Transgression I maximum 1,25,000 years BP Cheniers

Transgression II maximum 6,000 years BP Younger beach ridges Regression minimum 1,900 – 1,700BP Developmentofancient cities and ports in reclaimed land area. On going transgression From 1500 years BP submergence of the developed cities and ports under water

92-2 BTH 66 Abuodha, Pamela Atieno

SEA LEVEL CHANGES ON THE KENYAN COAST DURING THE QUATERNARY PERIOD

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Kenya is found on the African continent in the East bordering the Western Indian Ocean. The Kenya coast is approximately 600 km long from Kiunga in the north to Vanga in the south. Along the coast of Kenya, coastal terraces, dunes, cliffs and beach ridges are among the most important geomorphological features indicative of the Quaternary sea level changes. Coral reefs in coastal Kenya occur as fringing coral platforms, running parallel to the shoreline on the coastline. In other places the coral reefs occur as platforms on the intertidal flat and as backshore raised reef limestone, forming cliffs of 12- 15 m high.

In Northern Kenya dune ridges are the main characteristics of the coast. Sometimes at least two generations of dune ridges can be found, the older probably being of young Pleistocene age, the younger closer to the sea of Holocene age.

In the Southern Kenya, the coast becomes very complex. Cliffs formed by wave erosion in coral rocks with raised shorelines are the most prominent feature indicating a shoreline of emergence. However, where fresh water reaches the coast, deep creeks are found. Mangrove swamps are very common especially in muddy areas where fresh water enters the coast.

Coastal terraces occur as distinctive platforms in stepwise manner in many places along the coast of Kenya. The terraces were cut during the Pleistocene to recent fluctuations in sea level. The beach ridges, closely associated with the dunes are of variable Holocene age. Coastal terraces that have been recognized by various workers are the Matuga surface (90-140 m), Changamwe terrace (45-70 m), Ganda terrace (20-37 m), Kilifi terrace (15-18 m), Malindi terrace (7-10 m), Shelly beach terrace (4-5 m), Leven Reef terrace (0-2 m) and the submarine platforms at -5 and -15 m below datum.

It has been assumed that the shore terraces of Kenya correspond to eustatic movements of sea level. However, if the dating were reasonably correct, the terraces would be found well below sea level if no rise of land had occurred during the time in question. Evidence of tectonic movements can be seen in the dipping of sedimentary strata on the coast in Kenya. It can therefore be concluded that the geomorphology of the Kenya coast is not only as a result of sea level changes but also due to isostatic readjustments and tectonic movements.

92-3 BTH 67 Aliyeva, Elmira

QUATERNARY CASPIAN SEA: DYNAMICS OF LEVEL FLUCTUATIONS AND RESPONSE GEOCHEMICAL CHANGES

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Quaternary history of the Caspian Sea –lake represents an uninterrupted changes of the transgressive and the regressive phases. For the example on the background of the general tendency of the Caspian Sea level fall since the beginning of XXth century repeated temporary rises (measured by from some tens of centimeters to 1-2 m) have taken place. Analyzing climatic conditions through the Quaternary time one can say that the Caspian Sea level has been rising in a humid (pluvial) setting in the Caspian basin, which is characterized by the increase of atmospheric precipitation and the decrease of temperature and evaporation. Such conditions existed at the borders of interglacial and glacial periods that is proved by direct correlation of the Caspian Sea transgressions with climatic events of Europe on the base of absolute age data. The regressive phases in Caspian Sea Pleistocene history took place both in the maximum of glaciation epochs and interglacial periods, which have been followed by reducing of atmospheric precipitation led to sea level drop. Thus, Caspian Sea level short-periodical fluctuations have been initiated by general Eurasian climate change reflecting the eustatic processes of the North Atlantic Ocean. Such dramatic environmental changes led to considerable shifts in geochemical setting. Through the Late Pliocene-Quaternary section one can observe significant variations in bionomic conditions of

the basin expressed in differentiating of Fe/Mn, Sr/Ba values. Late Pliocene Caspian Sea was characterized by the largest salinity and depth- (Fe/ Mn - 5; Sr/ Ba - 0.41), which then significantly reduced in the Early Pleistocene (Fe/ Mn - 7.1; Sr /Ba - 0.134). Middle-Upper Pleistocene basins' depth and salinity underwent numerous variations, reaching the lowest values at the end of Pleistocene time- 6-7 promiles. Being based on ferrous/ferric oxide ratio one can observe unstability of geochemical regime in studied basins. The strong reduction conditions in Late Pliocene have been changed by weak reduction geochemical facies at the beginning of Early Pleistocene transforming then into moderate reduction setting at the end of Lower Pleistocene. Analogous geochemical environment preserved during Middle- Upper Pleistocene.

92-4 BTH 68 Petersen, Kaj Strand

LATE QUATERNARY ENVIRONMENTAL CHANGES RECORDED IN THE DANISH MARINE MOLLUSCAN FAUNAS

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Late Quaternary, marine deposits in Denmark have yielded 247 subfossil species of molluscs. The sites are presented, and comparisons are made between the subfossil mollusc assemblages and the 278 shell-bearing mollusc species presently living in the Danish seas. 184 species are common to the two groups. The 63 species no longer occurring around Denmark are used as indicators of changing environmental conditions, including temperature, salinity and depth, throughout the last 130,000 years. Seven modern faunal regional units are defined and considered: the Baelt, the Baltic, the Kattegat, the Limfjord, the North Sea and the Vendsyssel regions, and the Skagen area based on the Skagen III Well DGU File No. 1.287. The Late Quaternary, marine, shell-bearing molluscs, comprising 341 subfossil and recent species, are characterized from the point of view of climatic (i.e., Arctic, Subarctic, Boreal and Lusitanian) affinities and animal-sediment relationships. On this background the faunal and environmental evolution recorded in the 217 m long Skagen Well core is analysed and described. The mollusc assemblages in the Skagen sequence indicate a deeper-water facies during the Eemian, the Weichselian and the older Holocene in contrast to what hitherto was known in other parts of the Danish area during the Late Quaternary. For the Skagen Well the chronozones Preboreal/Boreal, Atlantic, Subboreal and Subatlantic can be identified by 14C dating. The environmental changes within the seven regions through the Late Quaternary are evaluated by depicting the molluscan communities encountered in the seven Late Quaternary stages together with remarks on studies of the neighbouring areas. By following the marine communities through the Late Quaternary in the light of the classical bottom communities sensu C.G.J. Petersen, it is demonstrated how facies have changed both through time and space within the Danish marine realm. The well-established, more temperate Eemian marine fauna was closely associated with shallow-water environments. The inferred climatic changes reflect an interglacial-glacial cycle. However, the climatically induced changes during the Holocene in the marine environment were small and overshadowed by the facies changes.

92-5 BTH 69 Morén, Lena

SCENARIOS OF PAST AND FUTURE SHORE-LEVEL DISPLACEMENT IN SCANDINAVIA

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Crustal movements and shore-level displacement will affect subsurface conditions of importance for the performance and safety of deep geological repositories for spent nuclear fuel. To support performance and safety analysis an empirical model of the glacio-isostatic movements and shore-level displacement for the area covered by the Scandinavian ice sheet during the Weichselian glaciation has been developed.

The model was initially based on detailed lake-tilting investigations. These made it possible to express the course of glacio-isostatic uplift in mathematical terms without using rheological assumptions. In addition to the lake-tilting information the model is based on 72 shore-level curves from all over Scandinavia and information concerning present relative uplift recorded by precision levelling and tide gauge data.

The main uplift, still in progress, is mainly calculated from two factors designated the down load factor and the inertia factor. The down load factor represent the subsidence/uplift at the time for the maximal subsidence/uplift rate, and the inertia factor describes the evolution of the subsidence/uplift with time. There is a strong linear correlation between the inertia factor and lithosphere thickness. The model has been incorporated into a GIS (Geographic Information System) application, and can be illustrated together with other GIS data.

The purpose of the modelling was to illustrate the course of events since the last deglaciation and the model is based on Late Weichselian and Holocen information. However, scenarios of past and future shore-level displacement have been constructed assuming that the depression of the crust is proportional to the ice load and that the evolution of the subsidence/uplift in time always follows the same pattern as geological data indicates it did after the last glaciation.

92-6 BTH 70 Firth, Callum Richard

PATTERNS AND RATES OF QUATERNARY CRUSTAL MOVEMENTS IN THE UNITED KINGDOM: COASTAL EVIDENCE

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A wide range of former marine/shoreline features are present around the British coastline from which regional crustal movements can be evaluated. Interpretations based upon Late Quaternary (last 15,000 years) features/deposits has allowed detailed assessments of patterns and rates of crustal movement to be made which have been compared with tide gauge records. In general the Holocene marine evidence indicates that northern Britain is rising (0.5-1mm/yr) in response to glacial unloading whilst south-eastern Britain is sinking (1-2mm/yr).

Marine features associated with former interglacial periods (Stages 5e, 7, 9/11and 13) are also present however their interpretation is difficult, since their age and association with sea level at the time of formation are often poorly constrained. It seems likely that at least some of the sites may have been influenced by glacio-isostatic movements. The evidence suggests that long-term subsidence has prevailed in the southern North Sea at a rate of 0.05-0.1 mm/yr. The shoreline evidence however also suggests that rates of subsidence may have been 3-5 times faster in the early Quaternary. There is also some limited evidence of uplift of some parts of the United Kingdom, however this may have been localised and of limited duration. Certainly few of the Stage 5e raised marine deposits in western and southern Britain appear to have been displaced. In contrast features/deposits in eastern England appear to have undergone limited subsidence.

The long term crustal movements clearly suggest rates of movement considerably lower than that proposed by the Holocene data. This implies that the rates of movement derived from Holocene data have been influenced by glacio-isostatic movements and thus are not representative of longer the term crustal movements.

92-7 BTH 71 Zazo, C.

QUATERNARY PALEOSEA-LEVELS IN CAPE VERDE ARCHIPELAGO

ZAZO, C., DABRIO, C.J., GOY, J.L., SOLER, V., HILLAIRE-MARCEL, C., GONZÁLEZ-DELGADO, J.A., BARDAJÍ, T., GHALEB, B., and GILLOT, P.Y., Departamento de Geología, Museo Nacional de Ciencias Naturales (CSIC), José Gutiérrez Abascal, 2, Madrid, 28006, Spain, mcnzc65@mncn.csic.es

The aim of this work is to analyse the connections between vertical sea-level changes and horizontal displacements of physical and ecophysical sea-surficial conditions between the Atlantic tropical region, and the Mediterranean basin during the Quaternary, using the record of raised marine terraces in Cape Verde Archipelago.

These volcanic islands are located in the Central Atlantic area (17º12'-14º48'N, 25º28'-22º45'W), 450 km off the western African coast and 2000 km east of the Mid-Atlantic Ridge, in the pathway of the warm North Equatorial and Guinea currents.

The flat, low-relief Sal Island is particularly suitable for this study owing to the absence of vegetal cover, and its place at the eastern flank of the archipelago that faces the trade winds. The most complete marine sequences comprises seventeen terraces at elevations between 57 m (asl) and 0m.

Isotopic and paleomagnetic data, coupled with detailed mapping, suggest that at least ten of the raised marine terraces were deposited during interglacial or interestadial periods in the last 800 Kyr. Warm fauna (Strombus bubonius, Nerita senegalensis, Cantharus viverratus, etc.), the so called "Senegalese", is common in all marine terraces. This fact points to the Cape Verde Archipelago as a main source region of "Senegalese" fauna that entered the Mediterranean Sea during some interglacials and particularly OIS 5e, instead of the Gulf of Guinea where no fossil marine terraces bearing this warm fauna have been cited so far.

Financial Support.- MCYT Projects, BTE 2002, 1065 and 1691

92-9 BTH 73 Latimer, Jennifer C.

GLACIAL/INTERGLACIAL PRODUCTIVITY AND THE PHOSPHORUS MASS BALANCE IN THE SOUTHERN OCEAN

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Models of the ocean phosphorus cycle suggest that much of the phosphorus (P) entering the oceans is deposited on continental margins. However, during times of sea level low stand (i.e. glacial intervals), this P is actually deposited in deeper water off the continental margin. Furthermore, as rivers cut through the continental shelf, the shelf sediments may become a source of P to deeper waters. As a result of the change in the locus of deposition and the new source of P to deeper waters, higher levels of primary productivity in the open ocean may result.

To test this hypothesis, we have used bulk sediment geochemistry and detailed P geochemistry from cores recovered during ODP Leg 177 and ODP Leg 189 from the Southern Ocean. We have sampled at 2-5 kyr resolution in order to investigate glacial/interglacial variability in P burial and export production. Detailed P geochemistry allows for the determination of P that was once associated with organic matter compared to detrital sources. Comparison of detailed P geochemistry with P/Ti ratios reveals that the ratios do reflect enhanced burial or preservation of organic P. All sites do exhibit glacial increases in export production as recorded by reactive P concentrations and P/Ti ratios. However, P accumulation rates lead P/Ti ratios suggesting that the two records may reflect the differences in local productivity versus more global influences of P delivery to the oceans. These findings support the idea that changes in sea level may influence open ocean primary productivity. While the residence time of P in the oceans is on the order of 10-20 kyr, which is of the same order as the sea level change, we see evidence for higher rates of P delivery to the open ocean during glacial times. Using P accumulation rates, we will evaluate the P mass balance during glacial and interglacial times in the Southern Ocean and attempt to link the variability to sea level high and low stands.

92-10 BTH 74 Simms, Alexander Ray

THE ROLE OF ANTECEDENT TOPOGRAPHY IN SHAPING COASTAL CHANGE CAUSED BY SEA LEVEL RISE

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The link between global warming and sea level rise has sparked a rejuvenated interest in determining the effects of sea level rise on coastal environments. Recent studies have focused on using the past record of Holocene sea level changes as a way of predicting the impact of future sea level rise on coastal environments. While undertaking such a study of the coastal environments of Corpus Christi Bay in Central Texas, we found that antecedent topography had a dramatic effect on the evolution of the bay. During the last sea level fall (OIS 5-2), terraces formed in the paleo-valley of the Nueces River. As sea level rose (OIS 1), the Nueces valley was flooded to form Corpus Christi Bay. High-resolution seismic profiles and sediment cores, reveal that the flooding of fluvial terraces resulted in abrupt changes in the bay. Such abrupt changes include the formation or destruction of spits, oyster reefs, tidal delta complexes, and bayhead deltas, including their incipient wetlands. Thus, flooding of terraces acts to punctuate the effects of sea level rise within estuaries and bays.

SESSION NO. 93, 1:30 PM

Wednesday, July 30, 2003

T2. Holocene Sea Level Changes, Coastal Evolution and Future Prospects (Posters) (*Commission on Sea-level Change and Coastal Evolution*)

Reno Hilton Resort and Conference Center, Pavilion

93-1 BTH 75 Mörner, Nils-Axel

SEA LEVEL CHANGES: OBSERVATIONS VERSUS MODELS

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Sea level rose for glacial eustatic reasons up to about 5000 BP. After that, global sea level has been dominated by the redistribution of ocean water masses (and by that ocean-stored heat). This redistribution of water masses is driven by the interchange of angular momentum between the solid earth and the hydrosphere (in feedback coupling) primarily expressed as changes in the

oceanic surface current systems. In view of this, there has been very hard to define any global eustatic signal. This is where and why a dialectic between models and observations enter the sea level debate. According to the glacial loading models, global sea level is now rising by 2.4 mm/year or 1.8 mm/year. The IPCC models have hypothesised of a very rapid rise in the near future, ranging for original wild estimates of 1-3 m in a century to the presently advocated value of 47 +37 mm in a century. The INQUA Commission on Sea Level Changes and Coastal Evolution (www.pog.su.se/sea) hosts the true world specialists on sea level research. This commission has presented an observationally based analysis of the present sea level changes and the changes to be expected in the next century. Both the glacial loading models and the ICPP scenarios are strongly contradicted by observational data for the last 100-150 years that cannot have exceeded a mean rate of 1.0-1.1 mm/year. In the last 300 years, sea level has been oscillation close to the present with peak rates in the period 1890-1930. Sea level fell between 1930 and 1950. The late 20th century lacks any sign of acceleration. Satellite altimetry indicates virtually no changes in the last decade. Therefore, observationally based predictions of future sea level in the year 2100 will give a value of +10 +10 cm (or +5 +15 cm), by this discarding model out-puts by IPCC as well as global loading models. In conclusions, there are firm observationally based reasons to free the world from the condemnation to become extensively flooded in the 21st century AD.

93-2 BTH 76 Gehrels, W. Roland

LATE HOLOCENE SEA-LEVEL AND CLIMATE CHANGE IN THE WESTERN ATLANTIC OCEAN

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High-resolution sea-level data, extending beyond the span of instrumental observations, are necessary to analyse the response of the sea surface to natural climatic changes and to date the onset of ongoing sea-level rise recorded by mid-latitude Atlantic tide gauges. This study establishes three high-resolution sea-level records, spanning the past 1200 years, from Wells and Machiasport (northern Gulf of Maine, USA) and Chezzetcook (Atlantic coast of Nova Scotia, Canada). Sea-level changes are reconstructed from foraminiferal and chronological analyses of salt-marsh peat sequences. The relationship between foraminiferal distributions and elevation on the modern salt marshes is quantified by regression analyses and applied to fossil foraminifera in cores to reconstruct former heights of the salt-marsh surface relative to tide levels. The peat sequences are dated by ^{210}Pb, ^{137}Cs, $^{206}Pb/^{207}Pb$ and AMS^{14}C. We use pollen markers and historical archives to date the onset of land clearing subsequent to European settlement in the late 18th century. We corrected for palaeo-tidal changes in the Gulf of Maine and the Bay of Fundy and for the effects of autocompaction. The latter was achieved by comparing the chronology with a series of AMS^{14}C dates on basal peat. Finally, we detrended the sea-level records to account for long-term glacio-isostatic subsidence by selecting the nearest tide-gauge record to Wells (at Portland) as a baseline. The calculated errors on former mean tide level positions are ±20 cm for the Maine sites and ±7 cm for Chezzetcook. Twentieth century data reconstructed from the salt-marsh sequences compare well with nearby tide-gauge observations. Results of this study suggest that, during the past millennium, steric change has been an important contributor to sea-level variability in the western Atlantic on decadal to centennial timescales. Rates of 20th century sea-level rise in the western Atlantic are unprecedented in the past millennium.

93-3 BTH 77 Horton, Benjamin P.

HOLOCENE LAND- AND SEA-LEVEL CHANGES IN GREAT BRITAIN

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Over the last decade there has been a significant increase in the number and distribution, spatially and through time, of reliable observations of past relative sea level in Great Britain. The increase in data has attracted the attention of those modelling the glacial isostatic adjustment (GIA) processes. Although small in global terms, the ice sheet that covered much of the British Isles at the Last Glacial Maximum (LGM) was large enough for GIA processes to produce vastly contrasting relative sea level (RSL) changes at different locations. Due to the size of the British Isles LGM ice sheet the glacial isostatic component of RSL change is highly sensitive to shallow earth structure, especially lithospheric thickness and the viscosity of the upper mantle. This is in contrast to, and independent from, rheological constraints derived from regions beneath the Fennoscandia and Laurentide ice sheets.

Despite significant improvements in the agreement between predicted RSL changes derived from different GIA models and observations from dated sediments there remain important discrepancies. Until the reasons for these are solved, the best estimates of current relative land- and sea-level change come from analysis of the observations, supplemented with estimates from models where there is a good fit.

Analysis of more than 1200 sea level index points and 180 limiting dates for 52 locations in Great Britain over the last 16kyr provides estimates of late Holocene land-level changes (negative of relative sea-level change). Maximum relative land uplift occurs in central and western Scotland, ~1.6mm/yr, and maximum subsidence in southwest England, ~1.2mm/yr. Sediment consolidation, arising from autocompaction as the sediment accumulates and from land drainage, increases the subsidence in areas with thick sequences of Holocene sediments, with an average effect equivalent to an extra ~0.2mm/yr land subsidence, but more in parts of southeast England, 0.5 – 1.1mm/yr. Modelled changes in tidal range during the mid to late Holocene in eastern England suggest that the calculated rate of land subsidence is overestimated unless such changes are quantified. The effect is most significant, equivalent to ~0.4 – 0.6mm/yr, for large coastal lowlands, the Humber and Fenland that were tidal embayments during the mid to late Holocene.

93-4 BTH 78 Smith, David E

PATTERNS OF ISOSTATIC UPLIFT FOR THE HOLOCENE IN SCOTLAND AS DETERMINED BY GAUSSIAN TREND SURFACE ANALYSIS

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Isobase models showing land uplift in Scotland, UK, at intervals during the mid and late Holocene are produced using over 3000 altitudes on comparable shorelines analysed by Gaussian Trend Surface Analysis. This analytical technique is an improvement on Polynomial Trend Surface Analysis because it produces a figure for which the base value is zero, rather than trending to infinity, and can thus provide an estimate of actual sea surface levels beyond a centre of isostatic uplift provided the figure corresponds to the data within statistically acceptable limits. Using data from several dated shorelines permits any changes in the spatial pattern of uplift over time to be determined. In the analysis shown here, each of the four models produced fit the shoreline altitude data closely, while the changing sea surface level indicated accords reasonably well with patterns derived from studies elsewhere. It is argued that the method used has considerable potential in determining isostatic uplift in previously glaciated areas, provided adequate comparable shoreline altitudes are available.

93-5 BTH 79 Parnell, Andrew C

STATISTICAL RECONSTRUCTIONS OF FORMER SEA-LEVEL AROUND THE HUMBER ESTUARY, UK

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The Humber Wetlands in the UK have been at the forefront of many substantial research projects aimed at understanding palaeoenvironment and archaeology changes of the area. However, existing research has failed to produce robust results fully consistent with archaeological evidence. Current reconstructions, for example, suggest that some archaeological sites were under water at times when they are known to have been occupied. These discrepancies are particularly evident in the late Holocene where palaeoenvironmental records are sparse but archaeological records are in abundance. This project describes the development of statistical techniques to combine the two sources of data to produce estimates of past sea level and to quantify their associated errors.

93-6 BTH 80 Smith, David E.

SEA SURFACE LEVEL CHANGES DURING THE HOLOCENE OFFSHORE SCOTLAND, UK

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Knowledge of the patterns and trends of sea surface change in the Holocene, both regionally and globally, is in its infancy. Even the most recent published graphs involve large uncertainties. This paper describes a methodology which produces regional sea surface trends based upon information from glacio-isostatically uplifted areas. Using detailed shoreline altitude data from Scotland, where land uplift has been in progress at least since the last ice sheet began to decay, a graph of offshore sea surface trends for the early and mid Holocene has been produced. The graph is based upon dated shorelines, projected across high resolution shoreline isobase patterns, and upon detailed stratigraphical information. It discloses a rapid sea surface rise in the early Holocene, followed by a much slower rise after circa 5500 radiocarbon years BP. During the rapid rise, there were at least two episodes when the rise either slowed or was reversed, whilst after circa 5500 at least two episodes of reversal occurred before the present sea surface trends commenced. Although the potential margin of error of the graph is relatively large, the trends within the graph are considered to be accurate.

93-7 BTH 81 Smith, David E.

MULTI-PROXY MORPHOLOGICAL AND STRATIGRAPHICAL APPROACHES IN RECONSTRUCTING FORMER HOLOCENE SEA LEVELS: AN EXAMPLE FROM THE CREE VALLEY, SW SCOTLAND, UK

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The Cree valley lies towards the margin of the Scottish glacio-isostatic uplift area, and its physical landscapes and deposits reflect subtle changes in relative sea levels during the Holocene. In reconstructing these changes, detailed morphological mapping and survey, together with lithostratigraphical, sedimentological and biostratigraphical techniques, supported by radiocarbon dating, have been employed. The earliest event recorded is an estuarine deposit, abandoned at circa 8300-8600 radiocarbon years BP and correlated with the Low Buried Beach in Scotland. This was followed by a marine transgression which began earlier than 8100 radiocarbon years BP, correlated with the Main Postglacial Transgression. In the Cree area, this event exhibits at least one minor fluctuation, at circa 7200-7400 radiocarbon years BP, and a major fluctuation at circa 6100-6500 radiocarbon years BP which reached an estuarine surface correlated with the Main Postglacial Shoreline, before culminating at circa 5000 radiocarbon years BP in an estuarine surface correlated with the Blairdrummond Shoreline. Relative sea levels then fell, with a minor fluctuation at circa 2500-2900 radiocarbon years BP, before attaining present levels. As the shorelines were reached, barrier systems formed, one of which played an imortant role in the progress of marine transgression and regression.

93-8 BTH 82 Baeteman, Cecile

COASTAL CHANGES WITHOUT SEA-LEVEL FLUCTUATIONS. EXAMPLES FROM A TIDE-DOMINATED COASTAL LOWLAND (BELGIUM)

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Facies changes registered in the coastal Holocene sedimentary sequence are far too often attributed solely to sea-level fluctuations. Detailed stratigraphic and sedimentological investigation of cores and outcrops from the western Belgian coastal plain, supported by numerous radiocarbon assays, demonstrate that other controlling factors such as sediment supply and accommodation space can play a dominant role in the development of the vertical sedimentary succession.

The particular characteristics of sedimentation processes in which tidal channels play a major role, should also be examined in order to detect the origin of successive coastal changes which might be recorded as distinct facies changes in the vertical sedimentary sequence. It is also essential to relate the sites studied on a local and regional scale in the same tidal basin (or estuary) before one can be conclusive about the relative importance of the controlling factor(s) that determined the change in the pattern of the sedimentary environments at a particular time.

A comparison of sites in different locations and showing a different stratigraphy, but formed in the same time span, will be discussed in relation to the sea-level curve. An example will be shown whereby in a period of decelerated relative sea-level rise, but characterized by a considerable supply of sediment, rapid facies changes registered as frequent alternations of mud, peat and gyttja are produced. These facies changes are determined by a sedimentological control related to the tidal channel and creek network, and not by sea-level fluctuations.

Another example will show the relative importance of accommodation space in Late Holocene deposits. No accommodation space resulted in deep vertical incisions of the tidal channels, while an increase in accommodation space forced the tidal channels to migrate laterally. These sedimentary processes resulted in distinct facies changes in the sedimentary sequence, but do not reflect a particular sea-level fluctuation.

93-9 BTH 83 Long, Antony J

THE DEGLACIAL AND RELATIVE SEA-LEVEL HISTORY OF DISKO BUGT AND THE JAKOBSHAVNS ISBRAE ICE STREAM, WEST GREENLAND

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New relative sea-level (RSL) data from Disko Bugt, a large marine embayment in west Greenland, are used to examine the deglacial history of the Jakobshavns Isbrae ice stream. RSL data show rapid deglaciation from the outer part of the bay after 10.3 ka cal. yr BP. Following initial rapid retreat, ice stream recession slowed as it approached the eastern shores of the bay. Sea bed elevations increase here and the ice stream terminus lingered for several thousand years before retreating into the narrow bedrock-confined Jakobshavns Isfjord.

The focus of this paper is the timing of ice stream retreat into the Jakobshavns Isfjord. A prominent moraine at the mouth of the Jakobshavns Isfjord c. 200-300 m asl marks the initial location of the ice stream terminus. RSL data from a staircase of isolation basins c. 5 km inland of this moraine are used to determine the timing of deglaciation, the elevation of the local marine limit (c. 40 m asl), as well as the rate and form of RSL change since deglaciation. Lakes from above the local marine limit, up to an elevation of 275 m asl, provide further information on the relative dynamics of the ice stream and the ice sheet in this region.

RSL data from an isolation basin with a submerged sill c. –4m asl record convincing evidence for a significant late Holocene RSL rise since c. 3 ka cal. yr BP. This is compared with other records of late Holocene RSL change from within the bay to examine whether it reflects forebulge collapse following the retreat of the Greenland and Laurentide Ice Sheets, or renewed crustal loading caused by a significant readvance of the Greenland Ice Sheet in the late Holocene, from c. 4-5ka cal. yr BP onwards.

Long, A.J. & Roberts, D.H. Late Weichselian deglacial history of Disko Bugt, West Greenland, and the dynamics of the Jakobshavns Isbrae ice stream. Boreas. In press. Long, A.J. & Roberts, D.H. 2002. A revised chronology for the 'Fjord Stade' moraine in Disko Bugt, West Greenland. Journal of Quaternary Science, 17, 561-579. Long, A.J., Roberts, D.H. & Wright, M. 1999. Isolation basin stratigraphy and Holocene relative sea-level change on Arveprinsen Ejland, Disko Bugt, West Greenland. Journal of Quaternary Science, 14, 323-345.

93-10 BTH 84 Saito, Yoshiki

HOLOCENE DELTA EVOLUTION IN ASIA: IGCP-475 DELTAMAP PROJECT

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The delta is an important and typical coastal feature. In particular, large rivers form huge deltas in South, Southeast, and East Asia. More than 50% of the world's population lives in Asia, and most of Asia's population lives in deltaic areas. Moreover, more than 80% of the world's total area of rice paddies is in Asia. Deltaic lowlands in Asia are also important to the study of sedimentology and global sediment flux. Rivers in Asia and Oceania contribute about 70% to 80% of the world's sediment flux from the land to the ocean. Deposits of these huge sediment discharges have formed mega-deltas during the last 6-7 kys. Why are so many large deltas distributed along the Asian coast? One is the presence of large rivers with a high sediment yield, which have their sources from the Himalayas and the Tibetan Plateau and with high precipitation due to the monsoonal climate. The other is the stable or slightly falling sea level over the last 6-7 kys. Most of the Asian region recorded a middle Holocene sea-level highstand 2-4 m above the present sea level about 6-7 ka by hydro-isostasy. The long-stable sea level has allowed more than 200 km of shoreline migration since this period and the formation of deltas with a wide delta plain. A new IGCP project, IGCP-475 "Deltas in the Monsoon Asia-Pacific Region (DeltaMAP): Late Quaternary Development and Recent Changes Due to Natural and Human Influences" has started as a 5-year project from 2003-2007. In terms of sedimentary dynamics, active margin processes, and human-related issues, the monsoon Asia-Pacific encompasses probably the world's most exciting region for sedimentary research. This area also includes a breadth of climatic, tectonic, and anthropogenically-altered environments. The project seeks to understand these diverse settings within the unifying theme of monsoon-driven sedimentary systems. Primary goals for the next 5 years will be to (1) develop an adaptive and comprehensive conceptual model for monsoon-driven river-delta systems and (2) enhance regional and international collaboration on delta research. The first annual meeting of IGCP-475 will be held in Thailand from January 16-21, 2004, jointly organized with the 5th International Conference on Asian Marine Geology (held in Bangkok, 13-18 January, 2004).

93-11 BTH 85 Mateo, Zenon Richard P.

BASIN-WIDE STUDY OF HIGH-FREQUENCY DELTA SWITCHING AND FLUVIAL AVULSION IN LINGAYEN GULF, NORTHWESTERN PHILIPPINES: POTENTIAL FOR IDENTIFYING TECTONIC, CLIMATIC, AND SEA LEVEL CONTROLS

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The onshore and offshore evolution of the Lingayen Gulf bayhead plain in northwestern Philippines is established using remotely sensed images, maps, bathymetric charts, written and anecdotal accounts, surface sediment samples, high-resolution seismic profiles and core data.

Delta progradation and switching accompanied by meander belt migration formed the present bayhead plain. Historical cases of natural and man-induced delta switching occurred between the mid-19th to early 20th century and around 1935. Delta retreat and progradation at rates of 19 to 25 m/yr are documented by historical changes in shoreline position and marked by transgressive and regressive types of beach ridge sets. Similar and older ridges, which occur as far as 16 km inland, are used to reconstruct former delta lobes. Five kilometers from the present shoreline, at least 17 delta lobes were built successively or simultaneously by the major bayhead rivers: Agno to the west, Dagupan at the center and Bued-Patalan to the east.

Offshore, very high-resolution (Parasound) profiles reveal a former delta-plain formed during a lower sea stand. Rapid sea-level rise prior to 7,575±185 cal yBP transgressed this surface and deposited a transparent package with basal lensoidal fine sands overlain by offshore muds. This also translated the shoreline approximately 16 km inland, from a previous position approximately 17 km seaward and 60 m lower than the present. Subsequent deceleration and fall to the present sea level induced progradation, partly represented by four vertically stacked muddy prodelta lobes defined by truncated bi-directional reflections and correlated with the four youngest Dagupan deltas.

Associated with these deltaic units are seven meander belts that display a general migration to the southwest but all emanate from the Agno Alluvial Fan. The switching of deltas and migration of river systems are attributed to the alternate switching of the active distributary channel of the alluvial fan, which can be controlled by tectonism, sea level and climate change. The nature and interaction of these controls may potentially be revealed by such high-frequency events, pending better age controls using radiocarbon or luminescence dating methods.

93-12 BTH 86 Hori, Kazuaki

DELTA INITIATION AND HOLOCENE SEA-LEVEL CHANGE: EXAMPLE FROM THE SONG HONG (RED RIVER) DELTA, VIETNAM

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Delta initiation and subsequent delta growth were investigated by using radiocarbon-dated borehole cores from the Song Hong (Red River) delta, Vietnam. The sediments underlying the present delta plain record three depositional systems since the last glacial maximum (LGM): fluvial, estuarine, and deltaic, in ascending order. The landward part of the initial delta was characterized by an active tide-influenced accumulation of sandy sediments. The seaward part of the initial delta is composed of muddy prodelta and seafloor sediments that accumulated slowly. Radiocarbon ages of molluscan shells and organic materials suggest that the transition from estuary to delta occurred at approximately 8500 cal yr BP. The transition was induced by deceleration of the post-glacial sea-level rise, which was coeval with the delta initiation. The stacking pattern of the delta system is very different from that of the estuary system. The sediments of the estuary that developed during the rapid rise in sea level between 11000 and 8500 cal yr BP display a retrogradational stacking pattern, forming a thick transgressive systems tract. On the other hand, aggradational as well as progradational stacking with clinoform architecture characterized the delta system between 8500 and 6500 cal yr BP as the sea level continued its slow rise. Progradation has been dominant during the last 6500 yr because the cessation of sea-level rise resulted in little accommodation being added. The results of this study are similar to those for other major delta systems, such as the Changjiang and the Ganges-Brahmaputra deltas, despite large differences in sediment discharge, tectonics, basin size, and coastal environment. This implies that the post-glacial sea-level rise and the change in the rise rate markedly influenced the evolution of depositional systems at river mouths.

93-13 BTH 87 Mörner, Nils-Axel

THE MALDIVES SEA LEVEL PROJECT. I: GENERAL OUTLINES

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The INQUA Maldives Project started in 2000. Prior to that, quite little was know about the actual changes in past sea level in the Maldives. . With respect to multiple integrated sea level processes, the Maldives have a uniquely position (as described in Integrated Coastal Zone Management, No. 1, 2000, p. 17-20). Our team has undertaken two major expeditions plus a number of shorter visits in the Maldives. Our filed data includes extensive diving, reef ecology, coring marine lagoonal clay beds, coastal studies, coring fens and inland lagoons, levelling, sampling sea level index points, radiocarbon dating of some 35 samples, analyses of bones and pottery. The Maldives do not consist of predominantly catch-up coral reefs of Holocene age as previously proposed. On the contrary, the Maldives are predominantly formed by older reefs. The Last Interglacial level is at about +1.5-2.0 m (a reef body reaching –5 m is dated >40,000 BP). Flat inner-atoll areas in the order of –40–50 m seem to have been eroded by sea level variations during the isotopic stage 3 sea level with a cave at –29 m dated at about 27,000 BP. The LGM level seems to be deeper than usually at –150 m due to increased geoid relief during the last glaciation maximum (LGM). During this period the old reefs were strongly carstified. Paleogeographically, the LGM–Maldives consisted of a few large islands, most probably covered by tropical forests and traversed by drainage patterns and river systems. From 18,000 to 5000 BP, sea level rose episodically cutting submarine shorelines and coastal caves. Present sea level was reached at about 4500 BP. Sea level oscillated around the present in the last 4000 years. The subsequent development is discussed separately.

Co-authored with the Maldives Project Team Members. The Maldives Project includes the following research scientists: N.-A. Mörner (SE), J. Laborel (F), M. Tooley (GB), S. Dawson (GB), W. Allison (MV), S. Islam (BD), F. Laborel (F), J. Collina (F), C. Rufin (F), D. Dominey-Howes (GB), G. Possnert (SE) and T. Sjövold (SE).

93-14 BTH 88 Mörner, Nils-Axel

THE MALDIVES SEA LEVEL PROJECT. II: PAST-PRESENT-FUTURE

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The Maldives have a uniquely position in sea level research (as discussed in Integrated Coastal Zone Management, No. 1, 2000, p. 17-20). In the last decade, they have attracted special attention because, in the IPCC-scenario, the Maldives would be condemned to become flooded in the next 50-100 years. Our research data do not lend support to any such flooding scenario, however. On the contrary, we find no signs of any on-going sea level rise. Our results comes from visits to numerous islands including extensive work on Hulhudoo and Guidhoo in the north, in Viligili and Loshfuchi (the site of "the reef woman") in the middle, and in Addu in the south. This includes coring, levelling, sampling and dating (35 C14-dates). Present sea level was reached at about 4500 BP. In the last 4000 years, sea level oscillated around the present in the last 4000 years. At 3900 BP, there was a short and sharp sea level high-stand at about +1.2 m. For the last millennium, a detailed sea level record is established: +0 m 1000-800 BP, +60 cm 800-300 BP, 0 to just below 0 in the 18th century AD, +30 cm 1790-1970 AD, fall to 0 in ~1970 up to today. At about 1970, sea level fell by 20-30 cm (presumably due to increased evaporation). This is recorded in storm level, high-tide level, mean sea level and in lake and lagoon levels (from the north to the south). In the last decade, there are no signs of any rise in sea level. Hence, we are able to free the islands from the condemnation to become flooded in the 21st century.

Co-authored with the Maldives Project Team Members.

93-15 BTH 89 Haldorsen, Sylvi

THE EFFECT OF GLOBAL CHANGE ON ST LUCIA, AFRICA'S LARGEST COASTAL LAGOON

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St Lucia is Africa's largest coastal lagoon and separated from the Indian Ocean by the highest vegetated coastal dunes in the world. Its present large surface (350 km2) and small depth (on

average 90 cm) makes it sensitive to climate changes. Small changes in sea level have a major effect on the surface area and ecology.

During the Eemian Interglacial the estuary was a marine bay. The high coastal dune system was probably not fully developed at that time. During the lowering of the sea level in the Early Weichselian the climate became drier. The basin probably dried up and for a period became a river plain.

Pollen and the occurrence of peat indicate a short and rather moist episode around 23 000 BP. This might have been triggered by the high solar radiation in the southern hemisphere at that time. Fossil soil profiles along the shores of St Lucia are related to the same climate event.

Peat and ancient soil profiles are overlain by sand of up to several metres thickness. The sand contains marine diatoms and was probably originally deposited in the Eemian marine bay. The climate during the Last Termination was dry. The marine sand was eroded by wind from the now dry bottom of St Lucia and deposited over the present lowland coastal plain and dune system.

Due to the high surface area relative to the depth, St Lucia goes through major salinity cycles. It is not obvious how a future sea-level rise will influence upon the estuary conditions. There will be a higher inflow of seawater, but a wetter condition may on the other hand result in a larger outflow of freshwater. We can, however, safely conclude that the lake will not return to an Eemian condition. The high coastal dunes will now form an efficient barrier, and in contrast to the conditions during the Eemian these dunes will separate St Lucia from the Indian Ocean.

93-16 BTH 90 Achimo, Mussa

LATE WEICHSELIAN TO HOLOCENE EVOLUTION OF THE MAPUTO BAY, MOZAMBIQUE

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During the Quaternary the volume of the world's oceans fluctuated, with sea level falls as the water has been incorporated into polar and high latitude ice sheets, and sea level rise as these have subsequently melted. Sea-level lowstands were therefore related to the Pleistocene glaciations, while high-stands correlate with interglacials. In general the climate variations in Africa shows a simple relation: Cold or cool climates are associated with dry episodes and warm climates are associated with wet episodes. This applies to the major Milankovich driven glacials and interglacials, as well as to short-lived intervals related to sun spot activities. The reconstruction of palaeo-shorelines in the Maputo Bay, and the climate around the Maputo Bay is based on bathymetric maps. At about 18,000 yr BP (-130 meters sea level) the Maputo Bay was located in an inland position. As the sea level rose to about 20 m below present around 9000 - 10000 years BP, a barrier island complex developed in the northern coast, which is well defined by 20 m contour palaeoshoreline. The Maputo Bay is only formed around 8000 – 9000 years BP (when the sea level was 10 to 12 m below the present, and it was a long lasting still stand sea level. A huge island was protecting the bay from the sea. Tidal inlet and its associated ebb delta were separating the island from the peninsula in the south and were connecting the lagoon into the sea. The complete picture of Maputo Bay patterns with its modern sedimentary environments including Inhaca Island may have evolved when the sea level has stood close to its present level around 7000 – 5000 years BP, after which the Maputo Bay became more or less stable. Coral reefs may have also developed during this period. Submarine modifications of the topography during and after the sea-level rise make it difficult to make safe interpretations of the coastal palaeomorphology. However, we believe that many of the present major submarine bottom forms, which are seen on the maps today, are related to coastal processes during the sea-level rise, and were preserved when they were flooded during the Holocene transgression.

93-17 BTH 91 Woodroffe, Sarah

CONTEMPORARY INTERTIDAL FORAMINIFERA DISTRIBUTIONS OF MANGROVE ENVIRONMENTS FROM CLEVELAND BAY, CENTRAL GREAT BARRIER REEF SHELF, AUSTRALIA: IMPLICATIONS FOR SEA-LEVEL RECONSTRUCTIONS

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Contemporary foraminiferal samples and associated environmental information were collected from Saunders Creek, an estuarine mangrove environment, and Sandfly Creek, a fringing mangrove environment, in Cleveland Bay on the Great Barrier Reef (GBR) coastline, Australia. They were collected to elucidate the relationship of the foraminiferal assemblages with the environment. There is a statistically significant relationship between elevation and foraminiferal assemblages, a relationship best developed where the mangrove fringe is well formed and is not prevented from lateral expansion by geomorphological features (such as chenier ridges). The data supports the vertical zonation concept, which suggests that the distribution of foraminifera in the intertidal zone is usually a direct function of elevation, with the duration and frequency of subaerial exposure as the most important factor. A regionally recognized A. beccarii dominated foraminiferal assemblage is found at both sites, existing between just above MLWNT and MHWNT. This assemblage is the most accurate sea-level indicator in this tropical location because of its presence at more than one site. In addition, the relationship between foraminiferal and floral mangrove zones is questioned. Mangrove zones are in equilibrium with the local environment, and their upper limit is determined by diverse factors including, but not solely tidal inundation.

93-18 BTH 92 Moriwaki, Hiroshi

MID- AND LATE HOLOCENE CHANGES IN SEA LEVEL AND SHORELINE ON RAROTONGA, COOK ISLANDS

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Holocene coastal plain characterised by beach ridges and swamps, which provide excellent data on sea level and shoreline, is most developed on Rarotonga of the Cook Islands in the south Pacific. We present here a model for mid- and late Holocene changes in sea level and shoreline for Rarotonga based on micro-landforms and surface deposits in the coastal plain, using air-photographs, level-equipment, power shovel, hand-borer and radiocarbon dates as well as general field survey. Sea-level change obtained is as follows: Sea level attained near-present levels c. 6000 14C BP, following early Holocene rapid sea-level rise. A gradual rise occurred until c. 4000 14C BP, when +1.5 m maximum height was attained. Sea level was essentially stable c. 4000 to c. 600 14C BP. Since c. 600 14C BP sea level has fallen to the present-day level. The sea-level curve is similar to others obtained in Polynesia. Hydro-isostatic movement is plausible to be responsible for this highstand, while recent sea-level fall since c. 600 14C BP is likely related to climatic change as discussed in western Polynesia. Shoreline changes have been greatly dominated by the sea-level change. Marine transgression attained most inland points c. 5000 - 6000 14C BP when sea level ceased rising rapidly and reached near-present sea levels. The shoreline began to prograde c. 4000 14C BP, which matches the culmination of sea-level rise. Coastal plain has expanded to the present coast conspicuously on northeastern coast, providing low flat area most suitable for human settlement. Post 600 BP sea-level fall resulted in slight emergence of the coastal plain, which had widely developed. This mid- to late Holocene coastal evolution helps to properly evaluate its relation to human occupation history as well as early human settlement in the Cook Islands.

93-19 BTH 93 Leroy, Suzanne A. G.

THE ROLE OF ERRATIC SEA-LEVEL CHANGES ON THE EVOLUTION OF A COASTAL WETLAND WITH THE EXAMPLE OF LAKE ANZALI, NORTHERN IRAN

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The modern Lake Anzali with a maximum surface of 160 km2 and maximum depth of 5.5 m is the largest freshwater coastal wetland of northwestern Iran. It is connected and/or discharges to the Caspian Sea with a partly regulated 3.5 km long channel. A Late Holocene prograding beach-ridge complex and recent beach sediments separate the lake from the sea. The surface of Lake Anzali, which receives water and sediments from fifteen rivers originating from the Alborz Mountains, is only 2 m above the mean level of the Caspian Sea (presently it is at 26 m below oceanic level), consequently sea water can temporarily enter into the lake during high storms or when the Caspian level permanently increases. This recently took place in 1991-1996 with a doubling of the lake area. In spite of apparent sedimentation in the lake, the coastal zone was eroded on c. 30-100 m. The records show that the highest sea level was in 1930 at –25.25 m and then dropped to –27.00 m in 1945. The decrease gradually continued to –28.20 m in the following 30 years. Later it increased erratically up to 2.5 m from –28.44 m of 1977 to –26.29 m of 1996. In 2000, it was at –26.36 m. The recent development shows that Late Holocene evolution of Lake Anzali and its surrounding has been closely linked to Caspian Sea level fluctuations. The beach ridge prograded most probably during a sea level decreased.

93-20 BTH 94 McMillan, Kent

HOLOCENE STRATIGRAPHY AND TIMING OF SEA LEVEL ON-LAP, HUNTINGTON BEACH, CALIFORNIA

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Recent subsurface exploration was conducted at a near-shoreline site on the coastal plane, midway between Huntington Mesa on the north and Newport Mesa on the south, in Huntington Beach, California. The site stratigraphy consists of nearly 18 m of estuarine and littoral sediments overlying fluvial sediments extending to greater than 27 m. Nine fine-grained marker beds were correlated between 6 boreholes and 21 cone penetration test locations. Radiocarbon dating of organic matter in the fine-grained deposits and shells in the littoral sands reveal the section spans more than 12,000 ybp. On-lap of rising Holocene sea level occurred at the site approximately 8,000 ybp. Prior to on-lap, the coastal plane aggraded at a rate of approximately 1 m/1,000 yr. Three dates between 7,090 ybp and 8,040 ybp (representing 9 m of section) plot directly on the sea level curve, indicating coastal aggradation kept pace with sea level rise for about 900 years. Thereafter, the rate of sea level rise out-stripped deposition, and the shoreline lay to the east of the site. The coastal plane has aggraded at a rate of approximately 1.3 m/1000 yr to the present time. Exploratory boreholes and test sites were arrayed in three northeast-southwest transects oriented transverse to the trend of a postulated south branch of the Newport-Inglewood fault zone. No evidence of vertical separation of the fine grained marker beds was discernible, suggesting the section has not been affected by faulting.

93-21 BTH 95 Törnqvist, Torbjörn E.

RECONCILING HOLOCENE SEA-LEVEL HISTORY ON THE US GULF COAST: IS THE MISSISSIPPI DELTA THE ROSETTA STONE?

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Published Holocene relative sea-level (RSL) curves for the US Gulf Coast are in mutual conflict, with some characterized by a smooth RSL rise akin to widely accepted eustatic sea-level curves vs. others, including several recent ones, that are characterized by a conspicuous “stair-step” pattern with prolonged (millennium-scale) RSL stillstands alternating with rapid rises. In addition, recent work on the Texas Gulf Coast has revitalized the notion of a Middle Holocene RSL highstand, estimated at about 2 m above present mean sea level. An extensive sampling program in the Mississippi Delta (Louisiana) focuses on the collection of basal peats that accumulated during the initial transgression of the pre-existing, consolidated Pleistocene basement. We preferentially select plant macrofossils indicative of brackish to saline conditions from these basal peats and subject them to AMS 14C dating. The first data set of approximately 30 sea-level index points from a ~20 km2 study area in the eastern part of the delta provides conclusive evidence that RSL rise followed a smooth, negative exponential trend for the time interval 8000–3000 cal yr BP, thus invalidating the occurrence of RSL stillstands. Although a true Middle Holocene highstand never occurred in this subsiding setting, the high level of detail of our time series enables a rigorous test of this hypothesis. Correction of our data set for a subsidence rate of 1 m ka-1 (we assume a linear subsidence rate compared to the tectonically relatively stable adjacent Texas Gulf Coast) leads to sea levels of 1-2 m above present during the time interval 6000–4000 cal yr BP. However, this model also implies a RSL position near –2 m around 8000 cal yr BP, which is inconsistent both with data of this age from Texas, as well as with eustatic sea-level data. We therefore conclude that a Middle Holocene highstand for the US Gulf Coast is highly unlikely, and that the entire area is still responding glacio-isostatically, by means of forebulge collapse, to the melting of the Laurentide Ice Sheet. Our results demonstrate the power of continuous time series of RSL change from subsiding settings.

93-22 BTH 96 Kaplan, Samantha W.

PEAT RECORDS OF LATE HOLOCENE CLIMATE AND SEA-LEVEL CHANGE IN SOUTHERN FLORIDA

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Pollen, charcoal, and other microfossils from two coastal peat cores are used to reconstruct late Holocene climate and sea-level changes in southern Florida. One core comes from the mangrove fringe of Whitewater Bay and the other from Lignumvitae Key. In addition to the proxy indices, modern analog statistical techniques are used to compare the fossil pollen assemblages to over 189 modern surface samples from peninsular Florida, the southeast US and the Caribbean. Close analogs in the paleorecord are assumed to be similar to the modern vegetation types and by association to the environmental conditions, such as effective precipitation, hydroperiod, and salinity, that control their distribution. Results indicate that plant communities at both coastal locations have responded to climate and sea-level fluctuations over the last 3500 years. The Whitewater Bay site, which now supports a saline dwarf mangrove forest, was a freshwater *Cladium* marsh with relatively long hydroperiods circa 3400 yr B.P. The core from Lignumvitae Key, with a basal age of 2290 yr B.P., also shows a transition from freshwater or slightly brackish conditions at the base to saline mangrove peat at the top. Sedimentological evidence indicates that sea level rose gradually throughout the late Holocene with a period of accelerated rise, or a level higher than modern, circa 1000 yr B.P. Reduced effective precipitation also occurred about 1000 yr B.P., contemporaneous with the onset of the Medieval Warm period. At 400 yr B.P. changes in plant community reflect another episode of reduced precipitation and possible evidence of freezing temperatures at the Whitewater Bay site. Overall, the late Holocene in southern Florida is characterized by gradually decreasing moisture availability punctuated with century-scale fluctuations. Likewise the eustatic history is that of a gradually rising sea level superimposed by minor oscillations.

93-23 BTH 97 Peros, Matthew C.

LATE HOLOCENE SEA LEVEL CHANGE, MANGROVE SYSTEM RESPONSE, AND TAINO ARCHAEOLOGY: NEW EVIDENCE FROM CUBA

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Relative sea level (RSL) change is a critical influence on coastal geomorphic processes, the behavior of coastal ecosystems, and human settlement and subsistence. In the northern Caribbean region – which consists of southern Florida, the Bahamas, and northern Cuba – even minor changes in RSL have disproportionately large effects on the low relief coastlines. The northern Caribbean region is underlain by the tectonically stable Bahamas Platform, which suggests that changes in RSL should be uniform throughout the area. Despite this, published data show that the Late Holocene RSL history of the region is contentious. Most evidence indicates that RSL was roughly 3 metres below present level around 4000 BP, and then rose at a decelerating rate until it reached its current position. However, recent data from Florida suggests that RSL may have been up to 1 metre higher than present between 1000 to 2000 years ago, before it dropped to its present position. Other records indicate rapid fluctuations of up to 1 metre superimposed over these general trends.

This poster presents the first evidence for Holocene RSL change from northern Cuba. These data consist of radiocarbon dated mangrove peat, and show that RSL rose to its present position at a rate similar to many records from southern Florida and the Bahamas. There is no evidence for a Late Holocene RSL highstand. This work also has implications for the prehistory of north central Cuba. A large, presently submerged Taino village, Los Buchillones, is located in the nearshore of the region of this study. The new RSL data provide insight into the location and construction of the settlement and help account for the high quality of the preserved artifacts and their provenance. In addition, fossil pollen evidence from peat deposits reveals how mangrove systems have responded to rising RSL. Research of this nature is crucial in understanding how coastal systems will respond to rates of RSL rise projected over the next century.

93-24 BTH 98 Whittecar, G. Richard

GEOMORPHIC EVOLUTION OF A FRESH-WATER TIDAL ESTUARY DURING LATE QUATERNARY SEA LEVEL AND CLIMATE CHANGES

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Variations in sedimentation style and in landform patterns indicate that changes in sea level and climate influenced the Late Pleistocene and Holocene evolution of the lower Mattaponi River, eastern Virginia, USA. In the fresh-water tidal (FWT) section of the river, large wetlands with thick (>3m) mucky silt or clay lie inside sinuous meander bends. Some wetlands may have formed as the channel migrated laterally, but most marshes accreted vertically, particularly at sites downstream of obdurate cliffs that influence the thalweg at high flows. Proximity to the main channel controls only minor variations in marsh sedimentation at most sites, usually recognized as either a slight coarsening of the silt fraction or an increase in clastic sediment. Significant sedimentation from high fluvial flows is recognized only in the upper reaches of the FWT zone, but lower reaches may receive considerable volumes of fine sediment moving with the estuarine turbidity maximum. Across the FWT zone, meander bends change from symmetric (tide-dominated) to asymmetric (river-dominated); farther upstream across the Coastal Plain, the river appears underfit with the sinuous river channel flowing in a valley with large moderately sinuous meanders. All of these active meanders impinge on fluvial and marine terrace sediments, the youngest having been deposited by low-sinuosity streams transporting mostly sand and gravel.

Interpretation of these observations suggests that a relatively straight Mattaponi River transported mostly bedload from the crystalline Piedmont uplands during the most recent Late Pleistocene (stage 2?), a period of pronounced cryoturbation in that upland. Later, during the same period of lowered sea levels, large sinuous meanders developed as the river channel incised both downward and outward. The causes of the wider channel (e.g. higher discharges?) are unknown. As sea level rose during the late Holocene, most channel meanders in the FWT system maintained their position as the marshes accreted vertically at a rate similar to the global average sea level rise (1-2 mm/yr). Existing sediment data suggests that the average position of the fresh-water-salt-water interface migrated very little during the same period.

SESSION NO. 94, 1:30 PM

Wednesday, July 30, 2003

T32. Effects of Volcanic Eruptions on the Atmosphere and Climate (Posters)

Reno Hilton Resort and Conference Center, Pavilion

94-1 BTH 99 Pyle, David M.

PARTICLES IN TROPOSPHERIC VOLCANIC PLUMES: SIZE, COMPOSITION AND POTENTIAL ENVIRONMENTAL IMPACT

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Persistently degassing volcanoes contribute substantially to the aerosol burden of the troposphere. Volatiles known to be released from degassing volcanoes include acidic gases (such as sulfur dioxide, hydrogen fluoride and hydrogen chloride), and toxic trace metals (including mercury, cadmium and lead). The continuous release of such species from active volcanoes may lead to significant short- and medium-range environmental impacts, but these remain relatively poorly studied.

We present the first application of a multi-stage impactor to study volcanic particle emissions to the troposphere from Masaya volcano, Nicaragua. Concentrations of soluble cations and anions were determined in 12 size bins. The near-source size distributions showed major modes at 0.5 micron (sulfate, hydrogen and ammonium ions); 0.2 and 5.0 micron (chloride) and 2.0-5.0 micron (fluoride). Potassium and sodium ion distribution mirrored the sulfate size-resolved concentrations closely, suggesting that these were transported primarily as potassium sulfate and sodium sulfate in acidic solution, while magnesium and calcium ions peaked in size populations both less than, and greater than 1 micron. The estimated flux of volcanic sulfate leaving the crater was 0.07 kg per second. Effects of relative humidity were studied by comparing daytime (transparent plume) and nighttime (condensed plume) results. Enhanced particle growth rates were observed in the nocturnal plume as well as preferential scavenging of soluble gases, such as hydrogen chloride, by condensed water. Neutralization of the acidic aerosol by background ammonia was observed at the crater rim and to a greater extent 15 km downwind.

We discuss the implications of these results for the understanding of the chemistry of tropospheric volcanic plumes, and their potential environmental impact.

94-2 BTH 100 Mosley-Thompson, Ellen

HIGH RESOLUTION ICE CORE RECORDS OF LATE HOLOCENE VOLCANISM: CURRENT AND FUTURE CONTRIBUTIONS FROM THE GREENLAND PARCA CORES

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Anthropogenic climate forcing on a global scale has necessitated efforts to differentiate the contributions of natural forcing mechanisms from those attributable to human activities of the past two centuries. One natural cause of short-term climate change is the perturbation of the Earth's radiation balance by volcanic gases emitted into the stratosphere where they may remain for several years affecting surface temperatures and modifying both atmospheric and oceanic circulation patterns. Ice cores have been used to establish the history of explosive volcanism and to quantify the sulfate emissions attributable to specific eruptions for inclusion in climate models. Only a few such histories have been annually dated using multiple seasonally varying constituents and the emissions estimates are not always based on high resolution sulfate analyses. Precise dating is critical for robust comparisons with other histories. Questions have been raised regarding the quantity and timing of material delivered to the polar ice sheets and how much reliance can be placed upon a reconstruction from a single core. Knowledge of transport time and the relationship between the quantity of sulfur gases emitted and the sulfate deposited is critical if the full potential of ice cores for volcanic reconstruction and climate modeling constraints is to be realized. A suite of spatially distributed, multi-century cores has been collected under NASA's Program for Arctic Regional Climate Assessment (PARCA) and these provide an excellent archive of volcanic emissions reaching Greenland. The Greenland PARCA cores have been accurately dated and the ongoing chemical analyses are providing new volcanic histories that complement the limited records that exist. The PARCA cores promise richly detailed histories of excess sulfate (EXS) emissions from both known and yet to be identified volcanic eruptions. The high temporal resolution of these ice core volcanic records will help resolve timing issues and their broad spatial distribution will provide a more representative estimate of the EXS flux associated with a specific eruption.

94-3 BTH 101 Hall, Valerie A.

TEPHRA-DATED AGRICULTURAL COLLAPSE AND RECOVERY IN IRELAND THE WAKE OF THE BLACK DEATH

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In the mid-14th century AD, climatic deterioration may have initiated the processes that destroyed the habitat of the Black Rat. Movement of this animal from its home range appears linked with the epidemic of Bubonic Plague known as the Black Death. It has been estimated that between one third and one half of the population of Europe perished. Such population depletion must have affected agriculture but little id known of the years that followed the Black Death from the archaeological and documentary record. In Ireland, pollen analytical investigations of the fortunes of agriculture can be traced as there is a wealth of suitable deposits that contain an historically-dated Icelandic tephra layer from the eruption of Oraejajokull in AD 1362.

Comparison of pollen data from lowland raised bog sites shows, that in some areas, agricultural collapse was complete and may have taken up to one hundred and fifty years for a recovery. In other areas agriculture continued unabated. The work indicated that the agricultural economy of

other parts of Europe must have been similarly affected, even where evidence points to major population reduction.

94-4 BTH 102 Makeev, Alexander O.

PEDOGENETIC IMPACT OF VOLCANISM ON THE HOLOCENE PALEOSOLS OF KAMCHATKA PENINSULA

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Kamchatka peninsula is characterized by long-distance marker layers of tephra as a result of the largest explosive eruptions during the Holocene. Due to a combination of cold climate and comparatively young age tephra layers are not deeply transformed by weathering. This, together with low bioturbation intensity, results in a sequence of clearly visible horizontal layers, retaining their morphological, chemical and mineralogical identity. These marker layers are interstratified with buried soil profiles, making it possible to study transformation of tephra material within the soil profile under various climatic conditions though the whole Holocene.

Soils of Kamchatka, formed on volcanic ashes were studied with consideration of extensive set on radiocarbon dating and constitution of tephra-paleosol sequences. The soils have been formed under various bioclimatic conditions, including the main types of vegetation of Central and Western Kamchatka (tundra, taiga, mountain meadows, etc.). The age of present day surfaces in the study area differs from tens of years to 1760 years before present. The vegetation type mostly determines modern features of volcanic soils. These allow using surface organic horizons as diagnostic.

Constitution of soil profile is strictly determined by constitution of tephra-paleosol sequence. A set of buried soil horizons within the time span of 8000 years before present was studied. The degree of both physical and chemical weathering increases with tephra age. Tephra marker horizons have been compared within buried soil profiles and adjacent bogs, showing less advanced weathering under the thick layer of peat.

The study of constitution and spatial distribution of tephra-paleosol sequences allows determining tephrostratotype as a steady sequence of tephra marker horizons. GIS approach allows to present cartographic images of tephrostratotypes for any given point within the study area, based on combination of marker horizons of 29 largest explosive Holocene eruptions.

94-5 BTH 103 Liu, Jiaqi

VOLCANIC ERUPTIONS RESULT IN EARTH-SHAKING AND ENVIRONMENTAL CHANGES

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Volcanic eruptions are among the strong tectonic movements, which not only change geological structure and landscapes, but also result in environmental changes. A large number of volcanic ashes and volatile gases with water, carbon dioxide, halogens, sulfur and others can cause solid and liquid aerosol, which may destroy ozone layer and form a “parasol” leading to cooling and rainy weather lasted a couple of months or years. In term of long time scale there is a relationship between volcanic eruptions and climate changes, that is active volcanic eruptions usually occurred in worm climatic period (interglacial), and inactive volcanic eruptions usually accompanied with cold climate period (glacial). This regulation has been confirmed by volcanic eruptions occurred in China and the world. For example, the volcanic eruptions frequently occurred in Antarctic before 35 Ma, then had been low-spirited util the Quaternary, while ice sheet just formed after 35 Ma corresponded to inactive volcanic period. Comparing frequency of volcanic activities with tectonic events in China it can be seen that intensive volcanic activities constantly accompanied with tremendous tectonic events which change nature and environment. For instance, the volcanic eruptive upsurges of 45 Ma, 35 Ma, 13 Ma, 1.2 Ma and others can be found in Tibetan Plateau and East China, which just corresponded to collision between Indian and Eurasian Plates, opening of marginal seas, uplift of Tibetan Plateau and so on. These events basically changed Asian and global environment. Volcanic activities can also cause living to die out. Famous dinosaurs were died in the Cretaceous maar lakes in Liaoxi, Northeast China, which resulted in volcanic eruptions. The same situation occurred in the Miocene maar lakes in Shanwang, Shandong Province, East China.

SESSION NO. 95, 1:30 PM

Wednesday, July 30, 2003

T33. Quaternary Divisions and the Boundary Between the Tertiary and Quaternary (Posters)

Reno Hilton Resort and Conference Center, Pavilion

95-1 BTH 104 Rudyuk, Viktoriya

STRATIPHICATION AND CORRELATION OF QUATERNARY ALLUVIAL DEPOSITS OF THE SOUTH-WESTERN PART OF THE EASTERN- EUROPEAN PLATFORM ACCORDING TO UNIONIDAE DATA

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On the basis of studying the collection of fossil Unionidae in the alluvium deposits of the Dniestr, Danube, Prut valleys the stages of their development were defined. The stages correspond to general changes of climate. Also Unionidae are a good bench mark for correlation of distant sections, due to their wide distribution not only in alluvial but in estuary, lacustrine, and marine deposits. In the second half of the Late Pliocene in the fresh-water reservoirs of the South-Western part of the Eastern-European platform the representatives of the Bogatschevia genus - the B. tamanensis group (Rashkiv complex, alluvium of the X terrace) had a wide distribution in the Tamanian deposits of the Akchagil and Upper Akchagil. The cooling that occurred in the Eburonian (after forming alluvium of the X terrace) caused the extinction of majority of sculptured forms of Unionidae and wide distribution of ancient forms of modern Unionidae. This gives grounds for setting a boundary between the Pliocene and Eopleistocene over alluvium of the X terrace. In the stratigraphic scale this cooling is correlated with the Early Apsheronian of the Pricaspian area. In Boshernitsky complex Unionidae of the B. sturi group had a wide distribution. Their distribution was limited by the narrow stratigraphic diapason - alluvium of the IX terraces of the Dniester, Prut, Danube. It corresponds to the Eopleistocene and is correlated with the Lower Apsheronian, Gurian. Alluvium of the VIII terrace is clearly correlated in the vast territories according to the composition of fresh-water mollusk species: Potomida sublitoralis, Bogatschevia (Pseudosturia) caudata, Unio chasaricus etc. Finds of typical forms in the Middle Apsheronian deposits give an opportunity to correlate them with alluvium of the VIII terrace of the Dniester. Alluvium of the VII terrace, on the basis of faunistic and palaeomagnitic data is correlated with the Upper Gurian, Lower Chaudinsky deposits of the Caucasian seacoast of the Black Sea. Alluvium deposits of the V terrace are correlated with Upper Chaudinsky deposits and underlying continental loams on the Chauda cape. The loams are correlated with the lower alluvium thickness of the Kolkotov terrace with Psedunio moldavica. Alluvium of the IV terrace is correlated with old Euksin deposits. Karangatsky deposits are correlated with alluvium of the II terrace.

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DEFINING THE LOWER-MIDDLE PLEISTOCENE BOUNDARY AT THE MATUYAMA-BRUNHES POLARITY TRANSITION: AN AUSTRALASIAN PERSPECTIVE

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The last major reversal of the Earth’s magnetic field, the Matuyama-Brunhes boundary (MBB), has long been used as a chronostratigraphic marker in Pleistocene studies. The MBB is dated at about 0.78 Ma, and occurred during Marine Oxygen Isotope 19. It has been widely identified in both marine and continental sequences and is also a key time marker for the chronology of human evolution and migration.

In New Zealand, the MBB is precisely located in shallow marine sediments of Wanganui Basin, where it corresponds with the base of the New Zealand Putikian Substage. A combination of marine biostratigraphy, sequence stratigraphy, magnetostratigraphy and tephrostratigraphy permit correlation from Wanganui Basin to other on-land sections and deep-sea cores. Loess-paleosol sequences in both the North and South Islands of New Zealand all post-date the MBB, but some glacial deposits are known to be older.

In Australia, the MBB is identified in many continental sequences, particularly saline lake basins. However, chemical weathering has resulted in variable Brunhes-age normal overprints that are sometimes difficult to remove using alternating field demagnetisation techniques. In such cases, thermal demagnetisation is preferred. Where strata are strongly weathered, and secondary magnetic overprints are suspected, identification of reverse polarity magnetisation provides a minimum age of 0.78 Ma. Australasian tektites are a potential lithostratigraphic marker just prior to the MBB, but have yet to be identified in the same on-land section as the MBB in Australia. A widespread arid shift in paleoclimate succeeded the MBB in Australia, but its effects were probably time transgressive across the continental landscape.

Placement of the Lower-Middle Pleistocene boundary at the MBB would make it a widely recognisable chronostratigraphic marker in weathered continental deposits, and would facilitate correlation of the boundary between marine and continental sequences.

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QUATERNARY STRATIGRAPHY AND DIVISION IN CHINA

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There are many kinds of Quaternary sediments in China, such as loess, laterite, lacustrine, fluvial, marine, glacial, cave, volcanic and other sediments. Among them, loess and lacusteine sediments have wide distribution, large thickness with almost complete sequence and long term continuity. The loess-paleosol sequence can be subdivided to 74 alternative loess or paleosol layers at least and three units named Wucheng Huangtuan, Lishi Huangtuan and Malan Huangtuan from the bottom to the top in loess plateau. The perfect profile of lacusteine sediments with rich biological fossil can be found in Nihewan, North China. Quaternary in China used to be divided into four parts: Early Pleistocene (Q1), Middle Pleistocene (Q2), Late Pleistocene (Q3) and Holocene (Q4). This division is unconformity with international dichotomy of Pleistocene (Q1) and Holocene (Q2). To avoid confusion, it has been suggested that Qp substitute for Q1 (Pleistocene), Qp1, Qp2, Qp3 for original Q1, Q2, Q3 and Qh for Q2 (Holocene) ie original Q4. The Pleistocene/Pliocene boundary is suggested at 2.6MaB.P. corresponding to Gauss/Matuyama and loess/red clay boundaries, and the bottom of the MIS 104 instead of 1.8~1.6MaB.P corresponding to the top of Olduvai and the bottom of paleosol S24 and MIS62. Qp2/Qp1 boundary is at 0.78MaB.P. corresponding to Brunhes / Matuyama, the bottom of paleosol S7 and MIS19. Qp3/Qp2 boundary is at 0.128MaB.P. corresponding to the bottom of paleosol S1 and the beginning of MIS 5e. Qh/Qp boundary is at 0.011MaB.P. corresponding to the bottom of paleosol S0 and MIS1.