SESSION NO. 29, 8:00 AM

Saturday, July 26, 2003

S6. Major Quaternary Continental Events in the Marine Record

Reno Hilton Resort and Conference Center, Carson 3&4

29-1 8:10 AM Stuut, Jan-Berend W.

ON THE RELATIONSHIP BETWEEN ANTARCTIC SEA ICE AND SOUTH-WESTERN AFRICAN CLIMATE

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The typical Fynbos vegetation of the Cape region of South-western Africa is brought about by the local Mediterranean (winter rainfall) climate and its associated sharp seasonal precipitation contrasts. The winter-rain realm is bordered by hyper-arid deserts which may rapidly expand in response to future global warming, such as during the last warm period 125.000 years ago. It is therefore essential to understand the mechanisms that drive the winter rainfall in such a restricted area. Here, we correlate variations in South-western African humidity with changes in Antarctic sea-ice extent. New records of Antarctic sea-ice extent compared to existing palaeoclimate records of South-western Africa reveal a coherent signal during the last 50 kyr BP, with enhanced continental humidity during periods of increased sea-ice presence. We propose that greater glacial Antarctic sea-ice extent causes an equator-ward shift of oceanic and atmospheric frontal zones, causing a northward shift of the belt of Southern Westerlies, leading to an expansion of the winter-rain region and thus, increased precipitation over South-western Africa. This relationship implies enhanced desertification in South-western Africa in response to retreating sea-ice edge in the Atlantic sector of the Southern Ocean if global warming continues.

29-2 8:30 AM Hemming, Sidney R.

HEINRICH LAYERS: MAJOR QUATERNARY CONTINENTAL EVENTS

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The quasi-periodic, millennial oscillations of the glacial interval from about 60 to 10 thousand years ago are interrupted by extreme events in the North Atlantic which are inferred to be the product of massive armadas of icebergs from the Laurentide ice sheet. These Heinrich events are associated with dramatic dips in the $\delta^{18}O$ of surface water in the North Atlantic and Nordic Seas. They are also marked by extreme $\delta^{13}C$ of benthic foraminifera that implies virtual shutdown of North Atlantic Deep Water formation, and thus dramatic changes in thermohaline circulation. Strong evidence exists for a Northern Hemisphere-wide climate impact associated with these events. Heinrich layers were deposited over very short intervals of approximately 500 ± 250 years, although the exact duration has yet to be well constrained. The flux of Heinrich detritus was at least five times higher than ambient glacial values, and it has a distinctive provenance indicating derivation from the region around Hudson Strait.

Heinrich layers offer a great example of application of multiple provenance methods to constrain sediment sources, and specifically to use marine sediment cores to understand major Quaternary continental events. Many different measures of their provenance have been applied in the North Atlantic's ice-rafted detritus belt (Ruddiman, 1977, GSAB), and it is the cumulative result that allows such a unique estimation of their derivation from the Hudson Strait. Particularly diagnostic indications of their provenance include detrital carbonate concentration, magnetic susceptibility, K/Ar ages of the fine fraction, Nd and Pb isotopes in bulk sediments, Pb isotopes in feldspar grains and $^{40}Ar/^{39}Ar$ ages of hornblende grains. Although less diagnostic, XRD mineralogy and Sr isotopes also add to the case for their provenance. Together the data require a source region where Paleozoic sedimentary rocks overlie a basement that has an Archean heritage and a strong Paleoproterozoic metamorphic overprint. The detrital carbonate concentrations in the open ocean approach those off the entrance to Hudson Strait, and this combined with the limited age spectrum indicated by the radiogenic isotopes yields the conclusion that Hudson Strait is the dominant contributor.

29-3 8:50 AM Rosell-Melé, Antoni

IDENTIFICATION OF THE MULTIPLE SOURCES OF ICE RAFTED DEBRIS IN THE NORTH ATLANTIC DURING HEINRICH EVENTS USING A BIOMARKER APPROACH

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During the last glacial period the ice sheets surrounding the North Atlantic discharged abruptly massive numbers of icebergs in quasi-periodic episodes. These events are known as Heinrich Events or HE, and are recorded in oceanic Quaternary sediments as prominent layers of ice rafted debris (IRD), whose properties differ from those of adjacent ambient sediments. For instance, the layers contain organic matter of pre-Quaternary origin characterised by a molecular signature more akin to that from a petroleum-like source than from an autochthonous marine input. We have used this to apply a biomarker approach to characterise the provenance of the organic material, and hence the IRD, in four deep sea cores in the North Atlantic containing HLs 1 to 6 (MD95-2024, ODP-609, BOFS-5K and SU90-09). The approach is similar to that applied in the petroleum industry for oil-source rock correlation as well as in oil pollution studies to track the sources of atmospheric pollution or oil spills.

The characteristics of the source material have been determined through the detailed characterisation of the biomarker composition of some of the largest glaciogenic debris flow deposits in the continental margins of the northern North Atlantic. This represents a novel approach to characterise geochemically IRD sources. It is possible because ice sheets drained through specific "outlets" known as trough mouth fans (TMF) in the ocean, and left in the continental margins massive deposits of debris which happen to be relatively rich in organic matter. In this communication we will discuss pros and cons of the use of biomarkers to determine provenance of IRD and the implication of some of the findings to understand further the HEs.

29-4 9:30 AM Herbert, Timothy D.

NON-SYNCHRONOUS CLIMATE CHANGE ALONG THE WESTERN MARGIN OF NORTH AMERICA DURING GLACIAL TERMINATIONS

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A regional set of marine cores now exists to study the evolution of ocean surface temperatures and other paleoclimatic signals along the west coast of North America. Core locations range from Vancouver Island to the north, to the tip of Baja California to the south. We report on the evolution of sea surface temperatures (SST) and marine productivity, as recorded by alkenones. Several sites also have pollen records, allowing us to compare marine and terrestrial responses. We find that surface climate signals covary tightly with global climate, as represented by benthic d18O, through 80% of a typical glacial-interglacial cycle. However, the associations between SST and ice volume break into three regional patterns during glacial maxima and terminations. North of Point Conception (heart of the California Current), SST patterns are very similar to benthic d18O and to Greenland ice core surface temperature data (ODP Site 1019). The abundance of redwood pollen very closely follows SST in this northern province. In the California borderland region, warmings begin during peak glacial conditions, and significantly precede the deglacial sea level rise. Off Baja California, SST follows benthic d18O, but without the high frequency oscillations of temperature observed in Greenland. These changes outline regional reorganizations of surface winds and currents during times of maximum ice volume. Our data suggests that the geographic extent and intensity of the California Current system was much reduced during glacial maxima in comparison to modern conditions. Furthermore, the regional patterns in ocean temperature change that we observe caution against matching terrestrial records directly to ice volume, a mistake that we believe has been made in interpreting the Devils Hole calcite record.

29-5 9:50 AM Lee, Meng-Yang

THE AGE OF THE AUSTRALASIAN IMPACT EVENT AND ITS RELATION TO EVENTS AT THE BRUNHES/MATUYAMA BOUNDARY

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Tektites are natural glasses formed by melting of upper crustal materials during the hypervelocity impact of an extraterrestrial object. The Australasian strewnfield, covering at least one-tenth of the Earth's surface, is the largest and the youngest of four known tektite strewnfields. The stratigraphic proximity of the Australasian microtektite layers with the Brunhes/Matuyama boundary has prompted the hypothesis that large impacts may trigger geomagnetic reversals. As the Australasian microtektite preceded the Brunhes/Matuyama reversal by estimates of ~12 to 16 kyr, these results are inconsistent with simple geophysical models linking geomagnetic reversals with impact events. Recently, detailed paleomagnetic records from the Pacific and Atlantic Oceans consistently found a decrease in paleointensity approximately 15 kyr prior to the Brunhes/Matuyama transition. In some of these records, a directional excursion to nearly full normal polarity with a low paleointensity remains after demagnetization. The close temporal proximity of the pre-transition low (the so-called precursor) to the B/M transition raised questions about its relationship to the reversal itself as well as to an apparently unrelated event - the Australasian impact, that just occurred before the reversal. A through examination of the question hinges on how accurate one can define the temporal relationships among these events. In this study, we (1) present detailed paleomagnetic records from deep-sea cores through the Brunhes/Matuyama reversal interval in association with well-defined Australasian microtektite layers, (2) reassess the lock-in depth of post-depositional remanence acquisition based upon a compilation of eight deep-sea cores, and (3) test the impact-reversal hypothesis by examining the stratigraphic and temporal relation between the Australasian impact event and the precursor of the B/M reversal.

29-6 10:10 AM Reid, Jane A.

WIDESPREAD SEDIMENT DEPOSITION IN NE PACIFIC OCEAN FROM CATASTROPHIC FLOODS OF LATEST PLEISTOCENE AGE, NORTHWEST US

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While evidence of the effects from latest Pleistocene glacial Lake Missoula and other catastrophic floods are well known in the Scablands of the northwest US, an unresolved issue has been the fate of the flood discharge when it reached the ocean at the mouth of the Columbia River. A pivotal key to this puzzle is provided by distinctive turbidites of equivalent age in Escanaba Trough, southern Gorda Ridge, some 1200 km distant.

To evaluate the connective pathway between the Columbia River and Escanaba Trough, this study compiled available 3.5-kHz high-resolution and airgun seismic-reflection data, long-range side-scan sonar images, and sediment core data between the Blanco Fracture Zone (BFZ) and southern Gorda Ridge (GR).

Upon reaching the ocean via the Columbia River drainage, the sediment carried by the catastrophic floods continued flowing downslope in the ocean as hyperpycnally generated turbidity currents. Because large-scale landslides on the Oregon margin prevented southward flow along the base of the continental slope, these tremendous turbidity currents flowed into Cascadia Channel, through the BFZ, and onto the Pacific Plate.

These data suggest that a nearly 90° right hand bend at the western edge of the BFZ divided the turbidity currents into two separate flows. Portions of the turbidity currents higher than the channel margins continued to travel uninhibited by the bend. These upper, flow-stripped, momentum-driven components moved southward, building the Tufts submarine fan. Most of these flows were trapped by the western flank of the Mendocino Fracture Zone (MFZ) to the south and ponded in basins on the western flank of GR and along the MFZ. The very largest of these flows breached a relatively shallow sill at the western edge of Escanaba Trough and settled into the dead-ended Trough. In contrast, the flows remaining confined in the Cascadia Channel after the bend continued onto the Tufts Abyssal Plain, 1000 km or more to the west.

Understanding these sediment-transport processes along with the known relationships between Wisconsinan and other late Pleistocene deposits in Escanaba Trough suggest that more than 7000 km^3 of terrigenous sediment was transported into the NE Pacific by latest Pleistocene catastrophic floods.

29-7 10:30 AM Khalifa, Mohamed A.

QUATERNARY CALCAREOUS DURICRUSTT, IN AL QASSIM PROVINCE, SAUDI ARABIA

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The calcareous duricrust is one of the important factor in shaping the landscape, in Al Qassim Province, Saudi Arabia, as it is protecting the underlying older rocks from denudation processes throughout the Quaternary period. Two types of duricrust can be recognized. The first covers most of the Paleozoic sandstones, and the Triassic mixed siliciclastic-carbonates. This type of duricrust is grey to brown in color, and occurs as scattered nodules with a thicknesses that varies from a few centimeters to decimeters. The second type covers the Upper Permian carbonates and clays of the Khuff Formation, and ranges in thickness from 60 cm to 160 cm. It consists of white massive caliche, overlain by white, yellow patchy duricrust capped by brown, nodular porous duricrust with black manganese oxides as pore filling.

The development of the duricrust is controlled by three factors: the climatic changes, type of underlying rocks, and tectonics. The repeated changes from arid to humid climate is the main controlling factor, in generation of duricrust. During humid periods descending water carries the dissolved carbonates downward as bicarbonates,where the carbonate rich solution are cerried upwards by capillary action during the arid periods.

It is evident that the limestones and marls possibly affect the development of calcareous duricrust, more than the sandstones and dolostones, since the former have supplied the calcium carbonates to form duricrust. The tectonic factor manifested in faults in the study area have provides the topographic lows, which enabled preservation of runoff water and inturn more water infiltration can rise later by capillarity carrying calcium carbonate rich solutions.

The development of calcareous duricrust is mainly attributed to the Pleistocene, Early Holocene alternating humid and arid periods. Two humid periods are documented, the oldest phase of which is between 9000 and 8000 years B.P., while the younger one is between 7000 and 5500 years B.P.

SESSION NO. 30, 8:00 AM

Saturday, July 26, 2003

S8. Isotope Stage 11: An Analog for the Present Interglaciation? (*Commission on Palaeoclimate*)

Reno Hilton Resort and Conference Center, Crystal 3&4

30-1 8:10 AM McManus, J.F.

MARINE ISOTOPE STAGE 11: ANALOGUE OR ANOMALY?

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Similar orbital configurations and comparable atmospheric greenhouse gas concentrations have led to the suggestion that Marine Isotope Stage 11 (MIS 11) is a suitable, possibly the best, geological analogue for the natural development of Holocene and future climate. Yet the apparently strong climate response during MIS 11 in the absence of strong seasonal insolation changes has long been described as the "the stage 11 problem". Any assessment of MIS 11 as analogue or anomaly must include consideration of the timing, duration, climatic stability, and overall amplitude of warmth and sea-level/ice-volume during this interglacial interval. These important questions are best addressed using multiple paleoclimate archives, with deep-sea sediment records prominent among them. Here we review evidence from a number of widely distributed marine locations indicating that MIS 11 was not likely to have been a "super interglacial" interval characterized by both significantly higher sea-level and global temperatures. We discuss the stability and strength of the meridional overturning circulation as a potential compensator for the limited insolation. We also present our own detailed faunal, ice-rafting, and isotopic records from ODP Sites 980 (55°N, 15°W, 2.2km), 983 (60°N, 24°W, 2.0km), and 984 (61°N, 25°W, 1.6 km) that confirm the relative stability of MIS 11 on millennial timescales, and document that the transition to the more characteristic instability of the Pleistocene occurred dramatically and abruptly following the warm interval. In addition, we consider a variety of tuning techniques and apply a new independent dating approach to deep-sea sediment sequences to show that the regional stable warmth of MIS 11 in the North Atlantic long outlasted the elapsed portion of the Holocene. Finally, we present our newest isotopic results from ODP Site 1242 (8°N, 84°W, 1.4km) in the tropical Pacific, and discuss possible ways to reconcile apparently conflicting evidence in existing records of sea-level, temperature, and variability during MIS 11.

30-2 8:50 AM Bowen, D.Q.

IN SEARCH OF STAGE 11 SEA LEVEL: TRACES ON THE GLOBAL SHORE

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Given similar orbital configurations for oxygen isotope stage 11 and the Holocene, the former may be a window for evaluating present and future sea level. Palaeoceanographers have used Mg/Ca ratios on benthic ostracoda to eliminate the temperature term in $\delta^{18}O$ measurements, allowing inferences to be drawn about sea level variability. These suggest a stage 11 sea level of ~ 10 m within a confidence band between ~ +20 m and ~ -8 m. But on world shorelines, stage 11 corals, marine sediments, and shoreline angles generally occur at higher elevations. Some believe, especially in `stable` regions, that these indicate sea levels up to 30 m; but most ascribe such elevations to regional uplift, so that estimates of stage 11 water level require separation of uplift and water level terms. Critically, the quality of stage 11 shoreline data compares unfavourably with the wealth of data for late Pleistocene and Holocene sea levels, so that method relies on extrapolation of 'uplift correction curves' based on average uplift rates derived from estimates of the 5e (5.5) water level. Estimates of this vary between 0 to ~ 10 m above 'sea level'; and related geodetic datum is sometimes ambiguous. So too is the exact age of the 5e high water (possibly multiple), with a range of up to 13 ka. Thus uplift rates often depend on arbitrary initial assumptions, highlighting a desirability for a common protocol. Similarly, stage 11 marine lithofacies does not always provide unambiguous markers for water levels; and there are relatively few reliable age estimates (ESR, TL, U-series, aminostratigraphy). Notwithstanding such uncertainty, however, `uplift correction curves` have provided estimates for a stage 11 water level between -3 to + 13 m, which lies within the band proposed by palaeoceanographers. Does this presage the future? Using examples from the Americas, Europe, Australasia, and Asia, further reconciliation of palaeoceanographical and shoreline evidence is attempted.

30-3 9:10 AM Loutre, Marie-France

MIS11 AND PRESENT INTERGLACIALS SIMULATED WITH A CLIMATE MODEL OF INTERMEDIATE COMPLEXITY

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Climate simulations performed with the LLN 2-D NH climate model have confirmed that climate is largely triggered by changes in insolation forcing although atmospheric CO2 concentration is also playing an important role, in particular in the amplitude of the simulated variations. We focussed first on the Marine Isotope Stage 11 (MIS11) some 400 kyr BP, which can be considered as an analogue for future natural climate changes. Different simulations were performed to identify the conditions constraining the length of this simulated interglacial. Clearly a good phasing between CO2 concentration and insolation variations is requested to drive the climate system into glaciation at that time, mostly because insolation changes are small then. In the light of these experiments, it appears that the long interglacial simulated under natural forcings for the next 50 kyr is a robust feature.

30-4 9:30 AM Helmke, Jan P.

LATE-PLEISTOCENE INTERGLACIAL CONDITIONS IN THE POLAR NORTH ATLANTIC REGION

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Sediment records suggest that during the last 500,000 years interglacial boundary conditions in the Northern North Atlantic (Nordic seas) with strongly reduced occurrence of iceberg-rafted debris (IRD) and high carbonate bioproductivity existed only in marine isotopes stages (MIS) 11, 5e, and 1. A detailed comparison of these three Late Pleistocene interglacial intervals shows that the specific climate conditions have varied significantly. It is indicated that IRD occurs on the central Iceland Plateau continuously during MIS 11 in contrast to the results from the later interglaciations MIS 5e and MIS 1. These observations also differ from the situation in the western Norwegian Sea, where all three interglaciations show IRD-free intervals. Foraminiferal assemblage data suggest that sea-surface temperatures (SST) in the Nordic seas were in general significantly lower in MIS 11 than in MIS 1. These findings point to a different pattern of surface water circulation and a geographical shift in the position of the major water mass boundaries in the Nordic seas during MIS 11 when compared with MIS 5e and 1. Thus, during MIS 11 the Polar Front, i.e., the boundary between the cold water masses of the East Greenland Current and the more temperate surface waters of the Arctic and Atlantic domains, was positioned further east, implying a much steeper SST gradient between the polar and subpolar region and an overall reduced thermohaline activity in the polar latitudes. Further differences among the interglacial intervals are evident from the carbonate preservation record, where a strong increase of carbonate corrosion occurs in MIS 11. Although the reason for this reduced carbonate preservation remains speculative, it indicates differences in the interglacial marine carbonate system between MIS 11 and MIS 5e and 1.

30-5 10:10 AM Prokopenko, Alexander A.

CONTINENTAL PALEOCLIMATE PROXY RESPONSES DURING THE MIS 11 INTERGLACIAL IN CONTINUOUS SEDIMENTARY RECORD OF LAKE BAIKAL, SE SIBERIA

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Here we review climatic proxy responses in the mid-Pleistocene portion of the continuous sedimentary record from Lake Baikal, Siberia. The MIS 11 interval in Baikal record is characterized by two plateaus of high biogenic silica (BioSi) content corresponding to MIS 11.3 and 11.2 and reflecting warm regional interglacial climate conditions, which lasted for about 32 Ka. MIS 11 is thus the longest interglacial in Siberia, greatly exceeding the duration of MIS 5e, 7e and 9e interglacials. At the peak interglacial conditions, ca. 9-10 Ka into the MIS 11, two distinct cooling episodes in Siberia are recorded in Baikal sediments, marked by short drops in diatom abundance and BioSi accumulation. Also evident are distinct changes in the seasonal lake productivity pattern: during these cooling episodes the dominant summer diatom assemblage was suppressed, whereas autumn assemblage expanded. These short-term climatic deteriorations in Siberia, spaced at ca.3 Ka, correlate with millennial-scale climate shifts in European pollen records. These important observations suggest the existence of a poorly understood natural mechanism to perturb the stability of climatic conditions during a 'full' interglacial. Our detailed clay mineral studies indicate that during the last interglacial and during MIS 11 the vertical profiles of smectite index in Baikal sediments are highly correlative with BioSi, organic carbon and other lacustrine paleoproductivity indices. Using the smectite layer index to compare the present and the last interglacials with MIS 11, we found no evidence in the non-biogenic fraction of Baikal sediments to support the proposition that MIS 11 was an anomalously warm interval in Siberia. The Baikal sedimentary record allows putting the MIS 11 interval into a larger context of mid-Pleistocene climate change. We found that glacial/interglacial climatic contrasts in southeast Siberia during mid-Pleistocene were muted. Instead of the extreme changes surmised from some marine climate proxy responses, the period of almost 200,000 years from MIS 15a to MIS 11 (ca. 580-380 Ka BP) apparently lacked extensive mountain glaciation, and was characterized by virtually continuous existence of a monodominant interglacial diatom assemblage in Lake Baikal, by stable littoral benthic diatom assemblage, and by lithogenic sediments with "interglacial" properties.

30-6 10:30 AM Rousseau, Denis-Didier

THE CONTINENTAL RECORD OF STAGE 11: A REVIEW

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The review of terrestrial records of marine isotope stage 11 indicates that they are mostly yielded by pollen and loess sequences. They occur in different localities around the world and show differ-

ent time resolution and environmental conditions. Other records are discussed which correspond to more particular conditions, i.e., the Lake Baikal deposits, or the terrestrial malacofauna from tufa deposits in Western Europe. If almost all the records indicate moister conditions than present, the temperature estimates vary from similar to the present, to warmer from place to place. Another problem related to the interpretation of terrestrial deposits of stage 11 is the time resolution and the sampling interval of the related deposits that makes correlation with other proxies even more difficult due to the long duration of this interglacial. However, a scenario is proposed to link the different reviewed record based on a general warm climate of MIS 11.

30-7 10:50 AM Tzedakis, Chronis

NATURE AND TIMING OF VEGETATION CHANGES IN S. EUROPE DURING MIS 11

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In contrast to the situation in higher latitudes where the effects of glacial and periglacial processes have produced stratigraphical discontinuities, favourable geological conditions in southern Europe have led to the relatively undisturbed accumulation of thick sedimentary Quaternary sequences. Such sequences provide an opportunity to develop complete and high-resolution records of terrestrial events over multiple glacial-interglacial cycles and bypass the problem of reconstructing a record by piecing it together from isolated deposits of often-uncertain chronostratigraphical position. Thus, unlike northern Europe where the terrestrial equivalent of MIS 11 remains a controversial issue, its position within these long sequences can be determined with increased confidence. In addition, the continuity of the records provides an opportunity to examine not only the full interglacial sequence, but also the intervals pre- and post-dating it, which are not represented in fragmentary records. However, despite a clear chronostratigraphical framework, these long sequences still lack a sufficiently precise terrestrial timescale because of problems associated with direct dating of lake sediment material. The development of chronologies for these long sequences is of critical importance because we need to assess how terrestrial events relate temporally to atmospheric and ocean changes to determine the forcing factors and differences in response characteristics.

Here we review the nature of vegetation changes in southern Europe during the MIS 11 complex. We then develop a chronology for these events and test the accuracy of the devised timescale. This allows comparisons to be made with records of climate variability from the North Atlantic on orbital and suborbital timescales. Of particular interest is to examine the extent to which marine and terrestrial stage boundaries coincide. More specifically, do forest communities persist in southern Europe throughout the 30 kyr interval of minimum ice volume or do they vary in abundance in response to insolation changes?

30-8 11:10 AM van Kolfschoten, Thijs

THE HOLSTEINIAN, THE EUROPEAN TERRESTRIAL EQUIVALENT OF MARINE ISOTOPE STAGE 11

VAN KOLFSCHOTEN, Thijs, Faculty of Archaeology, Leiden Univ, P.O. Box 9515, Leiden 2300 RA Netherlands, t.van.kolfschoten@arch.leidenuniv.nl.

An increasing number of paleoclimatologists believe that Marine Isotope Stage (MIS) 11 is more appropriate as a past analogue for the Holocene than the Eemian. This assumption led to a growing interest among biostratigraphers, paleozoologists and paleobotanists, who investigate the terrestrial-equivalent late Middle Pleistocene record, as well as the stages directly preceding and following this event. Their studies show that during this time-span in the European flora and fauna, species, regarded as Pliocene and Early Pleistocene relicts, became extinct. It is implicit therefore that the modern terrestrial flora and fauna was established during late Middle Pleistocene. The detailed studies of the Middle Pleistocene revealed a large number of temperate flora and fauna assemblages indicating several warm/temperate stages. Which of these warm/temperate continental stages is the equivalent of MIS 11? In Europe the Holsteinian seems to be a good candidate. However, in the literature one can find correlations between the Holsteinian and MIS 7, 9, 11 or 13 which indicates that a correlation between the marine oxygen isotope stratigraphy and the Holsteinian is still a matter of debate. The debated arguments will be summarized in the presentation and the conclusion that Holsteinian is the best candidate will be argued.

Assuming that the Holsteinian is the equivalent, what do we know about that stage? In glaciated areas as in the northern part of Western and Central Europe it is possible to find the Elsterian glacial deposits and hence, it is possible to trace the succeeding Holsteinian deposits and to characterize the stage paleobotanically and paleozoologically. This is crucial in order to be able to recognize the Holsteinian in the extra-glaciated areas where only scattered, fragmented parts of the Middle Pleistocene geological record can be studied. Furthermore it is possible in long sections such as Lac du Bouchet, Tenaghi Philippon to find equivalents of MIS 11 in southern Europe and to investigate the correlation between these equivalents and the northern European Holsteinian Stage. These investigation will also show the geographical gradients in the botanical and zoological characteristics of the terrestrial equivalent of Marine Isotope Stage 11.

30-9 11:30 AM Schreve, Danielle C.

THE ENVIRONMENT AND CLIMATE OF THE MIS 11 INTERGLACIAL IN EUROPE: EVIDENCE FROM THE VERTEBRATE RECORD

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The recognition of a biostratigraphically diagnostic mammalian assemblage for MIS 11 has permitted correlation of numerous localities across western and central Europe, from the British Isles to the Czech Republic and beyond. The mammalian biostratigraphic framework provides one of the most robust means of linking different depositional environments, thereby maximising the information potential of disparate and generally fragmentary terrestrial sequences. Moreover, the vertebrate faunas (particularly elements of the exotic herpetofauna), in conjunction with invertebrate assemblages, provide significant information regarding the palaeoclimatic and environmental character of this interglacial, the rapidity of climatic amelioration after MIS 12 and the nature and timing of sea level change. This is especially noteworthy for extreme NW Europe, where Atlantic influence is at its most profound. The paper will also review faunal turnover during the MIS 11 interglacial, including the evidence for early hominid dispersals and behaviour.

SESSION NO. 31, 8:00 AM

Saturday, July 26, 2003

S14. Deserts Over the Last 100,000 Years (*International Geological Correlation Programme 413: 'Understanding Future Dryland Change from Past Dynamics'*)

Reno Hilton Resort and Conference Center, Reno Ballroom

31-1 8:10 AM Kocurek, Gary

PHYSICAL RESPONSE OF AEOLIAN SAND SEAS TO CHANGES IN WIND REGIME OVER THE LAST 100,000 YEARS - AN APPROACH FROM SYSTEM SELF-ORGANIZATION

KOCUREK, Gary[1], EWING, Ryan[1], and WERNER, Bradley[2], (1) Department of Geological Sciences, Univ of Texas-Austin, Geol Science Dept, 1 University Station C1100, Austin, TX 78712-0254, garyk@mail.utexas.edu, (2) Institute of Geophysics & Planetary Physics, Univ of California - San Diego, La Jolla, CA 92093

The reconstitution of wind regimes has impacted aeolian sand seas throughout the last 100,000 years of Icehouse Milankovitch and smaller-scale climatic cycles. Approached as self-organizing systems, the physical response of dunes within sand seas can be partly understood from models and theory. Given a sediment supply, the availability of this supply, and wind energy, dune fields develop over relatively short periods of time. Through the process of merging with migration, dunes increase in size, crest length and spacing, with a corresponding decrease in defect density. Steady state is approached when all bedforms are similar in size, migrate at the same speed, and crestline orientation is as perpendicular as possible to all constructive winds. Dune type is a function of the direction and magnitude of these winds. With a change in wind regime, crest reorientation occurs at defects, and at a rate inversely proportional to defect density. Because the rate of change of spacing and orientation within well-developed dune fields with few defects is slow, most relict dune-field patterns do not form templates for new patterns, but rather new patterns form congruent with the new wind regime. Linear dune fields especially have a typically low defect density, and the rate of formation of a new pattern of dunes exceeds the rate of crest reorientation for the existing dunes, leading to the superimposition of generations of dunes. Although a large array of other complex dune-field patterns exists that are poorly understood, many of these probably originate through superposition of dune generations. Complex dune-field patterns are characteristic of accumulation surfaces where the frequency of wind-regime change exceeds any burial rate. In contrast, much of the aeolian rock record results from dune fields in which the accumulation surface was exposed for relatively short periods of time. Complexity of aeolian cross-strata in the geological record is best attributed to large dune size, which fosters the formation of superimposed dunes, and to main bedform crest orientation that is oblique to shorter frequency wind cycles, allowing the occurrence of superimposed lee-face dunes.

31-2 8:30 AM Yang, Xiaoping

LATE QUATERNARY EVOLUTIONS OF DESERTS IN NORTHWESTERN CHINA

YANG, Xiaoping[1], DODSON, John[2], and LIU, Tungsheng[1], (1) Institute of Geology and Geophysics, Chinese Academy of Sciences, P.O.Box 9825, Beijing, 100029, China, xpyang@263.net.cn, (2) Department of Geography, Univ of Western Australia, Nedlands, Australia

The desert landscapes in northwestern China include sand seas, gravel deserts, desert steppe, steppe and scrub-woodlands environments distributed in a wide range of the geomorphological and tectonic settings, from 155 m below the sea level in the Tulufan Basin to more than 5,000 m asl in the Kulun Mountains. Under the support from the National Natural Science Foundation of China we have been studying the evolutions of deserts in this extensive region during the Late Quaternary and their dynamic relationship with global changes. Detailed field investigations have been carried out in the Badain Jaran Desert of the western Inner Mongolia and in the Taklamakan Desert of southern Xinjiang. Great attention has been given to geomorphological and sedimentological evidence. The stratigraphy of the dunes in the Badain Jaran Desert, high lake levels in the areas near and within the large deserts indicate a much more humid climate in the western China during the marine isotope stage three. However, the period after 24 ka to the end of the Pleistocene was mostly characterised by increased temperature and reduced precipitation in the Tarim Basins. During the Holocene, higher lake levels, stratigraphy of dunes and results of palynological, isotopical and sedimentological analyses of lacustrine sediments in the western China suggest a few wetter periods, especially in the earlier part of the Holocene. We think, however, broad regional differences needed to be considered for the understanding of palaeoclimates in Central and East Asia.

31-3 8:50 AM Stokes, Stephen

ENVIRONMENTAL RESPONSES TO CLIMATE CHANGES IN THE EASTERN SAHARA SINCE THE PENULTIMATE GLACIAL

STOKES, Stephen, BAILEY, Richard, NICOLL, Kathleen, ARMITAGE, Simon, HAYNES, C Vance, and MAXWELL, Ted A, School of Geography and the Environment, Univ of Oxford, Oxford, United Kingdom, stephen.stokes@geog.ox.ac.uk

The chronology, style and extent of environmental changes as manifested in lacustrine sequences and offshore dust flux records is well established in West Africa for the period since c. 20 ka. This record is dominated by a significant transition from desert conditions to a more verdant landscape during the early Holocene insolation maximum. Evidence for significant increases in moisture during this period has also been described from the Eastern Sahara. Evidence of environmental changes during previous insolation maxima, during either glacial or interglacial stages is less well known throughout the Sahara.

Here we describe our attempts to extend the recorded evidence of environmental changes for the Eastern Sahara back to M.I.S 6. By optically dating a series of variously pedogenetically altered aeolian sand sheets, lacustrine and fluvial sediments, we have generated a regional model of inferred shifts in moisture regime over this period. Evidence from Bir Tafawi indicates the occurrence of superimposed and unconformity-bounded lake basins that relate to the three precessional maxima that occurred during M.I.S. 5. The analysis of so-called 'radar river'-like fluvial sediments confirms that during at least some periods of M.I.S. 5, there was a significant and interconnected surface drainage network present in the vicinity of southwestern Egypt and Northwest Sudan. Deposition during the last glacial period was dominated by sand sheets, which are well known from the Selima region of southern Egypt. These deposits have been variably reworked

and pedogenically altered during periods of ameliorated (i.e. humid) climate. Periods of climatic amelioration correspond closely with insolation maxima during the glacial period, suggesting that intensification of the monsoon occurred during this time, though probably not of sufficient intensity to result in the generation of extensive surface waters. Likewise, during the last glacial, insolation minima correspond to phases of widespread aeolian deposition. Some evidence of abrupt climatic transitions, including a possible Younger Dryas age aeolian reactivation, is apparent. We present details of the preserved and dated sedimentary record, along with inferences relating to the geographical extent of the palaeomonsoon in the Eastern Sahara.

31-4 9:10 AM Thomas, David S.G.

WETTING AND DRYING AT THE TSODILO HILLS, BOTSWANA OVER THE LAST 30 KA

THOMAS, David S.G.[1], BROOK, George[2], SHAW, Paul A.[3], and BATEMAN, Mark D.[1], (1) Sheffield Centre for International Drylands Research, Dept of Geography, Univ of Sheffield, Sheffield, S10 2TN, United Kingdom, d.s.thomas@sheffield.ac.uk, (2) Department of Geography, Univ of Georgia, Athens, GA 30602, (3) Centre for Environmental Change, Univ of Luton, Luton, LU1 3SE, United Kingdom

Few sites of paleoenvironmental and archaeological significance in the Kalahari Desert have yielded composite direct proxies of both arid and humid conditions during phases of occupation. The Tsodilo Hills, inselbergs that rise from the sandy Kalahari plain, are an exception, possessing both a rich archaeological archive and contiguous sedimentary records of aeolian and lacustrine conditions. Cave and rock shelter horizons indicate occupation of the site back to about 100 ka. Fish and wetland mammal bones in LSA layers have led to suggestions of standing water in this currently arid location.

To the southwest of the hills, lacustrine carbonates, containing abundant mollusc and diatom remains and shorelines provide evidence of perennial lake conditions in the past. Stabilised linear dunes are indicative of past drier conditions, with the dune closest to the hills eroded by lake waters and lower dune sediments superimposed by a shoreline feature. The lacustrine surface possesses four sub-basins suggestive of the feature having variable extents depending on the volume of runoff and seepage generated from the hills themselves.

17 radiocarbon ages from lacustrine carbonates, 6 AMS dates from molluscs, 6 OSL ages from dunes and 4 from shoreline deposits have to date been determined from the Tsodilo complex. Diatom and mollusc species analysis provide data on water conditions. The evidence suggests that linear dune construction has not occurred since the Last Glacial Maximum, with particular development at 36-28 ka. Lake stands indicating wetter regional conditions than present occurred at 40-32 ka, with more seasonal conditions from 36ka, and at 27-12 ka with a possible drying out at 22-19 ka.

The relationship between the local Tsodilo and regional palaeoclimatic records are considered. Data are consistent with other independent studies from the region, and with recent evidence obtained from Atlantic cores off the coast of Namibia. The presence of fish bones in archaeological horizons, potentially sourced locally or from the perennial wet Okavango delta 40km to the east, may provide information on the relationship between site occupation and prolonged climatic extremes.

31-5 9:30 AM Magee, John W.

SYSTEMATIC MULTIPLE OSL DATING OF LONGITUDINAL AND TRANSVERSE (SOURCE-BORDERING) DUNE PROFILES IN MONSOONAL NORTHERN AUSTRALIA

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Luminescence dating, particularly by optically stimulated luminescence (OSL), has revolutionised Quaternary dune chronologies of the past 2-300 ka. However, the paucity of natural exposures of deep dune profiles and the difficulties of OSL sampling of intact dune profiles at depth have often resulted in a dominance of relatively shallow dates and multiple sites with few dates in the literature. The upper portions of dune profiles are likely to be affected by ephemeral shallow aeolian reworking, bioturbation and pedogenesis. Resultant mixing of grains is likely to impact on the OSL age and raises questions regarding the veracity of periods of regional dune activity imputed from clusters of ages from multiple shallow sites.

We report the results of systematic OSL dating down dune profiles in the northern Great Sandy Desert of Western Australia with 14 dates through a 5m late Holocene longitudinal dune, 12 dates through a 10m Pleistocene longitudinal dune and 9 dates through a Pleistocene source-bordering transverse (lunette) dune. Though occurring in the semi-arid zone, these dunes are in the summer monsoon-watered part of the continent and therefore subjected to considerable seasonal pedogenic processes and are likely to be subject to bioturbation, particularly due to termites. The age profiles obtained are discussed in terms of the age(s) or dune building or mobility and indications of possible post-depositional sediment mixing.

31-6 10:10 AM Sinha, R.

QUATERNARY PALAEOCLIMATIC RECONSTRUCTION FROM MINERALOGY AND GEOCHEMISTRY OF THE SAMBHAR LAKE PLAYA SEDIMENTS, THAR DESERT, INDIA

SINHA, R.[1], SMYKATZ-KLOSS, W.[2], STUEBEN, Doris[2], and BERNER, Zsolt[2], (1) Engineering Geosciences Group, Department of Civil Engineering, Indian Institute of Technology Kanpur, Kanpur, 208016, India, rsinha@iitk.ac.in, (2) Institute of Mineralogy and Geochemistry, Karlsruhe University, Karlsruhe, 76131, Germany

Multiple phases of clastic- and evaporite- dominated deposition is revealed from a deep core (~23m) from the Sambhar lake playa located at the eastern fringe of the Thar desert in Rajasthan, India. Mineralogical and geochemical data have been used to identify evaporite facies reflecting complex interactions between playa hydrology and brine chemistry. Sharp mineralogical variations marked by relative dominance of carbonates and sulfates reflect fluctuations in salinity level induced by climate change. The complete absence of gypsum in the top 5m and dominance of carbonates in the bottom ~7m of the sequence are remarkable. The relative dominance of dolomite over calcite at certain levels coupled with high $\delta^{18}O$ values suggest high salinity conditions during which dolomitization of calcite by Mg-rich brines was favoured. Increased evaporative conditions would favor precipitation of gypsum thereby increasing Mg/Ca ratio and permitting the brine to act as a dolomitizing fluid. The upper ~5 m of the playa deposits are rich in organic matter suggesting high organic productivity. $\delta^{13}C$ values of the organic matter in the top 5 m shows rapid fluctuations (about -15 to - 24 ‰). Although such fluctuations could reflect relative abundance of C_3 versus C_4 or of terrestrial versus aquatic vegetation, such regional changes in vegetation type in the Thar desert during Late Holocene is not plausible. We believe that such variations in $\delta^{13}C$ values may reflect in situ variation of $\delta^{13}C$ due to lake level/salinity fluctuations. We observe a significant correlation between the $\delta^{18}O$ values and the MgO/(MgO+CaO) ratios of the carbonate fraction of the Sambhar Lake plays which supports our interpretation that the variation in the $\delta^{18}O$ values chiefly reflect changes in degree of brine evaporation i.e. in evaporation/inflow ratios. There is also a close correlation between the $\delta^{18}O$ values and geochemical ratios (Na/Al, Na/Ti, K/Na) and this strengthens our interpretations. Although poorly constrained chronologically at this stage, our data reconstructs the paleohydrological and paleolimnological conditions, induced by climatic fluctuations, in the Thar region for the last 25ka and may serve as the longest reconstruction so far in the Thar desert based on lacustrine sequences.

31-7 10:30 AM Zoeller, Ludwig R.

THE DESERT LOESS RECORD OF CLIMATE AND HUMAN IMPACT - EXAMPLES FROM SINAI PENINSULA AND LANZAROTE (CANARY ISLANDS)

ZOELLER, Ludwig R., Geomorphology Chair, Univ of Bayreuth, Bayreuth 95440 Germany, ludwig.zoeller@uni-bayreuth.de.

Desert loess or loess-like silt in desert environments is increasingly recognised as a record of paleoecology and paleoclimate in lower latitudes. Dating of these deposits has so far been rare mainly due to the lack of datable organic material.

Luminescence (TL, IRSL) dating has been applied to thick sequences of silt-paleosol sequences in the Wadi Feiran (Sinai Peninsula) and Lanzarote (Canary Islands). In both areas past shifts to slightly more humid conditions are witnessed by paleosols and mineralogical and geochemical data. In the Wadi Feiran, the sedimentation of up to 55 m thick silt took place during MIS 2, and intercalated paleosols are only weakly developed humic horizons. In Lanzarote both, very weakly and very intensively developed paleosols are found. The sequences dated so far range between ca. 200 and ca. 5 ka. Intensive soil formation occurred during MIS 3 and, apparently, during MIS 7. Weaker cambic soils developed during the lower and middle Holocene and apparently during MIS 5. Periods of stronger desert loess accumulation apparently started shortly after the maximum of an interglacial, but the strongest desert loess input coincides with the “Erg Ogolien” arid phase (late MIS 2) in North Africa.

The arrival of man to Lanzarote during a lower or middle Holocene moister period between 10 and 5 ka is deduced from numerous finds of ovicaprid bones. The first human occupation occurred thus much earlier than proved from the archaeological record so far. It resulted in disastrous soil erosion and land degradation long before the colonial age. The early onset of soil erosion affecting a very sensitive semi-arid ecosystem could have been enhanced by more arid conditions since ca. 5 ka. More closely spaced luminescence dating will improve our understanding of the paleoecology and man-environment interaction.

31-8 10:50 AM Lancaster, Nicholas

LINEAR DUNES: ARE THEY A PRODUCT OF GLACIAL WIND REGIMES?

LANCASTER, Nicholas, Desert Rsch Institute, 2215 Raggio Parkway, Reno, NV 89512, nick@dri.edu

Dunes of linear (longitudinal, seif) types are very widespread in deserts worldwide. Today, large areas of these dunes are stabilized by vegetation, or are being actively reworked in modern wind regimes. Many large linear dunes are today out of equilibrium with modern wind regimes, as indicated by comparison of dune trends with the directions of modern sand moving winds.

An examination of published OSL and TL ages for these dunes from deserts in the Middle East, Arabia, Australia, the western and southern Sahara, the Kalahari and Namibia suggests that the cores of most of these dunes are older than 10,000 years. In many cases, large linear dunes were actively reworked (or formed) during the Last Glacial Maximum. A trend of decreasing linear dune size with time is evident from some areas (e.g. Mauritania, Namibia, Arabia).

Modeling of the winds necessary to form many linear dunes suggests strongly that many linear dunes formed during periods when seasonal high-pressure cells in sub tropical latitudes were intensified and monsoon circulations were absent or much reduced in strength. This conforms to climate model results for glacial stages.

31-9 11:10 AM Tchakerian, Vatche P

SAND RAMPS AND LATE QUATERNARY AEOLIAN DYNAMICS, MOJAVE DESERT, CALIFORNIA, USA

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Sand ramps provide valuable information on the nature and dynamics of late Quaternary aeolian accumulation, stabilization and reworking in the Mojave Desert, California. Sand ramps consist primarily of aeolian sediments, intermingled with significant contributions from nearby fluvial and mass movement (colluvial) deposits, and are typically found on the western (windward) slopes of mountain ranges that lie astride well-developed aeolian sand transport corridors that extend from source areas in the western and central Mojave Desert toward depositional sinks that lie to the east and south.

These topographically controlled sand accumulations appear to be relict and show no evidence of present day aeolian activity. Most of the sand ramps contain multiple aeolian depositional units, separated by paleosols formed during periods of geomorphic stability. Based on geomorphic, stratigraphic, and paleosol analysis, as well as luminescence ages, aeolian deposition appears to have been rather discontinuous or in discrete pulses and occurred throughout the late Quaternary, with significant emplacements between 35-25 and 15-10 ka.

Aeolian constructional episodes seem to be driven primarily by climatically-driven variations in sediment supply from fluvial and/or lacustrine sources. Significant changes or fluctuations in the regional climate may impact aeolian sediment transport systems via changes in sediment supply, availability and mobility. Trace element geochemistry of sediment from sand ramps indicate that sources for each sand ramp changed through time, possibly as sediment availability from different local fluvial/playa systems changed in response to climatic oscillations.

31-10 11:30 AM Pederson, Joel L.

THE GRAND CANYON, ARIZONA (U.S.) RECORD OF FULL-LANDSCAPE RESPONSE TO MIDDLE-LATE PLEISTOCENE CLIMATE CHANGE

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Studies in Grand Canyon are building one of the best-dated and most-detailed non-glacial Quaternary landscape records. A combination of OSL, U-series, and cosmogenic-surface-exposure dating of the mapped hillslope and stream stratigraphy highlights the sedimentologic linkages, or lack thereof, between: a) hillslope, b) tributary catchment, and c) the mainstem Colorado River landscape components through time as a function of glacial-interglacial climate changes.

Grand Canyon has undergone major landscape aggradation episodes correspond roughly to the terminations of OIS 6 and 10, as well as a recent episode of valley-filling during both OIS 4 and 3. The recent part of the record argues against any simple relation of sedimentation-and-erosion cycles to climate. Relict hillslope colluvial mantles are laterally correlated to tributary fill terraces that formed from 50 to 30 ka (OIS 3). Tributary streams must have incised into this fill sometime during OIS 2. This stored sediment was remobilized into a subordinate tributary deposit from 12.5-6.5 ka.

In contrast to local catchments, there is a chronologic and stratigraphic disconnect between the local landscape and the "exotic" mainstem Colorado River. A massive fill deposit along the Colorado River formed 75-60 ka (correlating well to OIS 4) significantly predates tributary aggradation, as evident in stratigraphic relations. Records in the headwaters of the Colorado River suggest there should be a mainstem fill correlating to the Pinedale glaciation (OIS 2), but there is no field evidence for such a deposit. Other research in Grand Canyon leads us to suggest it may be beneath the channel of the modern river. Likewise, there is no notable early Holocene deposit of the Colorado River to match that of local tributaries.

We interpret these data to indicate that the greater Colorado River is relatively sensitive to climate forcing in its distant headwaters, whereas local catchments have sedimentologic responses that lag 10^4 ky after changes to full-glacial climate and are buffered in their response to increased bedrock weathering rates and relatively steady hydrology. The importance of climate transitions relative to full glacial or interglacial episodes is confused by this lag time; and these landscape responses to climate are likely distinct to weathering-limited drylands.

SESSION NO. 32, 8:00 AM

Saturday, July 26, 2003

S22. Observations and Modelling of ENSO and Other Aspects of Short-term Climate Variability During the Holocene

Reno Hilton Resort and Conference Center, Carson 1&2

32-1 8:10 AM Stott, Lowell

A RECURRING SUPER ENSO-LIKE SST AND SSS PATTERN IN THE TROPICAL PACIFIC DURING THE HOLOCENE

STOTT, Lowell, Earth Science, Univ of southern california, 3651 Trousdale Pkwy, Los Angeles, CA 90089, Stott@usc.edu and THUNELL, Robert, Department of Geological Sciences, Univ of South Carolina, Columbia, SC 29208

The western tropical Pacific warm pool has experienced large recurring temperature and salinity perturbations throughout the Holocene that lasted from centuries to millennia. Approximately ten times during the Holocene the surface ocean in the western tropical Pacific became warmer and saltier than it is today. These episodes are attributed to a more northerly displacement of the ITCZ during summer, and its influence on the hydrologic cycle across the Pacific Warm Pool. The most recent episode of warmer and saltier conditions in the western Pacific coincided with the Medieval Warm Period, which gave way to the relatively cooler and less salty conditions during the Little Ice Age. The recurring nature of large millennial scale ocean/climate change in the tropical Pacific has important implications for assessing how tropical and global climate could vary in the future.

32-2 9:10 AM Kukla, George J.

DO GLACIALS START BY TROPICAL WARMING?

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Frequency of paleoclimatic variations matches that of the elements of the earth's circumsolar orbit. It is therefore generally accepted that the seasonal and latitudinal redistribution of solar energy reaching the Earth controls the state of global climate. Correlation of paleoclimatic evidence with orbital changes shows that the build-up of polar ice accelerates, when due to the low obliquity, the insolation is preferably channeled to low latitudes at the expense of the high ones, and when, due to the precessional cycle, the solar beam in astronomic winter and spring becomes stronger than in summer and autumn. This is the case when the perihelion occurs after the winter solstice but prior to the summer solstice.

As a result of the insolation shift the planet loses less energy in the highly reflective high latitudes and absorbs more in the tropical oceans where the albedo is low. The heating of equatorial oceans is highly sensitive to the wave of solar radiation in transitional seasons. It increases when the energy income to the ocean is strong in spring and weak in autumn. Models show that in suchcase the El Nino warm anomalies become more frequent than the cold La Nina. Since the shift in the strength of solar beam toward boreal spring favors earlier establishment of snow fields in the high latitudes, the temperature gradient between the tropics and the poles, which drives the weather systems in middle latitudes, is invigorated. As a result the transport of water vapor to high latitudes increases, leading to the build-up of ice on land. Because the warming oceans in low latitudes form the largest portion of the planet, it is not only possible, but highly probable that the areally averaged global surface temperature during the first several millennia of the glacial ice build-up was increasing and consequently, that the glacials started with global warming.

32-3 9:50 AM Otto-Bliesner, Bette L.

MODES OF VARIABILITY IN A 1000-YEAR CLIMATE MODEL SIMULATION FOR 8.5 KA

OTTO-BLIESNER, Bette L. and BRADY, Esther C., Climate and Global Dynamics Division, National Ctr for Atmospheric Rsch, PO Box 3000, Boulder, CO 80307, ottobli@ucar.edu

Modes of internal climate variability are investigated for the Mid-Holocene, 8500 year ago (8.5 ka), using a 1000-year simulation with the NCAR Climate System Model (CSM). The CSM is a global coupled atmosphere-ocean-sea ice model.

ENSO variability, as measured by sea surface temperature (SST) anomalies in the Niño-3.4 region (5ºS-5ºN, 170º-120ºW), shows weaker variability (standard deviation=0.55ºC) compared to the present-day simulation (standard deviation=0.68ºC). This is consistent with the proxy data of Rodbell et al. and Tudhope et al. Warm and cold SST events in the central and eastern Pacific peak in boreal winter and wavelet decomposition shows that most of the power is contained at periods between 2 to 10 years, both similar to present. Extended warm and cold periods are also apparent in the time series.

The North Atlantic region shows considerable internal variability on decadal to centennial time scales. The North Atlantic Oscillation (NAO), defined as the normalized December-March sea level pressure difference between Iceland (64.2ºN, 22ºW) and Lisbon, Portugal (38.75ºN, 9ºW), indicates strong peaks at a period of ~7 years that occur intermittently every 100-200 years, and peaks in the 10-40 year band and the 50-80 year band that recur intermittently on longer time scales.

Time series of simulated eastern Greenland surface temperature and Greenland-Norwegian sea surface temperature exhibit strong fluctuations on multi-decadal time scales with a century long cold period that start at year 630 of the simulation. Eastern Greenland surface temperature cools abruptly by 8ºC. This cool event is also coincident with a weakening of both the North Atlantic Deep Water and Antarctic Bottom Water overturning cells and a Labrador Sea increase in sea ice extent. Proxy evidence suggests a major 100-year cooling fluctuation in the North Atlantic about 8.2 ka. It has been suggested that this event may have been caused by the response of the atmosphere-ocean-sea ice to a meltwater pulse emanating from the collapse of an ice dome in Hudson Bay. Our simulation for 8.5 ka forced only by Milankovitch orbital changes (no meltwater pulse) shows an event of similar magnitude and time scale.

32-4 10:10 AM Morrill, Carrie

CHANGES IN ENSO GLOBAL TELECONNECTIONS THROUGH THE HOLOCENE

MORRILL, Carrie and OTTO-BLIESNER, Bette L., Climate and Global Dynamics Division, National Ctr for Atmospheric Rsch, PO Box 3000, Boulder, CO 80307, morrill@ucar.edu

The El Niño-Southern Oscillation (ENSO) is one of the primary sources of interannual climate variations around the globe. Observational records of the past two centuries show that the global influence of ENSO via its teleconnections has varied through time, however. In this research, we use the NCAR Climate System Model (CSM) to examine how ENSO global teleconnections could have changed through the Holocene. There are two main motivations for this research. First, our results can be used to improve interpretations of paleoclimate records. It is often unclear whether a proxy has recorded a change in ENSO variability or a change in ENSO teleconnectivity. Model results can separate these two competing influences. Second, this research addresses the larger question of how changes in the base state of the climate affect teleconnections. Answers to this question are critical for predicting how the far-field influence of ENSO could be altered due to future climate change.

We use CSM simulations for five time-slices during the Holocene: pre-industrial time (~1850 A.D.), 3.5 ka, 6.0 ka, 8.5 ka and 11.0 ka before present. Orbital parameters vary between these simulations according to the calculations of Berger (1978). Trace gases are held constant at pre-industrial values. Results from the pre-industrial simulation show that the modeled effect of ENSO variations on global temperature and precipitation patterns is comparable to modern observations. Using all five simulations, we identify regions and time periods with altered relationships between ENSO and temperature or precipitation. We discuss the reasons for changes in these teleconnection patterns and consider the implications for paleoclimate records.

32-5 10:30 AM Menking, Kirsten M.

DID SUPPRESSION OF EL NIÑO CAUSE MID-HOLOCENE DROUGHT IN SOUTHWESTERN NORTH AMERICA?

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Large-scale eolian landforms in Estancia basin, central New Mexico, record two episodes of extreme drought and low groundwater levels during the middle Holocene followed by a rise in the water table through the late Holocene. Blowouts and associated lunettes formed when groundwater levels fell below the desiccated floor of pluvial Lake Estancia, allowing widespread deflation of Pleistocene lake sediments. AMS radiocarbon dates on gastropods found at the base of lunette deposits indicate that deflation initiated at ~7 ^{14}C kyr B.P., and examination of the architecture of lunettes and blowouts reveals two distinct episodes of deflation. When deflation ceased, playa fill began to accumulate in blowouts, and dates on reproductive cysts of *Artemia salina* (brine shrimp) found in fill sediments suggest wetter conditions by 5.4 ^{14}C kyr B.P. Further radiocarbon dates on *Artemia* cysts reveal a gradual infilling of playas through the late Holocene, which we attribute to a rising water table.

Elevation of the water table in Estancia basin presently is regulated by a balance between evaporation from the playas that occupy the blowouts and recharge of aquifers in the adjacent Manzano Mountains. Isotopic analyses of precipitation and groundwater reveal that recharge originates primarily as winter moisture, which is augmented during El Niños and significantly diminished during La Niñas. Thus, the late Holocene rise in the water table, as well as the low water table during the middle Holocene (blowouts and lunettes) may reflect the mid-Holocene suppression of El Niño, followed by its increasing influence during the late Holocene, as suggested by numerical models and recent geologic evidence from South America and Australia.

32-6 10:50 AM Guyette, Richard P.

HOLOCENE OAK TREE-RING CHRONOLOGY DEVELOPMENT AND ANALYSIS IN THE AGRICULTURAL LANDSCAPE OF THE MIDWESTERN UNITED STATES

GUYETTE, Richard P.[1], STAMBAUGH, Michael C.[1], and DEY, Daniel C.[2], (1) Forestry, Univ of Missouri, 203n ABNR, Columbia, MO 65211, guyetter@missouri.edu, (2) USDA Forest Service, 202 ABNR, Columbia, MO 65211

Recent research on the dendrochronology and abundance of ancient oak (Quercus spp.) collected from Midwestern streams and riparian forests indicates that the construction of millennium-length tree-ring chronologies is possible in the agricultural heartland of the United States. Over 100 oak logs recovered from stream and sediments have been 14C and tree-ring dated and range in age from modern to 13,818 years B.P. The temporal distribution of logs confirms the presence of oak in each thousand-year class from present to 14,000 years ago suggests the possibility of constructing a continuous Holocene plus length tree-ring chronology. These tree-ring chronologies will provide climate information for periods during the Holocene that have few climate proxies in the Midwest. The oak chronology region is surrounded by hundreds of miles of the most economically important agricultural region in the United States. Ancient oak wood, that grew thousands of years ago, is often found washing out of stream banks 7 m below soybean and corn fields.

As we cumulate cross-sections from trees that grew contemporaneously, we construct floating 14C and tree-ring dated ring-width chronologies. Cross-dated groups of ring-width series are being analyzed for periodicity and other climate related information that do not require absolute tree-ring dates. Here, we examine these proxy climate series to identify the presence and temporal variability of climate forcing, such as the El Nino/Southern Oscillation. How this cycle behaves during periods of low anthropogenic atmospheric input is a growing question. We cross-dated a temporal cluster of five 14C dated oak logs, which had a mean 14C date circa 2480 years B.P. Ten relatively dated tree-ring series (2 radii per sample, mean r2 among all radii=0.46) were used to construct a 268-year long mean chronology. We double-detrended individual ring-width series by first using a negative-exponential curve and then fitting a 32-year spline. The chronology mean sensitivity was 0.18 and sub-sample signal reached the 0.85 level with seven series. Spectral analysis of ring-width series indicates a peak in variance at 5.9 years. Fisher-Kappa and Bartlett Komogorov-Smirnov tests indicate this peak is significantly different from the white noise spectrum at the 0.01 and 0.001 probability level.

SESSION NO. 33, 8:00 AM

Saturday, July 26, 2003

S25. Regional and Global Changes in the Carbon Cycle (*IGCP n°459 UNESCO/IUGS and INQUA Commission on Carbon*)

Reno Hilton Resort and Conference Center, Crystal 1&2

33-1 8:10 AM François, Louis

IMPACT OF REDUCED TROPICAL SEA SURFACE TEMPERATURES ON THE RECONSTRUCTION OF CLIMATE AND LAND VEGETATION AT THE LAST GLACIAL MAXIMUM

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Many atmospheric general circulation model (AGCM) simulations of last glacial maximum (LGM) climate have been based on the CLIMAP reconstructions of sea surface temperatures (SSTs). Recently, CLIMAP SSTs for the LGM have been shown to be too warm in the tropical region. Model vegetation reconstructions which are based on the results of such climate simulations can thus be expected to yield significant errors leading for instance to an overestimate of the area of tropical forests at the LGM. A sensitivity test is performed with the CARAIB dynamic global vegetation model to study the impact of colder tropical SSTs on the reconstructed LGM vegetation. Climatic outputs from the ECHAM AGCM are used to force the CARAIB model. Two LGM ECHAM simulations are compared: (1) run with 21 ky BP insolation, 200 ppmv of CO_2, SSTs and glaciers from CLIMAP, (2) run with same conditions as in (1), but with SSTs reduced by 3 °C in the tropical region. The climatic anomalies of both simulations are combined with a reference present-day observed climatology to produce two sets of LGM climatic fields which are then used by CARAIB to reconstruct the vegetation distribution and the land carbon storage. The results of both simulations are compared with proxy vegetation data.

33-2 8:30 AM Maslin, M.A.

THE CLATHRATE GUN IS FIRING BLANKS: EVIDENCE FROM BALANCING THE DEGLACIAL GLOBAL CARBON BUDGET

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Kennett et al. (2003) have suggested that the large changes seen in the ice core atmospheric methane record are due to gas hydrate dissociation rather than changes in tropical wetlands. We use the global carbon isotope budgeting method to calculate the amount of gas hydrate release which would be required to balance the deglacial carbon isotope shift. A release of only ~120 GtC methane, is required to make a biospheric carbon transfer of ~1000 GtC compatible with the marine carbon isotope data. This represents less than 20 percent of the atmospheric methane increase between 18 and 8 ka observed in ice cores. This supports the theory that glacial-interglacial variations in atmospheric methane were driven primarily by changes in the extent of tropical and temperate wetlands and not by methane release from clathrates. Hence the Clathrate Gun Hypothesis is firing blanks. This method also invalidates the carbon isotope budget method as a means of estimating glacial-interglacial land carbon, as the release of very light gas hydrate carbon must be taken into account. This resolves the long running discrepancy between isotope and paleovegetation estimates of carbon transfer. Therefore we suggest global carbon models will have to incorporate glacial-interglacial vegetation shifts of at least 1000 GtC. Modelled time-series of gas hydrate release and the carbon budget; indicates that 1. Gas hydrate release is controlled by N. Hemisphere deglaciation while 2. most of the increase in atmospheric carbon dioxide is very rapid and occurs synchronous with warming in Antarctica

33-3 8:50 AM Hill, T. M.

METHANE HYDRATE AND QUATERNARY CLIMATE CHANGE: EVIDENCE FROM SEDIMENT RECORDS AND MODERN METHANE SEEPS

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Methane hydrates have been implicated as a possible forcing mechanism for rapid climate change during the late Quaternary. Releases from the hydrate reservoir are recorded as carbon isotopic spikes in marine sediment records and may represent a significant perturbation of the global carbon cycle. While the role of methane hydrates in rapid climate change is controversial, aspects of this hypothesis are currently being tested using high-resolution sediment records and studies at modern methane seep environments.

Carbon isotopic (δ13C) spikes previously recorded in Santa Barbara Basin (ODP Site 893) have been interpreted as evidence of massive local gas hydrate destabilization. Further studies of stadial/interstadial transitions ODP Site 893 at ultra-high resolution have uncovered additional δ13C excursions. These δ13C spikes occur immediately following bottom water warming associated with the onset of interstadials. These spikes occur in both benthic and planktonic foraminifera, and are very brief, lasting only decades.

The observed δ13C spikes are similar in magnitude to those observed in foraminifera from modern methane seeps (Santa Barbara Basin and Hydrate Ridge, Oregon). Benthic foraminifera living at modern methane seeps record negative δ13C values (to –10‰). In addition, certain foraminiferal species are well adapted to the high-organic, low-oxygen methane seep environment. Because these trends are recorded in live foraminifera, concern about authigenic carbonate altering the δ13C signature is negated.

Ongoing research is comparing the relative response of surface and intermediate waters during abrupt climatic warming. Intermediate waters are important because they reside at the critical depth of potential instability of the methane hydrate reservoir in the late Quaternary. In Santa Barbara Basin, δ18O changes record inferred intermediate water warmings of 2-3°C during stadial to interstadial transitions. These records also indicate that during stadial/interstadial transitions and the deglacial episode, intermediate water warming either preceded or may have been synchronous with surface water warming. This research continues to test and lend supportive evidence to the hypothesis that the methane hydrate reservoir may have played a crucial role in late Quaternary climate change.

33-4 9:10 AM van Huissteden, J.

METHANE AND CARBON DIOXIDE FLUX CHANGES DURING OXYGEN ISOTOPE STAGE 3 IN THE NORTHWEST EUROPEAN LOWLANDS

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During Oxygen Isotope Stage 3 the northwest European lowlands were situated within the periglacial zone, and marshy alluvial plains were an important part of the landscape. Sedimentation rate generally has been high in the river valleys, and the resulting fluvial deposits usually contain abundant peaty and humic silt beds. The rapid climatic fluctuations during O.I. Stage 3 may have had a strong influence on the carbon cycle of these extensive wetlands.

Sequestration of carbon dioxide in peat did not vary strongly with climate change. There is no clear evidence of large scale changes in vegetation. Also the sedimentary record does not show clear fluctuations of the amount of carbon stored in the deposits, e.g. by intensification of organic matter deposition during interstadials.

However, methane fluxes from wetlands are highly sensitive to temperature. Climate model output of the Stage 3 climate, derived from the "Stage 3 project" has been used as input to a wetland carbon flux model (PEATLAND). This resulted in differences between 'interstadial' and 'stadial' methane flux up to 50% in extreme cases. These differences are largely due to the differences in temperature, in combination with slightly higher primary productivity. The periglacial wetland ecosystems of northwest Europe and similar regions in Eurasia contributed to the atmospheric methane variations of the last glacial, and their methane fluxes may have reacted rapidly to temperature change.

33-5 9:30 AM Yakimenko, Elena Y.

SOIL CARBON RESPONSE TO BIOCLIMATE CHANGES WITHIN THE SOUTHERN PART OF THE FOREST ZONE OF RUSSIA

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The South Taiga subzone extends for more than 700 km from N to S of the European part of Russia, where biota changes according to the climate conditions (i.e., towards drier and warmer conditions in the S). Mixed coniferous forests are replaced by broad-leaved forests within this subzone. Accordingly soil cover changes from sod - podzolic soils to gray forest soils under natural vegetation.

To estimate vegetation influence on soil organic matter distribution and dynamics, three major South Taiga ecosystems: forest - dry meadow - arable land, have been compared at three locations: 125 km N, 45 and 125 km to the S of Moscow.

Unlike arable lands, forest and meadow ecosystems stimulate SOM accumulation. Along the transect grater organic carbon pools were found in the grasslands than forests or arable lands, though from North to South the difference became less. Regardless of the location, forest soils accumulated in the topsoil the highest amount of organic carbon, but unlike in meadow or arable soils it dramatically decreased down the soil profile.

Organic matter associated with small aggregates (< 0.250 mm) is known to be the most stable in the soil versus that one associated with large aggregates which more susceptible to transformations. There was a more pronounced difference in the ecosystem impact on aggregate formation at the northern boundary of South Taiga, where meadow vegetation developed more large macroaggregates. Soils at the southern boundary did not show that much difference between sites of different management, demonstrating higher soil aggregation in general.

The majority of organic matter in the topsoil of northern located soils was associated with the aggregates larger than 2 mm under all types of ecosystems studied. In the subsoil, the particle-sized fraction (<0.053mm) contained higher amount of organic C under both meadow and forest ecosystems, while the highest amount of OM in the arable soil was concentrated in the small macroaggregates. Soil to the south demonstrated different distribution of organic matter within the aggregates. Up to 30 cm depth, macroaggregates were the most enriched with carbon, and forest ecosystem showed the most intensive accumulation. Down the soil profile macroaggregates remain to be the major contributors to the organic carbon pool.

33-6 10:10 AM Ryskov, Yaroslav Georgievich

ARE THE PEDOGENIC CARBONATE THE SOURCE OR THE SINK FOR CO2 IN RUSSIAN SOILS?

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The role of soil carbonate as a buffer reservoir for atmospheric CO2 is not clear. Some scientists suggested that pedogenic carbonates can serve as a one of the possible sink of the CO2. In the present study, the temporal dynamics of pedogenic carbonate formation during the last 5000 years was examined using buried palaeosoils under archaeological barrows of different ages. Carbon isotope composition ranged from -2,5 ‰ to-10,3 ‰ which suggested the carbonates comprised lithogenic fragments and pedogenic components. In general, the concentration of pedogenic carbonates depends on the type, age and the parent material of the soils. Two carbonate accumulation phases during 4000-3500 and 2300 radiocarbon years B.P. occurred during the aridization of a climate. Earlier we demonstrated that in general, the bulk carbonate was leached from the profile and entered the carbon cycle. On the other hand, the dissolved lithogenic fragments served as a source of calcium-ion for formation of pedogenic carbonate. Demkin (1997) demonstrated that during the last 3500 years a considerable amounts of gypsum was leached from these soils and that the calcium-ions of this gypsum served as a source for pedogenic carbonate formation. The bulk carbonate formation in soils reached a value of 46 kg/m2 in chernozems, 57 kg/m2 in dark chestnut soils, 77 kg/m2 in light-chestnut soils. Contrastively, in the same time period, the formation of pedogenic carbonate reached only 6,6; 3,4; 2,6 kg/m2 respectively. This implies that dissolution and leaching of bulk carbonate was significantly higher compared to accumulation of pedogenic carbonate. Consequently, the Russian soils have served as an additional source of CO2, in spite of some of the CO2 being locked in as pedogenic carbonate. The soil carbonates are the source of CO2 and provide about 2,6% of common emission of CO2 from the soils.

33-7 10:30 AM Wang, Shilu

THE MASS BALANCE AND ISOTOPE CHANGE OF CARBON IN A SMALL LAKE IN CARBONATE REGION OF SOUTHWEST CHINA

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The mass-balance of DIC and POC in Lake Hongfeng, a stratified, mesotrophic-eutrophic lake, in southwest china is here modeled. It is discovered that dissolved CO2 in lake originates from CO2 in the watershed, which is transferred as DIC after dissolving carbonate. About 9-10°Á108 mol CO2 is annually absorbed in the weathering of carbonate and silicate rocks in the watershed. It is also revealed that 2.29°Á109 mol C of DIC is annually brought into the lake through the river inflow from the watershed, comparatively, 1.25°Á109 mol C of DIC is produced by the mineralization of organic carbon within the lake. The efflux of CO2 is approximately 1.7°Á108 mol a-1, equivalent to 7 percent of the amount of DIC input via river inflow, and 20 percent of the amount of CO2 absorbed in the watershed. The carbon retained in the sediments is about 13 percent of the total DIC from the watershed. The seasonal change of C isotope of DIC(ıÁ13CDIC) is not obvious. However, two types can be distinguished in the relationship ofıÁ13CDIC and ı?CO2. One is a negative correlation. It implies that photosynthesis and respiration dominatingly control the processes of carbon cycle within the lake. The other is the positive correlation between theıÁ13CDIC and ı?CO2. Also, C isotope of POC (ıÁ13CPOC) varies intensively with its sources and sampling season, on basis of which POC in Lake Hongfeng is though to be autochthonous as production of photosynthesis within the lake.ıÁ13CPOC is positively correlated with ıÁ13CDIC in summer when photosynthesis exceeds respiration, andıÁ13CPOC is negatively correlated with ıÁ13CDIC in autumn and winter as respiration exceeds photosynthesis. Although POC in lake is produced from DIC via photosynthesis, the amplitude of seasonal change of ıÁ13CPOC is much larger than those of DIC. Obviously the change of ıÁ13CPOC is mainly decided by the isotopic fractionation of photosynthesis. The partial pressure of CO2 (pCO2) and temperature are linearly correlative with ıÁıÁ13CCO2-POC, which imply pCO2 and temperature, as the main factors affecting isotopic fractionation, can be reflected by the C isotope of organic matter in sediments.

33-8 10:50 AM Probst, J.L.

THE MAJOR ROLE OF THE DIFFERENT CONTINENTAL ROCK OUTCROP ABUNDANCE ON THE GLOBAL CARBON CYCLE: IMPLICATION FOR ATMOSPHERIC/SOIL CO_2 UPTAKE BY CONTINENTAL WEATHERING AND ALKALINITY RIVER TRANSPORT TO THE OCEANS

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The silicate rock weathering followed by the formation of carbonate rocks in the ocean, transfers CO_2 from the atmosphere to the lithosphere. This CO_2 uptake plays a major role in the regulation of atmospheric CO_2 concentrations at the geological timescale and is mainly controlled by the chemical properties of rocks. A compilation of lithological, soil and geological maps available for regional and continental areas allowed us to construct for the first time a world lithological map with a grid resolution of 1x1 degree (Amiotte Suchet et al., 2003). The data are available on the IGCP 459 website. This study analyses the spatial distribution of the six main rock types by latitude, continents, ocean drainage basins and for 49 large river basins. As we already showed in previous works (Amiotte Suchet and Probst, 1993a and b, 1995), the flux of CO_2 consumed by rock weathering is greatly variable according to the rock types. Consequently, the relative outcrop abundance of the different rock types as well as their spatial distribution in relation to the latitudinal and altitudinal variations of the main hydroclimatic factors (precipitation, runoff and temperature) have a great influence on the global CO_2 consumed by rock weathering and on the riverine transports of dissolved inorganic carbon into the oceans. Coupling the GEM-CO_2 modeling (Amiotte Suchet and Probst, 1995) with the spatial distribution of the different rock types, it was possible in this study to estimate for each large river basin and for the global scale, the present-day CO_2 uptake by each rock type. The dissolution of carbonates and the chemical alteration of shales consume both 80% (40% each) of the total CO_2 uptake by continental weathering, even if their respective outcrop area represent only 13% and 25% of the total land area. On the contrary, sands plus sandstones and plutonic plus metamorphic rocks consume both only 12 % (respectively 5% and 7%) of the total CO_2 uptake while their outcrop areas occupy 54 % of the continents (26% and 28% respectively). Finally, the contribution of volcanic rock (acid and basalts) weathering (8%) to the total CO_2 flux is proportional to their outcrop abundance (7%). Nevertheless, the chemical alteration of basalts which cover only 5% of the total land areas represent 7% of the total CO_2 uptake.

33-9 11:10 AM Raymond, Peter

INCREASE IN THE EXPORT OF ALKALINITY FROM NORTH AMERICA'S LARGEST RIVER: CLIMATE AND LAND-USE CONTROLS ON ALKALINITY EXPORT FROM THE MISSISSIPPI RIVER

RAYMOND, Peter, School of Forestry and Environmental Studies, Yale, 205 Prospect St, New Haven, CT 06511, peter.raymond@yale.edu and COLE, Jon, IES, Millbrook, NY

Chemical weathering and the subsequent export of carbonate alkalinity (HCO3- +CO3-2) from soils to rivers is a significant fate of terrestrially-sequestered atmospheric CO2 . We show here that during the past half-century the export of this alkalinity has increased dramatically (59%) from North America's largest river, the Mississippi. This increased export is in part the result of increased flow resulting from higher rainfall in the Mississippi basin. Global change models predict a continuation in the alterations to the global water balance over the following decades with a general increase in precipitation. Thus it appears that the rate of alkalinity export and terrestrial CO2 sequestration through weathering could continue to increase in future years.

Sub-catchment data of the Mississippi suggest that the increase in the export of alkalinity is also strongly linked to land cover. Croplands, which make up >30% of the Mississippi watershed, export 4 to 9 times more alkalinity per unit area than forests. The direct mechanism is unclear, but sub-catchment observations indicate that cropland systems respond differently to rainfall events than forested systems. These observations have important implications for potential management of C sequestration in the United States and suggest that reconverting abandoned cropland fields to forest will decrease terrestrial carbon sequestration through weathering at a rate comparable to above ground forest biomass accumulation.

33-10 11:30 AM Balakrishna, K

ORGANIC CARBON TRANSPORT IN A LARGE TROPICAL RIVER, THE GODAVARI (INDIA): LABILE VERSUS REFRACTORY FRACTIONS AND IMPLICATION OF CARBON INPUTS TO THE BAY OF BENGAL

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This study gives an insight into the source of organic carbon and nitrogen in the Godavari river and its tributaries, the yield of organic carbon from the catchment, seasonal variability in their concentration and the ultimate flux of organic and inorganic carbon into the Bay of Bengal.

Particulate organic carbon / particulate organic nitrogen (POC/PON or C/N) ratios revealed that the dominant source of organic matter in the peak season is from the soil (C/N=8-14), while in the rest of the seasons, the river-derived (in-situ) phytoplankton is the major source (C/N=1-8).

Amount of organic materials carried from the lower catchment and flood plains to the oceans during the peak season are 3 to 91 times higher than in the moderate and lean seasons. Large-scale erosion and deforestation in the catchment has led to higher net yield of organic carbon in the Godavari catchment when compared to other major world rivers.

The total flux of POC, and dissolved inorganic carbon (DIC) from the Godavari river to the Bay of Bengal is estimated as 756 x 10^9 g yr^{-1} and 2520 x 10^9 g yr^{-1} respectively. About 22% of POC is lost in the main channel because of oxidation of labile organic matter, entrapment of organic material behind dams/ sedimentation along flood plains and river channel; the DIC fluxes are conservative through out the river channel.

Finally, the C/N ratios (~12) of the ultimate fluxes of particulate organic carbon suggest the dominance of refractory / stable soil organic matter that could eventually get buried in the coastal sediments on a geological time scale.

SESSION NO. 34, 4:30 PM

Saturday, July 26, 2003

Plenary Session

Reno Hilton Resort and Conference Center, Reno Ballroom

34-1 4:30 PM Hewitt, Godfrey

THE GENETIC CONSEQUENCES OF THE ICE AGES

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The realization of the scale and frequency of climatic oscillations in the last few million years is modifying views on evolution. Such major events caused extinction and repeated changes in the ranges of surving taxa, as witnessed in several paleo-records.

Spatial effects depend on latitude and topography, with extensive extinction and recolonization in higher latitudes and altitudinal shifts and complex refugia nearer the tropics. The population dynamics varied, with refugial bottlenecks, pioneer and phalanx colonization, and longer term metapopulation pulsation, depending on the organism and its geography.

These events can be expected to have effected the genetic constitution of the populations and species, which will carry signs of these past dynamics. Genetic variation may be assessed through allelic diversity, sequence divergence, phylogenetic trees and network shapes, and then placed in a geographic and historical context.

Such phylogeographic studies have burgeoned in the last few years, particularly in temperate regions. Present results will be reviewed from Arctic, Temperate and Tropical regions in the search for commonalities of cause in the resulting genetic patterns. A common pattern of southern richness and northern purity in north-temperate taxa is not apparent in arctic species, and is apparently more limited in tropical ones. Different patterns of species colonization across the same area may be deduced from the DNA evidence. Temperate refugial regions show relatively deep DNA divergence for many taxa, indicating their presence over several ice ages, and suggesting modes of speciation. A diverged genome found in several places, indicates a different colonization pattern in previous oscillations. Tropical montane regions contain deeply diverged lineages often in a relatively small geographic area, suggesting their survival there from the Pliocene. Man's own glacial and postglacial history is similarly interpretable from such genetic studies.

The pattern of genetic diversity produced by the ice ages can inform us of the effects of these climatic changes on any species, and particularly when combined with extensive fossil and paleoclimatic data.

34-2 5:10 PM Baker, Victor R.

QUATERNARY SUPERFLOODS

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There is a long history of controversy over the role of cataclysmic flooding in the origins of Quaternary landscapes and sedimentary sequences. A logically flawed doctrine of uniformitarianism greatly impeded scientific progress on this topic, and the pernicious consequences of flawed uniformitarian reasoning persist to the present day. During the later part of the 20th century there was a renaissance in cataclysmic flood studies, beginning with the controversy over the origin of the Channeled Scabland in the northwestern U.S. Following the resolution of that controversy, more recent discoveries revealed that cataclysmic flooding impacted the Quaternary margins the great ice sheets and the margins of large mountain glaciers in North America and Eurasia. Numerous spillways connected ice-marginal lakes and constituted flood-generated rivers in central North America and central Asia. The discharges of these temporary rivers greatly exceeded those of any modern river. Many of the largest floods produced flows equivalent in magnitude to those of ocean currents. Thus, they had immense capability to stimulate very rapid, short-term effects on Quaternary climate. They also greatly altered drainage evolution and the planetary patterns of water and sediment fluxes to the oceans.

SESSION NO. 35, 1:30 PM

Saturday, July 26, 2003

Surface Processes and Deposits (Posters)

Reno Hilton Resort and Conference Center, Pavilion

35-1 BTH 1 Solyanik, Evgene

GLACIAL AND GLACIFLUVIAL AMBER-BEARING DEPOSITS OF UKRAINE

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Finds of amber in the Lower Neopleistocene deposits of Ukraine have not been identified yet. But conditions for forming amber placers in the Early Neopleistocene existed in Volyn Polesye. The most important of these conditions were: 1) territorial proximity of primary Paleogene placers of amber, 2) block heterogeneity, 3) differentiated character of neotectonic movements, 4) denudation processes in the Neogene, 5) exarative-accumulative activity of Narev and Oka glaciations. Potentially amber-bearing here are the rills of glacial ploughing, allocation of which is controlled by active faults.

Middle Neopleistocene amber-bearing deposits were formed due to the exarative-accumulative activity of the Dnieper glacier, which influenced the paleorelief in the most degree. The primary deposits of Late Eocene-Early Oligocene age were destroyed by the separate tongues of the Dnieper glacier, with amber, as a result, being included into morainic deposits. The mechanism of amber accumulation in morainic deposits has been considered with Rafalovka glacial ridge taken as a model. The obtained data allowed making a supposition that terminal-morainic formations in the interfluves of the Styr-Stohid and Stohid-Tur'ya had similar to Rafalovka ridge structure and character of amber occurrence in morainic deposits.

The most favorable conditions for the accumulation of amber in glacifluvial deposits existed in the Styr-Goryn interfluve. Forming glacifluvial cover and including amber from the underlying Upper Eocene-Lower Oligocene sediments occurred due to the influence of Styr lobe of the Dnieper glacier. Placers of amber are confined to the glacifluvial deltas, which occupy the lowest areas of Upper Cretaceous and Paleogene surface.

The obtained results allowed distinguishing areas with maximum possible concentrations of amber in morainic, glacifluvial and glacio-lacustrine deposits: 1) morainic and outwash plains that are characterized by relatively more intensive development of accumulative processes and which have been formed in the limits of blocks which underwent slow elevation and subsiding; 2) outwash plains that are characterized by intensive development of accumulative processes and which have been formed in the limits of blocks which underwent relative subsiding.

35-2 BTH 2 ,

GROUNDING-ICEBERG DEFORMATION IN AN EARLY PREBOREAL GLACIOFLUVIAL DEPOSIT IN SE SWEDEN AND ITS REGIONAL SIGNIFICANCE

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The recession of the ice sheet in central Sweden at the end of the last glaciation and the development of the Baltic Ice Lake into the Yoldia Sea, which took place during the late Younger Dryas and the early Holocene, have been discussed for many years. During a regional investigation in the glaciofluvial deposits of the Stockholm area, southeast central Sweden, an early Preboreal glaciomarine site was selected to document the typical facies change from lake to marine environment. The studied sections reveal, from top to bottom, a fan-delta deposit, a near-coast full glaciomarine deposit, and a unit of poorly sorted ice-rafted debris. The top part of the unit consisting of ice-rafted debris is characterized by soft-sediment deformations that have the same characteristics as material moved forwards by a bulldozer. These deformation structures are interpreted as due to grounding of icebergs, the lateral movement of which caused detachment of the lower part of the succession into a direction reflecting eastward movement of the icebergs. The absence of laminations above the grounded-iceberg structure and the occurrence of the ice-rafted facies indicate a nearby position of the grounding line of an ice sheet. Comparison with the characteristics of modern grounded glaciers with a rapidly calving ice fronts shows several similarities, among which the dense masses of debris. The fact that the dropstones at this site are restricted to a specific level implies that the area was not frequently reached by icebergs, but a sudden arrival of a single iceberg occurred. Combination of all the above data makes it most probable that an iceberg reached the study area when the area underwent rapid deglaciation during the early Preboreal. This event may have contributed to a regional calving of the Scandinavian ice sheet.

35-3 BTH 3 Momade, Fatima

DUNE GEOMORPHOLOGY IN MAPUTALAND, MOZAMBIQUE

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The coastal region of Maputaland-Mozambique is characterised by an extensive low-lying coastal plain, which rises to a height of more than 100 metres in some places and attain a width of 2 kilometres. Maputaland in Mozambique extends from Ponta de Ouro, which borders South Africa to Cabo Santa Maria stretching for a distance over 100 kilometres, and encloses several swamps and coastal lakes such as Satine, Piti, Munde and Nela running in north south direction. The main objectives of this study was to access the different categories of dune morphology in Maputaland-Mozambique by using aerial photographs, satellite images and field checking. Two major distinct dune systems on the Maputaland coastal morphology were mapped: (1) vegetated dunes form a coastal dune system, which face the sea, and characterised by undulating surfaces and continuous irregular crests running in north-south direction. Transfer dunes move along the foot of slope of the vegetated dunes towards north and northeast. The recent dunes can be either mobile or partial mobile and can attain a height of 5 meters. (2) Inland dunes system comprises a series of dunes including the reworked, parabolic and climbing dunes. These series of dunes often truncate on the first coastal dune system indicating different spatial and temporal events of dune formation. Weathering and reworking processes have affected these dunes, altering their typical shape and smoothing their surface giving them a hummocky aspect. The climbing dunes, running east west in most cases, separate the coastal lakes, and seem to be a result of fragmentation of previous existed large coastal lagoon by the several blowouts events as the lagoon water level fell down. These blowouts seem to follow the uppermost paleo-topographical areas of the lagoon, and the superimposed climbing dunes suggest high rates of sediment transport and deposition. The fragmentations of coastal lagoons by blowouts, which are superimposed by climbing dunes, are common modern processes along Mozambique Coastal Plain (e.g. Umbedje Lagoon in Bilene Holiday Resort located about 100 km north of Maputo).

35-4 BTH 4 Botha, Greg A.

POLYPHASE DUNE AND SOIL FORMATION ON THE MAPUTALAND COASTAL PLAIN

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Maputaland forms the southern end of the East African coastal plain. Dunes have accumulated since the Neogene and the general coast-parallel arrangement of dune systems stabilised by grassland and forest has been assumed by previous researchers to young coastward. Detailed mapping of the dune morphology revealed that composite parabolic and hummocky dune systems represent polyphase aeolian reworking. The project assessed relative- and numeric dating techniques that can be used to differentiate dune systems. Soil profile characteristics were used to calculate soil development indices (SDI) for sampled horizons from holes hand augered to 6m depth. Weathering indices were calculated from geochemical data, magnetic susceptibility was measured and infrared stimulated luminescence dating of representative dune sands defined the period of pedogenesis since deposition.

The quartzose dune sands have weathered to form deep reddened soil profiles with higher SDI horizon values reflecting pH decrease, advanced rubification, clay increase and harder consistency down profile. The Holocene profiles exhibit decreasing horizon index values below the A-horizon whereas late Pleistocene profiles display downward increasing horizon index values within the upper 3m of the profile. Greater complexity and horizonation within some mid- to late Pleistocene aeolian sands manifests as distinctly mottled, clay-enriched horizons at depths of 2-5m below the surface. The SDI profiles from specific dune systems or stratigraphic units cluster well and effectively contrast the characteristic soil development on dunes of different ages. Plots of depositional age vs. sampled horizon index values enable the derivation of generalised rates of soil profile development and comparison of pedogenic processes on the high rainfall coastal barrier dunes relative to the drier interior. SDI horizon values distinguish composite profiles and highlight possible localised surficial reworking or profile burial. The technique is less effective in differentiating profiles where longer-term accretion occurred on a dune. When plotted against geochemical weathering index values or magnetic susceptibility, the SDI methodology proved effective in differentiating dune sands or provenances.

35-5 BTH 5 Ueki, Takeyuki

LATE CENOZOIC TECTONICS OF THE NORTHERN ITOIGAWA-SHIZUOKA TECTONIC LINE, CENTRAL JAPAN

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The Itoigawa-Shizuoka Tectonic Line (ISTL) is regarded as an onshore plate boundary between the North American and the Eurasian Plates. Because of lacking of geologic and geomorphic evidence indicative of distinct fault history for past several millions years, late Cenozoic plate motion and associated tectonics are still unclear. This study reconstructed geomorphic and geologic structural evolution to discuss late Cenozoic fault history, based on the chronology of terrestrial sequence, landslide geomorphology and folding structure surrounding to the northern ISTL. The northern ISTL is composed of the geologic Otari-Nakayama fault and the active fault system, bounding the Omine area on the east and west, respectively. Late Pliocene to Early Pleistocene fluvial and volcaniclastic sequence crop out in the central Omine area. At 1.6 or 1.5 Ma, east-flowing rivers formed the Aokidaira Member of Omine Formation that unconformably overlies the lower Pleistocene welded tuff bed and the Otari-Nakayama fault. The congromeratic Iyari Formation was deposited along the active faults at 0.9 or 0.8 Ma. Scarp development of the active faults then resulted in the disappearance of east-flowing rivers across the central Omine zone. The Middle to Late Pleistocene Shingyo Formation is a landslide-related sediment on the upthrown side of active faults. The late Middle Pleistocene large-scale landslides also developed there. Small-scale folding structure related to the Otari-Nakayama fault was formed after the normal Olduvai Subchron in view of paleomagnetism of volcanic successions. The geologic and geomorphic evidence indicates following tectonics of the northern ISTL. The Otari-Nakayama fault had been active from Early or Middle Pliocene to early Early Pleistocene at the earliest. Activity of the northern ISTL advanced basinward from the Otari-Nakayama fault to the active faults immediately before 1.6 or 1.5 Ma. The active faults has been active and progressively developed its scarp since then. This thrust front migration suggests the development of northern ISTL through a Pliocene and Quaternary E-W transpressive regime, and constant westerly relative motion of the North American against the Eurasian Plates.

35-6 BTH 6 Gill, G. S.

SEDIMENTATION MODEL FOR THE QUATERNARY DEPOSITS OF SIMLA HILLS, NORTHWESTERN HIMALAYA, INDIA

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Quaternary deposits of Simla hills are represented by the youngest horizon of the Upper Tretiary sequence-the Siwalik Group(Middle Miocene to Pleistocene) named as Upper Siwalik Boulder Conglomerate. During this period,the newly up heaved Lower Tertiaries in Simla were drained by the southerly flowing rivers of Koshalia, Ghaggar and Markanda which transported the materials from the positive region and debouched at the foot of the mountain.This resulted into the deposition of the Upper Siwalik Boulder Conglomerate as alluvial fans in the foreland basin carved out to the South of the Himalaya. Later, the adjacent fans coalesced together to constitute a thick, extensive, more or less continuous sedimentation unit.

The stratigraphic columns have been prepared for 20 different localities selected along the rivers Koshalia (5), Ghaggar (8) and Markanda (7). The various sedimentation units identified in these sections have been subjected to textural and palaeocurrent analyses. Alluvial fans of Upper Siwalik Boulder Conglomerate exposed in the Simla Hills exhibit varying lithology and texture, both vertically as well as laterally, indicating thereby more than one mode of deposition. Two primary modes of sedimentation characteristic of alluvial fan environment have been recognized in these sections. The onset of conglomerate deposition started with 'Water-laid sediments' followed by upward changes into 'Debris-flow deposits'.

The basal part of most of the conglomerate horizons consists of sheets of sand, silt and gravel. The conglomerate horizons of varying thickness are interbedded with pale-brown beds and lenses of clay/silt/sand. These indicate a 'water laid' deposition by a network of braided distributary channels. The upper part of the stratigraphic columns of the Upper Siwalik Boulder Conglomerate comprises poorly sorted, pebble to boulder-sized fragments (some of them measuring more than 256 mm) with lesser amount of clay/silt lenses. Such deposits characterize proximal alluvial fan conditions. The shift in the palaeocurrent direction from southerly to southwesterly is attributed to the Neotectonic activity at the foot of the Himalayan chain.

35-7 BTH 7 Choi, Sung-Ja

ISOSCELES TRIANGULAR UPLIFT OF SE. KOREA

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Strong earthquakes rarely have occurred on the Korean peninsula and only a few events have been recorded since 27 A.D. Historical and recent earthquakes are concentrated in the southeastern part of the Korean peninsula, where more than 30 Quaternary fault exposures recently were identified and mapped. About 6-7 well-preserved wave-cut marine benches were mapped along the ~102km long southeastern coast. The study area is divided into three parts on the basis of differences in altitude of these benches. The altitude of the marine terraces in the northern and southern blocks is <1m (I), 10-12m (II), 20-22m (IIb), 33m (IIIa), and 42-44m (IV). Altitudes are greater for each marine terrace in the middle block: 4-5m (I), 19-24m (II), 33m (IIIb), 48m (IIIa), 70m (IV). Both the northern and southern parts show an uplift rate of about 0.2m/ky. However, the middle part of the coast is uplifting at ca. 0.3m/ky. The different uplift rate reveals that the coast is tectonically divided into three blocks confined by two tectonic lines. One is newly named as the GHTL (Gampo-Hyodongri tectonic line) striking N45E and has raised the middle part of the study area from the north. The southern structure is the Ulsan fault zone striking N20W. This structure has caused a higher rate of uplift between the middle and southern parts of the study area. We propose that the middle part of the field area is a fault-bounded block shaped like an isosceles triangle, herein named the Wolsung block. Many of the latest Pleistocene faults have been found within this block. Micro-earthquakes (less than MM3) have been condensed and have kept the highest frequency along GHTL. The southeastern coast of Korea has been under E-W confining pressure during late Pleistocene to Holocene time. The latest Pleistocene faults in and around the block have a top-up-to-the-west reverse sense of motion. GPS vectors of the three blocks trend 290. The lower(II) and middle(III) marine terraces have been faulted at least twice since oxygen-isotope Stage 5e. One normal fault event occurred after Stage 5c and reverse faulting occurred after Stage 5a. Most recently, Holocene uplift due to reverse faulting has occurred in the middle part of the area. Even though the Korean peninsula is located in an intraplate setting,active tectonism has occurred through late Pleistocene and Holocene time.

35-8 BTH 8 Chwae, Ueechan

A SERIAL NE FAULTING FOR PLIOCENE TO HOLOCENE, SE. KOREA

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Since 12Ma ago, the southeastern block of Korean peninsula had rotated to clockwise because of opening the East Sea. A master fault of the block, YTL (Yonil tectonic line), strikes N20W and is ca. 60km long. The middle part of YTL is 5 km away toward the northeast from UFT (Ulsan fault) of N20W and is parallel to UFT. Both the northwestern and southeastern extensions of YTL join to UFT obliquely. In between those two faults, a lot of late Pleistocene fault of NNW-NS has occurred with short length of 1.5-0.5km. Those faults show left-overstepped pattern and have left lateral strike-slip fault movement sense. Those faults form a half of positive flower structure toward the southwestern side of the block, because there are well-developed topographic slopes and lowland on the southwest of YTL and UFT. The northeastern side of those two faults is composed of highland, where there is not any shear fault as a flower structure. Pleistocene faulting has been formed by confining EW stress from the east since Pliocene. Altitudes of northeastern marine terraces on the hanging wall of UFT are higher than that of the southwestern block. Within the trans-rotated block, a serial NE faulting had occurred as bookshelf and each fault-bounded block shows left lateral strike-slip movement sense due to trans-extension. The YTL and UFT did a role of master fault for paralleled NE faults. Horizontal distance among NE faults is about 7-5 km. The oldest NE fault, Ochun Fault, is about 35 km long and has a significant uplift on the southeastern block. The second fault, Joogjun Fault, to the southeast is shorter than that of the first and pulled up the southeast. The third, Eoil Fault, is ca. 20 km long and reversed the southeast. The final one named GHL (Gampo-Hyodongri tectonic line) is shorter than the third and shows uplift of the southeastern block. Altitudes of marine terraces of the coastal block, which is the hanging wall side of GHL, have been lift up relatively. It reveals that the scale and intensity of faulting get to reduce toward the southeastern coast and that age of faulting might become younger to the southeast. The serial NE faults had been transtensional shear fault and has changed to reverse sense to the west since Pliocene. The coastal block receives passive confining pressure from the closing East Sea.

35-9 BTH 9 Forsythe, Randall D.

A SEARCH FOR THE ILLUSIVE QUATERNARY TECTONIC HISTORY OF WESTERN PATAGONIA USING MULTIPLE APERTURE /FREQUENCY ACOUSTIC PROFILING

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For 50 years geologist have noted 'remarkable' geomorphologic features in the Southern Andes which appear on geologic maps as Quaternary faults. Despite the landscape-defining nature of these 'faults', little evidence exists to justify interpretations. The pervasive rain forest, recent glaciation and extensive Holocene volcanism combine to camouflage this record on land. In the last 4-5 years we have employed a portable digital multiple aperture and frequency acoustic profiling system to image the upper few hundred meters of deposits lying within lake and near shore environments. Some 300 kilometers of profiles have been obtained within diverse bathymetric and depositional environments. With a central frequency of 400 Hz, the system commonly reveals moderate scale (10-40 meter) acoustic stratigraphic sequences with internal heterolithic bedding definable down to a 2-3 meter scale. Evidence for Quaternary /Holocene faulting has been discovered in most of the environments thus far surveyed along the arc-parallel Liqune-Ofqui Fault, as well as in other areas away from the main fault zone. Movements of these faults in association with large earthquake events is of some interest in areas such as Valdivia, a city devasted by tectonic ground disturbance during the 1960 Chilean Earthquake.

35-10 BTH 10 Manville, Vern

DISSECTION OF AN IGNIMBRITE PLATEAU: AFTERMATH OF THE 64 KA ROTOITI ERUPTION, BAY OF PLENTY, NEW ZEALAND

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Following an explosive eruption, the duration and extent of the sedimentary response, i.e. the erosion of pyroclastic material, the perturbation of drainage networks and their return to equilibrium conditions, and changes in the rate and style of sedimentation and deposition, are functions of a number of factors. These include: (a) the volumes of material generated; (b) the eruptive style and dispersive power, which influence its type and distribution; (c) the pre-existing geomorphology of the impacted area; and (d) the climate at any point in time and space, which controls eustatic base-level and influences both the rate of erosion and the subsequent regrowth of vegetation, which in turn acts to stabilise pyroclastic deposits and inhibit erosion.

The Taupo Volcanic Zone in the central North Island of New Zealand is an ideal area in which to study such processes due to the youthfulness and degree of preservation of the products of a number of ignimbrite-emplacing eruptions. Eruption of the ~50 cubic km Rotoiti Breccia (RB) at the climax of the 64 ka Rotoehu eruption from the Okataina caldera buried an area of c. 850 square km beneath up to 100 m of unwelded pyroclastic flow units, damming the outlet to intra-caldera Lake Rotorua where extensive highstand shoreline terraces developed as a result. The RB forms a broad, gently sloping fan that was deposited over a dissected plateau composed of older welded units including the Mamaku and Matahina ignimbrites. The distribution of valleys in this buried plateau largely controlled the development of drainages on the Rotoiti Breccia. Medial areas of the RB are characterized by abundant secondary phreatic explosion craters and their deposits buried beneath several metres of debris- and hyperconcentrated flow units. Sea-level was ~ 50 m lower than at present at the time of the eruption, so that fluvial deposits comprising braided stream sediments are graded to this base and lie buried beneath the modern coastal plain. Erosion and reworking was essentially completed under the cool interstadial conditions of Oxygen Isotope Stage 3: landscape stabilization occurred prior to eruption of the Mangaone Subgroup Plinian fall units between 43 and 31 ka which drape both the Rotoiti Breccia and its reworked units.

35-11 BTH 11 Litchfield, Nicola J.

POST-LGM RIVER INSICION IN THE HIKURANGI SUBDUCTION ZONE, NEW ZEALAND

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The Last Glacial Maximum (LGM) was a time of regional river aggradation within the mid-latitude, sub-humid continent of New Zealand. Aggradation in the non-glaciated catchments of the eastern North Island occurred in response to reduced vegetation cover, for which the modern day, forest-clearance induced, aggradation in two catchments provides an analogue. The terrace deposits are generally well preserved along the trunk rivers of the nine largest catchments (catchment areas 1730 to 5870 km^2) and thus provide a datum to measure river incision rates in the actively uplifting Hikurangi Subduction Margin.

The LGM terrace has been mapped at 1:50 000 scale using a combination of aerial photo analysis and field mapping. The terrace is characterised by a paired, flat, surface, underlain by gravel, sand and silt fluvial deposits averaging 5-6 m thickness, with little to no loess cover, but in the north, tephra cover, sourced from the Taupo Volcanic Zone. Terrace dating has utilised a combination of tephrostratigraphy, loess stratigraphy, radiocarbon dating and luminescence dating, and is still in progress. The c. 26 500 cal. yrs BP Kawakawa Tephra is a key marker horizon found both within the terrace deposits and overlying older surfaces. Longitudinal profiles have been measured using RTK GPS, supplemented by Local Government survey data, and 1:50 000 scale topographic contour data for the uppermost reaches. In the reaches where the LGM terrace is preserved, terrace and river elevations are accurate to ±2 m.

River incision rates have been calculated using a preliminary terrace abandonment age of 18 ± 2 ka. Average rates are generally low (<3 mm/yr) in the south, and are more variable in the north, with rates as high as 11 mm/yr in the Mohaka Catchment. Potential factors contributing to the variability in incision rates, such as changes in climate, lithology, catchment area and slope, are presented for discussion. Further application will be to separate tectonic from climatic controls, and early interpretations are that variability in incision rates are primarily controlled by tectonics.

35-12 BTH 12 Gulyás, Sándor

THE FORMATION OF A CREVASSE SPLAY AND ITS GEOLOGICAL AND ECOLOGICAL IMPLICATIONS AFTER A MAJOR FLOODING EVENT IN RIVER TISZA, HUNGARY

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In the year of 2000 following the winter flooding of the river Tisza a huge crevasse splay developed behind a natural breech in the natural levee near the villages of Szajol and Tiszavárkony in Central Eastern Hungary. In a couple of hours following the retreat of the water from the floodplain huge canyon like depressions and troughs were formed with slumps on the softer sandy,loessy, muddy deposits exposing the underlying sediments. In historic times before the river controlling works in the 1800s these natural breaches served as a key hydrologic link between the floodplain and the river enhancing habitat qualities for aquatic and terrestrial riparian communities and supporting the development of human settlements and floodplain agricultural economy (fishing, collecting, grazing). During moderate flood flows, sediment and organic material were transported onto the floodplain. This material was accumulating to form a large "crevasse splay" where rapid deceleration of flows leads to deposition.

Hydraulic and sedimentologic conditions appear to favour the formation of small forests and bushy vegetation at breaches within a couple of days or weeks after the crevasse event. Protected native birds quickly inhabited the canyon walls made of soft sand and loess enhancing the remediation of the area.

Detailed sedimentological, geomorphological, and paleontological analysis of two profiles sampled at the two localities revealed the formation of two other crevasses during the Pleistocene and Holocene as well as the development of a point bar and infusional loess in the area. These data are very useful in understanding the prevailing conditions of the Tisza floodplain in historic times and help us to enhance natural conditions in the whole catchment of the river. They may also serve as modern analogies to depositional environment reconstructions via detailed macro and microstructural analysis of the sediments. From the upper soil layers bones of cattle, hog and and deer have come to light from historical times with signs of slaughtering and meet processing referring to the presence of a slaugtherhouse or a minor farm on the elevated part of the protected floodplain.

35-13 BTH 13 Sümegi, Pál

ALKALIZATION PROCESS AND HISTORY OF ALKALINE STEPPES IN HUNGARY (CENTRAL EUROPE)

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Sodification can be found on about 15 percent of the Great Hungarian Plain. The Great Hungarian Plain has got the size of 100.000 square kilometres and lays in the central part of the Carpathian Basin. One of the most and largest sodificated area developed on the Hortobágy region, which is included in Hortobágy National Park. The quartermalacological and paleobotanical results show that the grassland and open land vegetation dominated in the investigated area during Last Pleistocene and Holocene. The palynological data suggest that several alkaline steppe elements have been present since 35-40 thousand years ago. The greater part of Hortobágy was an alluvial plain at the end of the Pleistocene. The mineralogical, quarterpaleontological data prove unambiguously that on Hortobágy the sodification and the formation of sodic puszta took place far before history, productive agriculture and animal breeder cultures. Of course sodification happened not on the whole area of Hortobágy but on the southern, southeastern and eastern sides from where by the dominance of animal breeding and the development of river-control it spread to the central and the northwetern, wetern areas. So the anthropogenic effect made the sodification spread from the ancient patches to those areas that formerly were not periodically water supplied or were covered with water during a greater part of the year.

35-14 BTH 14 Coltorti, Mauro

UPPER PLEISTOCENE FLUVIAL SEQUENCES IN THE TARIJA BASIN (SOUTHERN BOLIVIA)

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The Tarija Valley Basin (Southern Bolivia) is filled with a ca. 150 m thick Quaternary fluvial sequence (Tolomosa Fm), containing very rich mammal faunas known since the XIX Century. A new detailed sedimentological and stratigraphical study has been carried out in the Basin, coupled with geomorphological investigations. Tephra layers, buried paleosoils and C14 dates on peat and organic rich soils allowed thorough correlations between the sections. The sequence is subdivided in two parts. The lower Ancòn Grande Unit, 50 m thick, is made of shallow channels filled with planarly or trough cross-bedded gravels and sands and gravity flow sediments. In the central part of the Basin there are mainly slightly weathered or bioturbated pinkish-reddish sands and silts. On top of the Unit, Ancòn Grande Log, there is a pedosequence made of several reddish illuvial Bt or Btk horizons. The depositional environment is typical of a braided plain, with the transition from coarser-grained alluvial fans, next to the slopes, to finer-grained distal plain with periods of dense vegetational cover. This Unit is conformably buried under the 100 m thick yellowish-greyish and finer-grained S.Jacinto Unit. Close to the slopes, alluvial fans, whose flat morphology is in place still preserved, are made of massive or trough cross bedded gravels and sands. In the central part of the Basin there is a cyclic repetition of channels filled with planarly cross bedded sands and thin gravelly lags. On top of the channels massive or laminated slightly weathered silts, peat layers, CaCO3 crusts and gypsum are present. Most of the mammal fauna was found within this Unit deposited in a sandy-dominated meandering alluvial plain with frequent channel avulsions and deposition of organic-rich layers inside swamps reached by occasional crevasse channels and splays. The upper part of the sequence is abruptly truncated and locally capped by trough and planarly cross bedded coarse-grained gravels arranged in a series of unpaired alluvial terraces observed all across the Basin. The deposition of the lower Unit, out of the C14 range, might be related to alternating Stadials and Interstadials at the beginning of the Upper Pleistocene. The upper Unit, mostly younger than 40 ka, locally reveals very high sedimentation rates (up to 2 cm/y).

35-15 BTH 15 King, Roger H.

EVIDENCE OF SOIL FORMATION IN HIGH ARCTIC POND SEDIMENTS

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Although most of the material in arctic lake and pond sediments is believed to be allochthonous, few attempts have been made to establish the provenance of this material. An investigation of soil conditions adjacent to a freshwater pond in the Truelove Lowland of Devon Island, Nunavut, Canada provided an opportunity to study the similarity between the products of soil formation and the pond sediment.

In the course of this study, samples were obtained from a soil catena formed on a raised beach adjacent to the pond. At the same time, four short (<0.4m) poorly stratified sediment cores were obtained from the pond. Both sample sets were analyzed for particle size, mineralogy, organic carbon, total carbonates, and total nitrogen. Fe, Al and Mn were extracted with sodium pyrophosphate, ammonium oxalate and dithionite-citrate-bicarbonate solutions; exchangeable Ca, Mg, K and autochthonous and allochthonous fractions obtained using established techniques; and macro, trace and rare earth element concentrations measured with INAA.

The soils range from Regosolic Static Cryosols on the beach crest, through Brunisolic Eutric Static Cryosols and Brunisolic Eutric Turbic Cryosols on the upper and lower foreslope respectively, to Gleysolic Turbic Cryosols in the sedge meadows adjacent to the pond. Pedogenic processes identified include decarbonation in the upper sola on the lower foreslope and carbonation in the lower sola resulting in carbonate pendants on the larger clasts; pervection of silt-sized particles; gleization resulting in significant Mn and Al mobilization in the meadow soils; organic matter accumulation, especially in the surface horizons of the meadow soils; and pedotranslocation of iron and aluminum in the better-drained foreslope soils.

Multivariate statistical analyses, including cluster analysis and discriminant function analysis, of the soil and sediment samples confirmed that the bulk of the pond sediment shares similar characteristics with the soil samples. However, it is clear also that the provenance of the pond sediment is complex and that it bears the imprint of numerous processes, both allochthonous and autochthonous in origin.

35-16 BTH 16 Brock, Amy L.

A NEW FORMATION PROCESS FOR CARBONATE PENDANTS: PAHRANAGAT VALLEY, NEVADA

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This study focuses on soil pendants found in five geomorphic surfaces in the northern Pahranagat Valley, Nevada that range in age from Early Pleistocene to Recent (Q1-Q5) and vary in lithology from dolomite to volcanic tephras. Soil developed upon these surfaces were described and analyzed using classic field methods and laboratory methods including SEM, EDS, XRD, and petrography to examine the genesis of soil pendants. Key features provide evidence for continued precipitation at the clast-pendant contact through time suggesting that newer deposits are not always found at the pendant terminus as other studies have assumed. These features include a void at the clast-pendant contact where precipitates such as calcium carbonate, silica and/or fibrous silicate clays may precipitate. This void remains open despite continued precipitation of minerals. Other features include significant amounts of parent clast grains that are incorporated into the pendant, detrital grain and parent material displacement and/or dissolution and presence of the fibrous clay sepiolite. This new formation process may provide an explanation for inconsistent ages obtained from pendant lamina in other studies.

35-17 BTH 17 Lezziero, Alberto

AN OVERCONSOLIDATED PALEOSOL LAYER UNDERLYING THE VENICE LAGOON: THE CARANTO

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The sedimentological, paleo-ecological, pedological, micromorphological, mineralogical, geochemical and palinological data obtained from a detailed study on sediment samples from 20 cores taken inside the central basin of the Venice lagoon and from the mainland area, has allowed a proper understanding of its late Quaternary evolutionary history. This study focuses on the stratigraphic importance of an altered compact calcareous mud layer, a few cm to a few m thick, locally known as caranto.

Many previous studies have indicated that the late Quaternary alluvial sediments underlying the Venice lagoon are dated from the last glacial maximum to the last phases of the Pleistocene and are overlain by an Holocene palustrine continental layer followed by a lagoonal sedimentation caused by the last marine ingression in the still present Venetian basin.

The indurated caranto layer, object of our study and laying on the top of the alluvial sequence refers to a stratigraphic gap from 18150-1750 cal BC to 3620-3360 cal BC. Radiocarbon dating of organic content of the caranto indicates for the first time that a continental late-glacial and holocenic deposition occurred from 12163-11894 cal BC and 4687-4541 cal BC. These deposits represent local sedimentation processes and indicate that alluvial activity was still present on the paleoplain.

Geochemical and mineralogical investigations of the sediments from the caranto, in general, gave no clear indications for an unambiguous characterization of this sedimentary formation.

Paleopedological, physical-chemical and micromorphological investigations have characterized the caranto level as a set of pedogenetic calcic and gley B and C horizons of a palaeosol developed on the antique alluvial plain. Pedo-features are indication of Fe-Mn and carbonate solution and re-deposition.

The same investigations performed on the palustrine level that tops the continental sequence, just preceding the last marine ingression, have indicated that this level is a paleosol, consists of A and B cambic horizons and belongs to a different pedogenetic phase.

The sedimentary sequence terminates with unaltered lagoonal sediments, related to the last marine ingression, dated 3620-3360 cal BC and is characterized by mud flats and salt marsh facies.

35-18 BTH 18 Klukanova, Alena

ENVIRONMENTAL MONITORING OF SLOVAK REPUBLIC - PARTIAL SYSTEM OF GEOLOGICAL HAZARDS

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Among general terms at the accession of states of Middle and Eastern Europe into European Community, acquisition of quality data about environment on national level, their processing into system information and mutual exchange of information play the main role.

By the Resolution of the Government of the Slovak Republic Nr. 620 dated 7th September 1993 directed the ME SR, MA SR and MZ SR to safeguard the performance of the functions of the centres of partial monitoring systems and to co-ordinate the realisation of the partial monitoring systems and partial information systems.

The Concept of the Monitoring system of the environment of the Slovak Republic and the Concept of integrated information system of the environment define the environmental monitoring as a systematic, spatially and temporarily defined observation of precisely defined attributes of the environmental compounds or influences upon the environment (usually in monitoring net points). To a certain degree of reliableness they are able to characterise given area and, to a higher level a larger region.

The Monitoring system of the environment consists of the ten systems. One of them is Monitoring of geological factors. Its centre is at GS SR. Thematically it is focused on those geological factors and on such outputs, which seem to be convenient as the input data for issues of protection of the environment and for optimum utilisation of geopotentials of the country. It is focused mainly on geological hazards, harmful natural or anthropogenic processes, which jeopardise the environment, as well as humans. The monitoring serves for observations and assessment of the mechanisms of negative changes in the geological environment.

Recently, Monitoring of Geological Factors consists of 13 autonomous subsystems, defined according to different type of the influencing geological process activated by natural or artificial factors: Landslides and other slope deformations; Erosion processes; Weathering processes; Volume unstable soils; Influence of mining impact upon environment; Changes of anthropogenic sediments; Stability of massifs underlying historic objects; Covered anthropogenic sediments; Tectonic and seismic activity; Snow pack quality; Seismic phenomena; Stream sediments quality and Radon volume activity.

35-19 BTH 19 Ashley, Gail M.

HYDROLOGY, BIOLOGY AND SEDIMENTOLOGY OF A FRESHWATER WETLAND IN A SEMI-ARID ENVIRONMENT, LOBOI SWAMP, KENYA

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Loboi Swamp is situated near the equator on the western fault-bounded margin of the East African Rift. The freshwater wetland developed during the late Holocene on a low relief alluvial plain probably from subsidence associated with extensional tectonics. The swamp is ~ 2 km2 and is groundwater fed by springs emanating from the bordering grid fault system. Spring waters are ~35°C, with pH ~6.4-6.9 and the water compositions suggest that the sources are dominated by meteoric water with little contributed by deep re-circulating fluids. The climate is semi-arid. P is ~700 mm/yr on the valley floor and 1200mm/yr in the adjacent highlands; ET is estimated to be ~2500 mm/yr. Rainfall patterns vary with semi-annual monsoon rains and El Niño and La Niña periods (5-7 years). An irrigation scheme at the Swamp is utilizing wetland water for agriculture.

The modern swamp is dominated by Typha domingensis Pers. (~80%) and Cyperus papyrus L. (20%). The stratigraphy revealed in a soil pit and 8 piston cores (1.5-4 m long) records the formation of the wetland ~500 yrs B.P. Basal sediments are flood plain (sandy silts) comprised of a buried Inceptisol that is capped with a peat. The peat is thickest (1.5 m) in the spring-proximal area near the faults and thins to 0.30 m in the spring-distal areas. Siderite concretions in the flood plain silts reflect the Fe-reducing conditions that developed as the surface was submerged and developed a wetland. Stable isotopes record the abrupt shift from predominantly C4 vegetation to C3 vegetation. The diatom record also suggests a rapid change to wetter conditions.

Soils and paleosols developed on the periphery of the wetland reveal evidence for dramatic fluctuations in hydrologic budget, as indicated by formation redoximorphic features during wetter phases, and vertic (shrink-swell) features during drier phases. The pollen record shows a prevailing dry climate despite the development of wetter conditions at the valley bottom. The combined records of hydrology, biology and sedimentology of this wetland in an arid region suggests an abrupt change to wetter conditions due to tectonic event, rather than change in climate. The wetland is being maintained by groundwater sources, but may now be under stress due to recent anthropogenic impacts of land use change.

35-20 BTH 20 Soller, David S.

PRELIMINARY MAP OF SURFICIAL MATERIALS IN THE CONTERMINOUS UNITED STATES

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Because surficial materials are important to society, it is important to understand their composition and distribution. The USGS National Cooperative Geologic Mapping Program is expanding its emphasis on mapping surficial materials. To facilitate the identification of priority areas for later detailed mapping (such as metropolitan areas experiencing rapid growth), we used a simple earth materials classification to compile quickly a preliminary digital map of surficial deposits of the conterminous U.S.

We used digital source maps that were statewide or larger in area that either showed surficial materials or could be interpreted to derive such information. For roughly the eastern half of the U.S., we used a version of the Quaternary Geologic Atlas of the United States (scale 1:1,000,000) that we simplified by combining units with similar properties into broader materials categories (e.g., alluvium, eolian sand) and recompiled to 1:2,500,000 scale. For the western half of the Nation, we used published statewide geologic maps (mostly 1:500,000 scale). Although some of these show complex surficial units, most emphasize the bedrock geology. In each digital map file, surficial geologic units were assigned to the appropriate category in our classification, and bedrock units were assigned to the surficial materials category (e.g., residuum type) most appropriate to their rock composition. These maps were merged into a single digital file and then supplemented with information from various other maps, such as those displaying extents of pluvial lakes and eolian sand deposits.

Our rapid overview approach has advantages and disadvantages; the map was generated relatively quickly and easily, but it does not provide a well-compiled and coherent view of the deposits. For example, no effort was made to resolve interpretive differences among state-scale geologic maps in the western U.S. nor to merge these sources with the coherent Quaternary Atlas source maps used for the eastern U.S. Abrupt changes in surficial materials along many state boundaries are an artifact of our mapping, and a limitation on its utility. However, this approach serves to provide an overview of surficial materials, and to identify areas where additional work is needed in order to resolve scientific issues that can, in turn, lead to improved mapping.

35-21 BTH 21 Soller, David R.

THE U.S. NATIONAL GEOLOGIC MAP DATABASE

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When scientific results are communicated to colleagues, decisionmakers, and the public, the information should be organized and presented so it is clearly and readily understood. Communication is greatly facilitated by the use of widely accepted, standard science terminology and methods. When analytical data and field observations are interpreted to produce a geologic map, the geologist needs to rely on established classifications and nomenclature to describe earth materials.

In the United States, the U.S. Geological Survey and the Association of American State Geologists are mandated by law to build the National Geologic Map Database (NGMDB). Recognizing that standardized geoscience information is necessary for building a national-scale database, the law also mandates the NGMDB to develop the necessary technical and scientific standards. The NGMDB provides access to geoscience maps and associated information, including: 1) various Web-accessible databases (e.g., a Map Catalog of bibliographic information about geoscience maps, a Geologic Names Lexicon, a prototype Paleontology database, and a prototype Image Library of geologic maps); 2) a comprehensive standards-development effort (including development of a standard science language for describing the lithology of earth materials); and 3) eventually, an online database of map information in GIS format.

Two aspects of this project may be of particular interest to Quaternary geologists: 1) the development of a standardized lithologic classification that is compatible with concepts and mapping of Quaternary deposits (for example, "till" requires special consideration because it connotes not just a lithology, but also degree of stratification and environment(s) of deposition), and 2) the compilation of Quaternary information in the U.S. Geologic Names Lexicon is less comprehensive than for older units, given the inherent challenges in correlating and classifying Quaternary units. We solicit comments and guidance about these two efforts, and the overall plan for building the NGMDB. Information about the NGMDB is available at http://ncgmp.usgs.gov/ngmdbproject/.

35-22 BTH 22 Follestad, Bjorn A.

NATIONAL PARKS AND THEIR FUTURE ROLE AS PROMOTED BY INFORMATION TECHNOLOGY IN A MODERN WEST EUROPEAN COUNTRY

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The landscape in Norwegian national parks is mostly dominated by a preglacial scenery which has been glacially sculptured during the last 2 – 2,5 million years The present-day scenery, including the well known fjords of western Norway, continues into the high plateau of central-southern Norway. In these areas there are national parks such as the Dovre-Sundalsfjella National Park and the Rondane National Park. These particular park areas have played an important role in classical Norwegian art and music. The landscape, which has provided inspiration for Norwegian artists and composers was formed mainly through a dominating cirque glaciation, which created peaks, ridges and cirque valleys, with or without glaciers in the present-day scenery. Large blocks left behind in the cirques and valleys as the ice melted could easily, on foggy and rainy days, create an illusion of the presence of trolls. In this presentation these features, which have been of great important for tourism in the past, are incorporated into an information technology package for the benefit of future tourists. Today's technology is considered to hold a great potential for presenting the landscape and scenery in the parks to a wide variety of visitors. Some interesting models created to meet the challenges opened up by the world of IT and GIS will be illustrated during the lecture. Although the broad geological history of the area will be discussed, it is not considered be a main topic of this talk.

35-23 BTH 23 Vanderlinden, Jean-Paul

SCIENTIST INTERACTING WITH THE ENVIRONMENT: LESSONS TO BE LEARNED FROM COLLABORATIVE EFFORTS IN THE STUDY OF THE EARTH RECENT GEOLOGICAL PAST

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Studying the environment through the fields of environmental science constitutes a particular way that humans have recently chosen to interact with … the environment. The purpose of this presentation is to analyze how environmental science came up with new approaches in the practice of the scientific endeavour. These approaches are the product of the multidimensional and global nature of the "environment" concept. This redefining of the way science is practiced led to further challenges in the way scientists interact. Through the definition of these challenges, this presentation analyzes how, theoretically and methodologically, studying environmental scientist can lead to particular insight into conducting science that crosses disciplinary and national boundaries. This framework is applied to a particular case study: the IMAGES program.

Founded in 1995, the IMAGES program was set up following the recognition that paleo-oceanography can not solely rely on individual researcher but has to be coordinated due to scale and cost that are associated with data collection. Up to this year IMAGES has been successful at coordinating several activities relating to data collection, standardisation and dissemination. The analysis of this international collaboration effort is undertaken through the conceptual triangulation of the following dimensions: linkage between scientific collaboration, its expression and the general social context, mutual learning resulting from the interactions of scientist, and the generation of new formal and informal networks of scientists. This presentation will illustrate how such a conceptual approach may lead to lessons that would benefit the scientific community in general and the administration of science in particular.

Finally it will be demonstrated how changes in the way humans interact with nature (i.e., new ways of conducting science) do lead to new ways for human to interact with human (i.e., new networks of scientists). Interaction with the environment, once it is changed, leads to new social relations. In the case of scientists involved in the study of the earth recent geological past, these new social relations may very well pave the way as a "best practice" for scientists that are involved in research that transcend the traditional disciplinary and national boundaries.

35-24 BTH 24 Lee, Xinqing

CARBON ISOTOPE OF SURFACE MATERIALS ALONG THE MEGA-TRANSECTION: BAOJI, CHINA¡ªHANHAYN HURYEE, MONGOLIA

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Carbon isotope has been used as a proxy for reconstructing paleoclimate. Yet, the quantitative definition is still dubious. In order to reconstruct the past climate in arid regions of central Asia, Its bioclimatic dependency should be examined. We did the examination on carbon isotope ($\delta^{13}C$) along a transect from the northern slope of Qinling Mountain, close to Baoji, China, though to Hanhayn Huryee at the north tip of Hovsgol Nuur, Mongolia, and report here the preliminary result. The N-S transect starts at 34°14'24"N (106°55'30"E) and ends at 51°35'08"N, (100°45'49"E). It crosses several climate and vegetation zones and is ideal for the proxy evaluation. The climate becomes moister from the Mongolia Gobi toward both south and north due to increase in precipitation. Vegetation well reflects the climate change. From the Gobi to the Siberia, it varies from desert steppe, cold steppe, and coniferous forest to subarctic meadow. Whereas southwards to the southern Chinese Loess Plateau, the vegetation varies from desert steppe, warm steppe to deciduous forest. The soil also closely follows the climate and the vegetation patterns. Histosols are found in subarctic meadow, spodosols in coniferous forest, mollisols in steppe, aridsols in desert and alfisolls in deciduous forest.

$\delta^{13}C$ of organic material in the surface soil (horizon A) has four plateaus along the transect. They are -28.2 ± 1.9 (‰ PDB), -25.4 ± 1.0 (‰ PDB), -24.0 ± 1.7 (‰ PDB), and -27.6 ± 1.3 (‰ PDB) from south to north. The first plateau corresponds to the Qinling Mountains; the second plateau is from 36°11'39"N (106°11'50"E) to 41°51'23"N (110°04'10"E), corresponding to the arid and semi-arid areas in Ordos Plateau and Inner Mongolia, China; the third plateau corresponds to the Gobi area in southern Mongolia, which is the driest place in the world; the last plateau corresponds to the mountain regions in northern Mongolia. The dry region has the highest $\delta^{13}C$, while the humid area the lowest one. The $\delta^{13}C$ values in Qinling Mountains are similar to those in the northern Mongolia. It seems that climate controls the $\delta^{13}C$ values of the surface soils, but the type of the plant seems not a factor controlling the isotope ratios.

35-25 BTH 25 He, Hongming

ENVIRONMENTAL PROCESS OF NATURAL AND HUMAN IMPACTS ON CHINESE ECOZONE

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The investigation is to provide systematic view on environmental process of natural and human impacts on Chinese ecological interaction zone belt. Various data have been employed, e.g., history document, observation records, statistic data, experiment data, and remote sensing data to illustrate environmental factors and countermeasures in Chinese ecological interaction zone belt. Natural and socio-economic environment dominant factors have been discovered. Quantitative and qualitative as well as comparative investigations have been conducted focusing on analysis of ecological interaction zone belt in China from vulnerable behaviors and patterns, causes and countermeasures in sustainable development view.

The characteristic features, which favor the discussion, could be obvious. First, ecological interaction zone belt depends on the stability of the interaction between the internal/natural structures and external/human forces. Environment situation and scope has vibrated at different periods affected by complex factors—-internal/natural and external/human. Second, processes of zone belt vulnerability caused by human activities in the late 100 years have been ten times faster/larger than that of nature. Finally, development strategies of sustainability with beneficent environmental, scientific and technological, economical and political view could be urgently demanded.

35-26 BTH 26 Zijaudinov, F.F.

FEATURES OF THE CONSTRUCTION AND THE OPERATION OF WATER BASINS LOCATED ON LOESS TERRITORIES

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At the droughty territories of Uzbekistan agricultural production is possible only if reservoirs have been created. So far as precipitations falls on the territory of the Republic of Uzbekistan during a year is very uneven, the creation of conditions for uniform irrigation may be achieved by he accumulation of winter-spring high-flood waters in reservoirs. He researches, conducted at big reservoirs (Charvak, Andijan, Tupalang, Gissarak and others), which are located in rivers Sirdarya and Amudarya, showed, that the construction and the operation of such hydro-technical objects is the reason of the rise of many unfavorable processes and phenomena.

Loess deposits of various geneses, in accordance with their nature, have weak water-stability. During the first years of operation of reservoirs, which were built on loess territories, the intensive remaking of the shores of these artificial reservoirs is observed.

In the first turn that is observed as the formation of a big number of landslides, which lead to the diminishing of reservoir's useful volume. Besides that, the change of hydro-geological conditions on all adjoining territory as a result of high filtration properties on loess rocks is marked. In particular, the steady raising of ground waters level is marked.

As a result, subsidence phenomena, flora's impoverishment on significant territories are observed, the engineering-geological conditions of the construction of ground objects get worse. One of important moments is the change of the seismic regime of reservoir and nearby territories.

According to instrumental observations the increase on order of origin intensity near the reservoir is established. That has led to the rise of additional residual deformations on significant territories near reservoir.

35-27 BTH 27 Durotoye, Bisi

RAINWATER HARVEST- A SUSTAINABLE URBAN WATER SUPPLY OPTION IN HUMID TROPICS

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Urbanization of small towns in Nigeria has led to anthropogenically engendered irreversible environmental degradation, creating peculiar problems for its inhabitants. Case studies of new urban areas in humid southwestern part of Nigeria reveal that rain water harvest is a sustainable option for water supply. Geoenvironmental evaluation of newly developing towns based on field mapping, aerial photo studies and grain size charcterization of underlying Quaternatery deposit reveal that flood catastrophies experienced are a consequence of the following: 1. Rapid urbanization of small town result from fast population increase, force human occupation of flood prone areas. 2. Massive destructive alteration of natural ecosystem in the process of urbanization, altered natural flow systems, surface processes and rainwater infiltration. 3. Bad planning and indiscriminate erection of walls and housing structures block flow channels to form big floods. 4. Bad refuse disposal schemes marked by indiscriminate dumping of solid waste and thrash in drainage and stream channels results in clogging of flow path of rainwater and pollution of surface water systems. 5. Absence of sewage proper disposal system cause pollution of surface and ground water systems rendering them unfit for human consumption and contributing to the growing scarcity of fresh water and degeneration of sanitary conditions in urban areas. Rainwater harvest by direct collection from rooftops into large surface storage tanks or in encased wells will provide essential clean water at least for domestic consumption. It is becoming more apparent that the need for water supply policy should include rainwater harvest for water supply in urban areas in humid tropical countries of the world.

SESSION NO. 36, 1:30 PM

Saturday, July 26, 2003

S5. Ice Sheets as Active Agents of Sediment Redistribution in the Earth System (Posters) (*Commission on Glaciation*)

Reno Hilton Resort and Conference Center, Pavilion

36-1 BTH 28 Clark, Chris D.

GLACIAL MAP OF BRITAIN AND GIS DATABASE

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We have reviewed the academic literature and British Geological Survey mapping to produce Britain's first comprehensive 'Glacial Map' and accompanying geographic information system (GIS) database. The map is produced at a scale of 1;625,000. Emphasis is on information that constrains the last (Devensian) ice sheet, primarily its extent and flow geometry. Evidence relating to earlier or later glacial events is excluded. The following are included: moraines; eskers; drumlins; meltwater channels; tunnel valleys; shelf-edge fans; trimlines; limit of key glacigenic deposits ('drift limits'); glaciolacustrine deposits, ice dammed lakes; erratic dispersal; and the main Loch Lomond Readvance limit. Offshore evidence is also included. The GIS contains over 20,000 features split into thematic layers (as above), stored as 'shapefiles' which are easily displayed within GIS software. Features are attributed such that they can be traced back to their published sources. Given that information included has not been collected by a systematic survey of the country but by piecemeal effort by numerous researchers over 150 years, our main caveat is that of data consistency and reliability. We have not field checked anything and merely report what has been published. It is hoped that this compilation will stimulate greater scrutiny of existing published data, assist in palaeoglaciological reconstructions of the ice sheet, facilitate greater use of field evidence in numerical ice sheet modelling experiments and help direct field workers in their future investigations.

36-2 BTH 29 Hiemstra, John F.

BUILDING UP TILLS BY SUB-MARGINAL, INCREMENTAL THICKENING

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Chiefly on theoretical grounds, it has been established that the most important till-producing mechanisms in a sub-glacial setting must be melt-out, lodgement and deformation. These three mechanisms are well established and virtually undisputed: they have been presented as principal end-members of the sub-glacial till deposition process.

Although as theoretical concepts the definition of till forming end-members may be useful, we believe that it is unlikely that these processes may individually be responsible for the formation of most sub-glacial tills. This is in line with current discussions on the actual extent of the process of deformation.

We are currently testing a hypothesis that proposes the incremental thickening of till sequences in sub-marginal or sub-glacial settings. Our investigations involve assessments of the relative contributions of the depositional mechanisms lodgement and melt-out and the role of sub-glacial deformation in the delivery and emplacement of sub-glacial tills. In a multi-scale approach, we employ both field methods (sedimentary, structural and clast fabric analyses) and laboratory techniques (micromorphology). We here present examples from contemporary glacial settings in SE-Iceland and a Loch Lomond Readvance setting in central Scotland.

In an attempt to explain the stacked till architecture in all of these examples, we propose a complex interplay of processes that accounts for sub-glacial debris undergoing cycles of release and (re)freezing onto the base of the glacier before it eventually becomes deposited as slabs of till. We envisage that the cyclic processes eventuate beneath an oscillating ice front, either seasonally or in phases of retreat and (re)advance.

36-3 BTH 30 Carlson, Anders E.

GENESIS OF AN EXTENSIVE INTERLOBATE DEPOSIT IN EASTERN WISCONSIN, USA

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Understanding the depositional environment of glacial landforms is critical to interpreting past ice sheet dynamics and climate change. Conceptual models of landform genesis exist, but often fail to properly describe individual landforms. Such is the case with the northern Kettle Moraine (nKM) of eastern Wisconsin – an interlobate deposit formed between the Lake Michigan and Green Bay lobes of the Laurentide Ice Sheet during retreat from its Last Glacial Maximum position. We use sedimentology and landform distribution in this interlobate deposit to interpret a unique genesis. The nKM consists of a low, debris poor axial zone between two, long, high-relief hummocky ridges that grade east and west into broad hummocky zones and pitted outwash. In the low axial zone there are moulin kames up to 55 m high. Diamicton and poorly sorted sand and gravel core these moulin kames and have an average clast roundness of 0.55±0.09 on a scale of 0.1 to 0.9. In contrast, the hummocky areas have an average roundness of 0.78±0.03. Cross beds and imbricated clasts indicate that melt water flowed towards the nKM axis. However, little fluvial debris is found in the axis area and the sediment there underwent little fluvial transport relative to the adjacent ridges and hummocky zones. Thus, we interpret the two ridges as subaerial, supraglacial channels that were incised into ice and abutted stagnant ice in the axial area as suggested by their abrupt ice contact face and hummocky nature. These channels drained each lobe adjacent to the stagnant ice in the nKM axis which diverted melt water and protected the axis from glaciofluvial deposition. This axial stagnant ice was preserved by initial debris cover deposited as ice lobes thinned. Later, this debris accumulated in the channels on either side or in moulin kames. Therefore, the high relief hummocky sides of the nKM and the bulk of nKM sediment were deposited mainly in supraglacial channels against stagnant ice along the axis. This suggests that the dominant depositional environment for the nKM was supra-glaciofluvial with little subglacial or proglacial sedimentation. The application of such genetic models to other landforms may deserve reevaluation.

36-4 BTH 31 Piotrowski, Jan A.

LANDFORMS FROM A GLACIER SURGE ON A GRAVEL BED: ELISEBREEN, NW SPITSBERGEN

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Retreat of Elisebreen, a glacier on Oscar II Land, NW Spitsbergen reveals a complex set of glacial landforms including drumlins, flutes, "till eskers", crack-fill ridges, hummocky moraines and thrust moraines. Similar landform assemblages have been considered as glacier surge proxies (Evans and Rea, 1999). Accordingly, we suggest that Elisebreen experienced a surge in its sub-recent history.

The most conspicuous landforms are:

1. Closely spaced flutes up to 1 m high and 200 m long with initiating boulders at their proximal ends.

2. "Till eskers", i.e. sinuous-shaped ridges, typically 0.3-0.5 m high, occurring nearby the flutes and oriented generally ice-flow parallel. They are composed of till, similar to the till in the flutes.

3. Crack-fill ridges consisting of till, off-set consistently by 10-30° in relation to the ice movement. These ridges are typically 0.3-0.6 m high. They are superimposed on both flutes and "till eskers".

4. A 30-35 m high thrust moraine with hummocks on the ice-proximal side.

Elisebreen rests on bedrock and, in its marginal part, on raised marine mud and gravel. Striated bedrock surfaces occasionally protrude through the <5-m-thick succession of unconsolidated sediments. It is suggested that this soft sediment triggered the surge due to its specific rheological behaviour in comparison with bedrock-overriding further up-glacier.

The sharp boundary between the basal till (which typically is less than 20 cm thick) and the undeformed sediments below suggests that fast ice motion was facilitated by deformation contained in the thin layer of till, and by basal sliding. Till mobility is evident from the presence of flutes and crack-fill ridges coupled with sediment deformation structures found therein.

Reference:

Evans, D.J.A., and Rea, B.R., 1999, Geomorphology and sedimentology of surging glaciers: a land-system approach: Annals of Glaciology, v. 28, p. 75-82.

36-5 BTH 32 Piotrowski, Jan A.

TIME-TRANSGRESSIVE THIN-SKINNED DEFORMATION IN A HOMOGENEOUS BASAL TILL AT KNUD STRAND, DENMARK

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Basal tills yield information about ice sheets' dynamics including their ability to transport and deposit soft sediments. However, the processes generating basal tills remain controversial despite intensive studies over the last decades. Here, we describe a basal till from the last glaciation at Knud Strand, western Denmark, containing soft intra-clasts and seek a tentative explanation for its texture and structure.

Fabric orientation and -strength, grain-size distribution, clay mineralogy and petrographic composition are highly uniform throughout the entire till thickness studied in detail in three vertical profiles. The boundary between the till and the underlying sediments varies between planar/sharp and deformed/diffuse. Numerous inclusions of peat and other soft sediments are present in the till.

A time-transgressive model is used to explain the lack of vertical change in till components and the preservation of soft sediment clasts randomly dispersed throughout its thickness. After the debris was lodged from the sole of an active glacier, it was sheared in a thin (<40 cm) zone moving upward as till accretion proceeded. The depth of deformation at any time was relatively small but its cumulative result from the ice advance is deformation structures spread throughout the entire till thickness. The small strain of the till allowed preservation of fragile clasts. The Knud Strand till probably owes its surprising lack of petrographical gradation to multiple reworking and homogenisation of different sediments over several glacial cycles.

36-6 BTH 33 Sjunneskog, Charlotte

CAN WE EXTRACT INFORMATION FROM ANTARCTIC MARINE DIAMICTONS THAT IS USEFUL IN INTERPRETING PAST ICE-STREAM AND ICE-SHEET ACTIVITY IN THE ROSS SEA?

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We address this question by (1) analysis of diatoms (abundance, stratigraphic age, and preservation), bulk chemistry, and Be-10 on selected piston cores from the Central Ross Sea, and from beneath the Ross Ice Shelf, and (2) controlled shearing experiments on diatomaceous mud, at pressures similar to that beneath ice streams.

The stratigraphic sequence described from the piston cores is post-glacial diatomaceous mud, overlaying mud and/or granulated sediment, capping a diamicton. The sub ice-shelf sediment cores consist of diamicton. The results show a wide range, within defined sediment sequences, in the measured parameters. True diatomaceous mud is dominated by a typical post-glacial diatom assemblage with high diatom abundance, excess of barium (Ba) and a 10-Be activity reflecting present day values. However some sediments classified as diatomaceous mud contain relatively low diatom abundance, with an assemblage dominated by reworked Tertiary diatoms. The sediment sequences containing abundant reworked diatoms are depleted in Ba and 10-Be. Despite evidence of a high proportion of reworked components, the 14-C dates of these sediment units indicate a Holocene age, suggesting that reworked carbon is relatively minor. Mud and granulated sediment sequences are variable in all parameters measured, but most mud samples are typically low in diatom abundance and characterized by excess zinc (Zn). Diamicton sequences are similar between sites with regard to bulk chemistry, and show a reduced 10-Be activity. The diamictons range from very poor to extremely rich in diatom valves and diatom debris, all indicating a stratigraphic mixing. Diamicton with high diatom abundance is dominated by a Miocene diatom flora, whereas diamicton with lower diatom abundance show a more intense stratigraphic mixing.

The variability in diatom signature, bulk chemistry and cosmogenic isotopes within these defined sediment sequences clearly show different depositional processes and sediment sources, both at present and in the past. In addition to illustrating how fine-grained diatomaceous sediment is altered by shearing, analyses of diatom comminution will give insight into mode of sediment transport. Initial results show distinct differences between diatom taxa broken by shearing versus breakage by normal load.

36-7 BTH 34 Barber, Donald C.

GLACIAL-MARINE SEDIMENT RECORDS OF NE LAURENTIDE ICE MARGIN ACTIVITY FROM 60(?)-10 KA IN THE NW LABRADOR SEA

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We analyzed lithostratigraphic parameters and the isotopic composition of planktonic foraminifera in a 12-m core from the upper continental slope off southeastern Baffin Island. The upper part of the core is well radiocarbon dated and contains detrital carbonate-rich (DC) layers correlative to Heinrich layers 1, 2 and 4. Heinrich layer 3 is present but has lower DC concentrations. In addition to Hudson Strait-sourced DC layers, the core contains dark gray, total organic carbon-rich (TOC), DC-poor diamict layers. These diamicts have been traced to a former ice stream source in Cumberland Sound based on comparisons of Sr-Nd-Pb isotopic compositions. Stratigraphic relationships between the TOC-rich diamicts and DC-layers suggest that ice discharges from Cumberland Sound occurred more frequently and at different times than those from Hudson Strait. Sediments underlying Heinrich layer 4 include at least two additional DC-rich layers, implying that H5 and H5a or H6 are present. Three TOC-rich diamict layers are present beneath H4. Planktonic oxygen isotope values are depleted in both types of layers, consistent with major iceberg and/or meltwater discharges during deposition. Both the DC layers and the TOC-rich diamicts are thicker in the lower, pre-H4 part of the core than those above H4. This observation is consistent with the hypothesis that the Laurentide ice sheet margin advanced farther seaward during the earlier part of the last glaciation. In any case it appears that the southeast Baffin Island margin of the Laurentide ice sheet delivered more sediment to the slope during the early part of Marine Isotope Stage 3 than during Stage 2. Using samples from the lower half of the core, we compared two commonly used proxies of ice-rafted detritus (IRD): 1) the number of grains larger than 2 mm visible in 2 x 2 cm windows in the core x-rays, and 2) the weight percent greater than 150 microns in sieved samples. In this environment the proxies deviate from one another, possibly due to slope sedimentation processes. Peaks in detrital carbonate associated with Heinrich events do not coincide with peaks in either IRD proxy. The IRD-poor nature of H-layers in the NW Labrador Sea illustrates that Heinrich events comprise more than simple iceberg discharges.

36-8 BTH 35 Creyts, Timothy T.

THE ENTRAINMENT OF SUBGLACIAL MATERIAL VIA GLACIOHYDRAULIC SUPERCOOLING

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Beneath many glaciers and ice sheets, hydrology modulates basal processes, including sliding, erosion, and sediment transport. Recently, the role of glaciohydraulic supercooling was exposed as an important process in the overdeepening near the toe of Matanuska Glacier, Alaska. Water that rises rapidly along the subglacial slope has the ability to translate its latent heat from an area of higher pressure to an area of lower pressure without raising its internal energy above the ambient pressure—dependent melting point. Thus, the water supercools. Because it is moving relatively rapidly, the flow also entrains local sediments. As the undercooled water crystallizes, sediments become trapped in an icy matrix. Subsequently incorporated into the basal glacial ice, these sediments account for 15—60 % by volume of the accreted material (Lawson and others, *J. Glac.*, 1998). Further investigations have shown that glaciohydraulic supercooling is more globally widespread. These occurences suggest that supercooling may have been an important process beneath the Laurentide Ice Sheet for mobilizing sediments.

With discharges in modern environments exceeding 0.1 $m^3 s^{-1} m^{-1}$, one would expect high bedload transport in the glaciohydraulic system. However, recent field studies have shown that bedload transport is supply-limited (Pearce and others, *Geology*, 2003). This limitation is either caused by a lack of clasts at the glacier's sole, by constricted hydraulic arteries that cannot pass larger clasts, or a combination of these processes. Because there are few larger clasts in the flow, few of the larger clast sizes are represented in the basal ice. We investigate ice condensation, sediment mobilization, and the corresponding flow constrictions that may limit the movement of basal sediment using a numerical model of transient water flow up an overdeepened subglacial water system. The model is based on the conservation laws of continuum mechanics with empirical condensation and sediment mobilization rules. Implications of the model are wide ranging for larger—scale geomorphology and glaciogenic sediment deposits.

36-9 BTH 36 Larson, Phillip C

CARBONATE-BEARING TILLS ON THE SOUTHWESTERN CANADIAN SHIELD: IMPLICATIONS FOR THE DYNAMIC EVOLUTION OF THE LAURENTIDE ICE SHEET

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Discontinuous carbonate-bearing tills overlie a significant portion of the Canadian Shield southwest of the Hudson Bay Lowlands (HBL) in northern Ontario. These tills are commonly interpreted to have been deposited during Late Wisconsin recession of the Laurentide ice sheet (LIS). However, an alternate explanation is that they were deposited significantly earlier in the glacial cycle and represent erosional remnants of a larger, more continuous subglacial carbonate-bearing till sheet. The Ontario till contains abundant Paleozoic carbonate and Proterozoic greywacke derived from the HBL and displays features consistent with a deforming bed origin. This suggests early advance of the Laurentide ice sheet out of the HBL was characterized by advection of soft sediment as a deforming subglacial layer. Tills predating and correlative with the last glacial maximum (LGM) in central Minnesota contain an abundance of HBL carbonate and greywacke clasts indicating long-distance transport by a deforming layer potentially as far as 1000 km from the HBL. Continuity of this deforming layer was dependent on sufficient flux of sediment from the HBL. Failure of deforming layer continuity as the LIS approached its maximum extent caused a transition to hard bed conditions in the interior portion of the ice sheet and consequent thickening and volumetric increase of the ice sheet, while the ice margin remained relatively stable or even receded. After long-distance sediment transport ceased, remobilization of subglacial drift around the LGM was followed by a transition during recessional phases of the LIS to short-distance transport of material eroded from crystalline basement rocks. During interglacial periods the unconsolidated sediment reservoir in the HBL was replenished allowing the sediment transport cycle to repeat with subsequent glaciations. Preglacial weathering regolith developed on crystalline shield rocks augmented sediment flux from the HBL during early glaciations. The progressive removal of regolith resulted in earlier initiation of hard bed conditions in successive glacial cycles. Although soft sediment deformation continued to play an important role early in all glacial cycles, ice sheet thickening and volumetric increase are favored earlier during later glaciations.

36-10 BTH 37 Carr, Simon J

MICROFABRIC INVESTIGATION OF SUBGLACIAL TILLS AS A KEY TO UNDERSTANDING THE ROLE OF SUBGLACIAL DEFORMATION IN THE DYNAMICS OF FORMER GLACIERS AND ICE SHEETS

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The analysis of particle arrangements within glacial sediments (fabric) has long been considered to reflect the behaviour of the ice that transported and deposited, or deformed the sediment. Particles can develop specific fabric arrangements as a response to bulk sediment strain driven by effective stress at the bed of a glacier. As such, fabric analysis has been used to try and understand the complex relationship between glacier and ice sheet dynamics and the geological evidence of former glaciation. Developments have focused on the use of stereonet patterns and statistical measures (vector and eigenvector analysis) of clast fabric to infer the process of sediment deposition/deformation, and consequent ice flow directions and dynamics. However, as this study identifies, fundamental processes of particle orientation (March, Jeffery and Taylor rotation mechanisms), and these suggest more complex explanations than have been previously reported.

The results of a detailed field and laboratory investigation of macro-scale (clast) and microfabrics from a till sequence in central Scotland, and a recently deposited till at Langjokull, Iceland are presented. The data highlights the systematic behaviour of different particles according to their size fractions, which orient either parallel or transverse to the stress field direction. This data has been interpreted in terms of the strain response of sediment to the applied total stress. Three fabric patterns are identified, that illustrate consistent (Type A) and progressively shifting (Types B1 and B2) subglacial conditions. More complex particle behaviour (Type C) is interpreted as amalgamations of type A and B patterns occurring during rapidly changing subglacial conditions. These orientation patterns indicate the degree to which subglacial sediment has undergone strain, and the nature of the deforming bed (erosional or accretionary).

It is concluded that this approach may yield fundamental information about the strain conditions underlying different ice masses, thus providing critical data for linking glaciological modelling with the sedimentary evidence of glaciation. In particular this may be used to assess the significance of subglacial deformation in the evolution of Late Quaternary mid-latitude ice sheets.

36-11 BTH 38 Russell, Andrew J.

JÖKULHLAUPS AS AGENTS OF GLACIAL SEDIMENT TRANSFER

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Glaciers and ice sheets erode, entrain, and deposit massive quantities of debris. Subglacial meltwater fluxes exert a fundamental control on ice dynamics and sediment transport budgets. Glacier outburst floods (jökulhlaups) are high meltwater fluxes, constituting high frequency, high magnitude events within many glacial systems. Using field evidence from Iceland, we examine the primary controls on sub-, en-, and proglacial sediment transfer by the action of jökulhlaups.

Jökulhlaups produce significant glaciological and sedimentological impacts because they can simultaneously erode, deposit, and re-work sediment. Jökulhlaups that impose flood waves at the glacier bed can induce increased glacier sliding on a localised scale. Jökulhlaups can re-work and entrain huge volumes of sediment in sub- and englacial zones, thereby extending the recognisable impact of jökulhlaups from the proglacial to intraglacial environment. Most jökulhlaups transport sediment to proglacial sandar, and often directly to oceans. Proglacial jökulhlaup deposits form distinctive sedimentary assemblages, coupled with suites of high-energy erosional landforms.

Skeiðarárjökull and Skeiðarársandur, Iceland are the world's largest glacier and outwash plain subject to frequent and regular jökulhlaups, collectively providing an analogue for Quaternary ice sheet margins subject to high magnitude jökulhlaups. Sediment budget studies based on Skeiðarársandur suggest that high-magnitude jökulhlaups are the dominant sediment transport events. Comparatively little is however known about sub- or englacial jökulhlaup sedimentary regimes. In this presentation, we (i) present evidence for jökulhlaup sediment entrainment within sub- and englacial locations, and jökulhlaup erosional and depositional impacts within subglacial sediments; (ii) identify glaciofluvial sedimentary characteristics diagnostic of fluvial accretion from hydraulically supercooled floodwater; and (iii) produce a model of the controls and characteristics of jökulhlaup erosion, transport, and deposition. Our synthesis of catchment-scale jökulhlaup processes, sedimentary deposits, and landforms provides a physical basis for inferring jökulhlaup dynamics from the stratigraphic record of formerly glaciated regions.

36-12 BTH 39 van der Meer, Jaap J.M.

SUBGLACIAL SEDIMENT DYNAMICS; THE LARGER PICTURE EMERGING FROM THE MICROSCOPE

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The study of a large number of large thin sections of glacial sediments of many different localities and environments has led to a new model of subglacial tills. However it has also led to a reassessment of subglacial sediment dynamics as a whole. We have studied tills that are the result of the squashing of bedrock by glaciers, but in which the sediment has not necessarily been in contact with the ice. On the other hand there are tills which completely consist of sediment that has been completely restructured by ice, without much material having been added by the ice. Both examples appear to be end members of a wide range of origins for subglacial tills. This presentation will show and discuss some of the possible origins

36-13 BTH 40 Kundic, Vesna

PROVENANCE AND AGE OF LOESS ON LONG ISLAND, NY, USA

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Loess ubiquitously overlies Late Wisconsinan glacial sediments on Long Island and is a major reason Long Island's soils have been so productive. The provenance of the loess was studied using single grain $^{40}Ar/^{39}Ar$ biotite and muscovite ages from two localities along the North Shore of Long Island: Caumsett State Park and the Stony Brook University campus (Zhong, 2002). Muscovite from Caumsett State Park loess has Ar/Ar ages ranging from 200-400 Ma consistent with its source being basement rocks to the north in Connecticut. Biotite in loess from Caumsett State Park did not give reliable ages.

Muscovite Ar/Ar ages from loess on the Stony Brook University campus are similar to those at Caumsett State Park. Biotite Ar/Ar ages of loess on Stony Brook campus also have a mode between 200 and 400 Ma consistent with their source being the basement rocks to the north in Connecticut. However, there are a small number of Ar/Ar ages for biotite that are up to 1800 Ma suggesting that a small proportion of the loess has sources to the west in the mid continent.

Optically Stimulated Luminescence (OSL) ages for a 2.7 m thick loess deposit at Wildwood State Park on the North Shore of Long Island are 13,780 ± 1,100 years for the bottom of the deposit, 13, 400 ± 1,250 years for the middle and 7,730 ± 690 years for just below the soil line. These data are consistent with the hypothesis that the immediate source of Long Island loess is glacial sediment deposited in glacial Lake Connecticut in Long Island Sound basement. The deposition of loess would have started when the proglacial Lake Connecticut drained and its bottom was exposed at about 15 ka (Lewis and Stone, 1991). The deposition ceased when the sea entered the Long island Sound basin at about 12 ka (Lewis and Stone, 1991) and its bottom was no longer exposed. The *ca* 8 ka age corresponds well to the Holocene cooling episode known as the 8.2 ka event (Dean et al., 2002; Yu and Wright, 2001). At that time a drier and colder climate might have been responsible for loess deposition on Long Island.

SESSION NO. 37, 1:30 PM

Saturday, July 26, 2003

S8. Isotope Stage 11: An Analog for the Present Interglaciation? (Posters) (*Commission on Palaeoclimate*)

Reno Hilton Resort and Conference Center, Pavilion

37-1 BTH 75 Vautravers, Maryline, J

HIGH-RESOLUTION CLIMATIC RECORDS OF THE SUBTROPICAL LATITUDES DURING MIS11: SITE ODP 1056 (GULF STREAM) AND MD01-2443 OFF PORTUGAL

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We present a detailed study of Leg 172 Site 1056 (32ºN, 76ºW, 2200 meters water depth) from the Gulf Stream path, and of core MD01-2443 (37ºN, 10ºW 2900 meters water depth) taken off the Iberian Margin. Our results are based of stable isotope analyses on both planktonic and benthic species. These data were used to put the two cores onto a comparable time scale. Determination of the planktonic foraminifera faunal associations yields crucial information about the surface and sub-surface water dynamics at the two sites (stratification, upwelling, and deep-winter mixing) in relation to surface changes. These counts are also used to estimate Sea Surface Temperatures (SSTs) using the SIMMAX modern analogue approach. In addition, the lithic content (IRD) provides records of the iceberg-melting inputs at our two locations. At Site 1056, the SSTs calculated for August indicate that the Gulf Stream surface water at 27.5ºC in MIS11 was no warmer than at present time, although SSTs tend to increase toward the end of MIS11. Curiously, February SSTs display a initial phase warmer than the present day by 3ºC, which later cool to about 21.5ºC, close to their present value. The Summer SSTs at Site MD 01-2443 (post upwelling SST) increase during the first part of MIS11 but are only about 1ºC higher than during the Holocene. During this early phase the upwelling indicators are only slightly reduced, while Subtropical fauna records a maximum. However, these indicators increase and decrease respectively toward the end of MIS11, exhibiting several fluctuations. We also found evidence for two substantial main IRD events occurring during the MIS12 glacial inception. The observed contrast between MIS11 winter/summer SSTs at the Gulf Stream Site suggests that surface water was not warmer than at present, but that the warm stream was apparently extending its influence longer during the year, resulting in the winter warming. As a consequence, the overall heat transfer to the high latitude might have been higher than at present. The SST evolution in core MD 01-2443 may confirm this finding. Since, the seasonal upwelling occurs off Portugal during summer, if the SSTs were mainly higher in winter it would be possible to reconcile evidence from early MIS11 of both maintained upwelling activity and intense post upwelling warming.

37-2 BTH 76 Federici, Luna

OCEAN CIRCULATION AND CLIMATE DURING THE STAGE 11 INTERGLACIAL INTERVAL

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The Marine Isotope Stage 11 (MIS 11), an interglacial of 400ka is the period in the Pleistocene most similar to the Holocene in climate forcing by insolation and naturally occurring greenhouse gases and thus can be studied as an analog for the present and future climate. This project is a high-resolution analysis of the Stage 11 interglacial using a marine sediment core from ODP Site 984 on the Reykjanes Ridge in the North Atlantic. A multi-proxy approach is used to investigate the 'super' interglacial climate and ocean circulation of 400ka. The ice-rafting debris and sortable silt records from this period both demonstrate millennial scale variability, as in the Holocene. The sortable silt data indicate that thermohaline circulation varied in a similar fashion during Stage 11 as in the Holocene. These results suggest the existence of a persistent internal mode of variability in the ocean circulation-climate system. The ice-rafted debris levels in Stage 11 allow for the possibility of a diminished Greenland ice sheet, particularly late in the progression of the interglacial, beyond the elapsed duration of the Holocene. A glacial amplifier with a 18O threshold value of 3.5 per mil emerges from the paired IRD and isotope data, as do lower frequency circulation cycles from the sortable silt mean signal. An estimate of 16,500 –22,000 years for the duration of Stage 11 interglacial suggests that if these two similarly forced interglacials follow similar trajectories, the Holocene interglacial warmth would naturally continue many thousands of years into the future in the absence of anthropogenic perturbation.

37-3 BTH 77 Ortlieb, Luc

EL NIÑO OCCURRENCES DURING THE MIS 11: PALEONTOLOGICAL EVIDENCE FROM NORTHERN CHILE

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The presence of warm-water mollusk species within faunal assemblage assigned to the Marine Isotope Stage 11 in several localities of northern Chile (23°-30° S) provides evidence for recurrent El Niño conditions ca. 440-400 ka. MIS 11 thermally anomalous molluscan assemblages (TAMA) are found in some coastal areas which allowed the development of larvae of extralimital species. As a few of the same warm-water species found in the MIS 11 TAMA presently appear, during El Niño years, in the most protected area of Mejillones Peninsula (23°S), it is established that enhanced poleward coastal currents drive larval transport from areas located several hundred km to the north. Under present geomorphological and climatic conditions, individuals of these warm-water species can only survive for some time (unless a La Niña event occurs immediately after a warm event, as observed in June 1998), and are not able to reproduce themselves and colonize the area. During the MIS 11, coastal lagoons and wide beach-ridge systems offered favorable environments for the development of TAMAs around Mejillones peninsula. The large and dense populations of MIS 11 fossil shells pertaining to extralimital species of mollusks suggest either that climate conditions were warmer than at present during that interglaciation, or that strong ENSO events were able to frequently bring stocks of larvae and re-furnish the area. The first interpretation is not supported by the fact that many MIS 11 coastal deposits, formerly located in exposed areas, only contain shells of cool-water species, identical to that presently living in the area. Hence, it can be assumed that during the MIS 11, like nowadays, the coastal waters in northern Chile were cooled by the Humboldt Current and upwelling processes. The surprising number of extralimital species of mollusks found in the MIS 11 sediments, and the long distance (more than 2000 km) separating the (present) southern limit (5°S) of biogeographic distribution of several of these species may indicate a greater strength of the ENSO impacts with respect to present Holocene situation. Geochemical studies on fossil shells from MIS 11 deposits, presently underway, may soon provide indications on seasonal and interannual variations of SST and on the occurrence of short-term anomalies which might be related to ENSO conditions.

SESSION NO. 38, 1:30 PM

Saturday, July 26, 2003

S14. Deserts Over the Last 100,000 Years (Posters)

Reno Hilton Resort and Conference Center, Pavilion

38-1 BTH 95 Harvey, Adrian

RELATIVE INFLUENCE OF CLIMATIC AND BASE-LEVEL CHANGE ON THE LATE QUATERNARY EVOLUTION OF ALLUVIAL FANS IN THE NORTHERN GREAT BASIN, NEVADA, USA

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Mountain-front alluvial fans in the northern Great Basin were affected by late Quaternary climatic changes, and by climatically-induced base-level changes through fluctuations in pluvial lake levels. Several fan groups studied on the margins of and near pluvial Lake Lahontan were all affected by climatically-led variations in sediment supply, but only those on steep mountain fronts adjacent to deep lakes were affected by base-level changes during lake desiccation.

Major periods of fan aggradation occurred prior to the last glacial maximum and during the Holocene, with little or no fan deposition occurring during and after the last glacial maximum, at the time of high lake levels. The differential effects between fans with and without base-level influence are expressed in differences in fan geometry and fan morphometry.

The fans of the northern Great Basin contrast with fans adjacent to pluvial Lake Mojave further south within the Mojave Desert, where there there was less effective base-level control and where the effects of Late Quaternary climatic change were more pronounced. These differences are expressed in fan geometry and fan morphometry.

38-2 BTH 96 Rindfleisch, Paul R

QUATERNARY GEOMORPHIC SYSTEMS AND PALEOENVIRONMENTAL RECONSTRUCTION IN THE GUADALUPE MOUNTAINS REGION, WEST TEXAS AND SOUTH-CENTRAL NEW MEXICO, USA

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The purpose of this poster is to introduce preliminary results from our examination of the Quaternary geomorphic systems of the Guadalupe Mountains Region (GMR) of west Texas and south-central New Mexico. This research has two streams: (1) investigation of quartz and gypsum sand dunes in the region, and (2) an analysis of soils, paleosols, and stratigraphy on alluvial fans. The ultimate purpose of this research is to integrate dated events occurring within both systems in order to reconstruct paleoenvironmental conditions, and to compare the responses of these systems to existing climate-geomorphologic response models.

Stratigraphy and dating of the aeolian deposits in the Salt Basin section of the GMR indicates several periods of aeolian activity probably beginning in the late Pleistocene. The quartz sand dunes in the region can be subdivided into older (mid-Holocene) stabilized dunes and sand sheets, and younger nebkha dunes. Current aeolian activity in the region is limited to gypsum dunes and is controlled primarily by surface production of gypsum through evaporative pumping and the deflation of existing gypsum dunes due to anthropogenic activities. One aspect of this research will be determining if aeolian activity is a function of climate change or other factors such as sediment supply and availability.

The western escarpment of the Guadalupe Mountains is mantled by a large bajada that is thought to have formed in the late Pleistocene. Fan dissection, vegetation growth in apical channels, and development of soils on fan surfaces seem to indicate that fan-forming processes have diminished in recent time. Carbonate and possibly gypsum cemented soil horizons and sediment layers have been identified on fan surfaces and in the subsurface throughout the region, and determination of carbonate stage of surface soils and paleosols and radiocarbon and uranium-series dating is under way. These data along with carbon and oxygen isotopes analysis of carbonate cemented soil will be used to establish a geochronology for the region and can then be correlated with data from the dune system.

38-3 BTH 97 Miller, David M.

QUATERNARY GEOLOGY OF THE IVANPAH 1:100,000-SCALE QUADRANGLE, CALIFORNIA AND NEVADA

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As part of a USGS project to map Quaternary deposits in the arid southwest, this map was prepared to depict process and age characteristics of surficial deposits and generalized bedrock units. The 100,000-scale Ivanpah quadrangle, covering much of the Mojave National Preserve, California, and part of adjacent Nevada, consists of northeast-trending high-relief mountains and pediment domes separated by internally and externally drained alluvial valleys. Quaternary basaltic cinder cones and lava flows mantle pediments in much of the western part. Surficial geologic deposits were identified by process of deposition using geomorphic and sedimentologic features. Geomorphic position, surface roughness, pavement maturity, pedogenesis, and inset relations were used to differentiate deposit ages.

Geologic mapping, conducted using field methods and interpretation of remote-sensing images, identified Quaternary deposits cut by faults. Several faults cut middle to early Pleistocene deposits, such as in the Mid Hills. Others questionably cut old Quaternary deposits, such as near the town of Cima, in the lava fields, and near Old Dad Mountain. Younger faults exist in the northern Bristol Mountains, where several faults cut deposits as young as latest Pleistocene. Pliocene tectonism over much of the quadrangle is indicated by asymmetric mountain ranges and valleys that include tilted Miocene deposits, all cut by Pliocene faults.

Valley-axis floodplains and playas are sources for eolian sand and dust, as reflected in the sediments near sources such as Soda Lake and Kelso and Ivanpah valleys, where eolian-enriched alluvial deposits are common. Eolian-enriched alluvial deposits display a marked change in vegetation and animal habitat, commensurate with expected effects on soil moisture properties of the deposits. Groundwater-discharge deposits, created by past springs and wetlands, are present in several locations, providing markers of past groundwater levels associated with wetter climates.

38-4 BTH 98 Reynolds, Richard L.

GEOLOGIC, ECOLOGIC, CLIMATIC, AND LAND-USE INTERACTIONS IN THE HIGH DESERT OF THE CENTRAL COLORADO PLATEAU (USA)—THE PAST 40,000 YEARS

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Studies in the high desert of the central Colorado Plateau (USA) are elucidating relations among geologic substrates, hydrology, vegetation communities, soil crusts, past and current land-use history, wind-erosion vulnerability, and recent effects of severe drought. Geologic, palynologic, and geochronologic studies reveal climatically controlled episodes of aeolian and alluvial activity separated by periods of stability and paleosol formation, all spanning the past 40,000 years. Holocene deposits of aeolian sand that contain far-traveled atmospheric dust (as much as about 30 %) are important substrates for modern vegetation communities and surfaces stabilized by biologic soil crust (BSC). Aeolian and slope processes, acting on different bedrock substrates, have redistributed sand, silt, and clay in surficial deposits with resultant strong influence on soil respiration, soil moisture, as well as contemporary spatial patterns and temporal dynamics of plant nutrients.

Undisturbed surface sediments were compared to those of previously grazed surfaces (before 30 years ago) with respect to BSC, chemistry, particle size, mineralogy, and microbial activity to evaluate their respective nutrient status and physical properties. BSC on the previously grazed surfaces has lower diversity of species and is less dense than on undisturbed surfaces. The disturbed surfaces show significantly lower contents of some nutrients such as P, N, C, Na, and Mn, as well as lower rates of soil respiration. We attribute the lower amounts of nutrients to wind-driven soil erosion on poorly stabilized surfaces degraded by grazing. Particle-size distribution and content of magnetite (a mineral-dust component in this setting) differ among surfaces in patterns that are consistent with such wind erosion.

Monitoring of saltation and dust deposition at sites having different land-use histories, including two currently grazed settings, show a range of aeolian activity, with most wind erosion at one of the currently grazed sites. Extreme drought in the region during 2002 greatly exacerbated vegetation loss, wind erosion, and dust-event frequency at this site. The other sites experienced far fewer effects of drought.

38-5 BTH 99 Schmidt, Kevin M.

QUATERNARY GEOLOGY OF THE MESQUITE LAKE 1:100,000-SCALE QUADRANGLE, CALIFORNIA AND NEVADA

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As part of a USGS project to map Quaternary deposits in the arid Southwest USA (http://deserts.wr.usgs.gov), this map and associated database depict process and age characteristics of surficial deposits and generalized bedrock units. The 100,000-scale Mesquite Lake Quadrangle, located south of Las Vegas, NV encompasses characteristic Basin and Range topography with northwest-trending, high-relief mountains separated by arid internally and externally drained alluvial valleys. Geomorphic position, deposit surface roughness, pavement maturity, development of pedogenesis, source lithology, and elevation were used to differentiate deposit ages. Geologic mapping, conducted using field methods and interpretation of remote sensing images, identified units offset by Quaternary tectonics, debris-flow prone areas, and active aeolian features. Evidence of tectonics is primarily limited to late Pleistocene and older deposits. Faults are oriented northwest and located in the Spring, Bird Spring, Lucy Gray, Highland, and McCullough Mountains. Some Quaternary faults were linked to previously recognized bedrock structures with late Tertiary offset. In the Kingston Range, we identified five regionally extensive, Quaternary debris-flow sequences. As a proxy for rock strength, Schmidt Hammer measurements of debris-flow boulders depict decreasing values with increasing deposit age. Mid-Holocene deposits exhibit similar values to unweathered material whereas boulders on mid-Pliestocene deposits express substantially lower strength as the varnished surfaces spall and the granitic rock weathers to grus. Mass wasting is also an active process during the present arid climate, as evidenced by the intermingling of asphalt and a 1930's vintage automobile with debris-flow deposits. Lastly, valley axis floodplains, salt flat deposits, and playas were determined to be important sources for eolian transport. In Pahrump, Mesquite, and Ivanpah Valleys, sand sheets, dunes, and vegetation mounds are well developed on the eastern and southeastern edges of valley axis and playas. Continuing research efforts are investigating the relationships between surficial geology, relative erodibility, hydrologic properties, and plant distribution in the context of land use and climate change.

38-6 BTH 100 Wagner, Jennifer D. M.

SPELEOTHEM RECORDS REVEAL ABRUPT CLIMATE VARIATIONS IN THE ARID SOUTHWEST UNITED STATES OVER THE LAST GLACIAL CYCLE

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Although the desert southwest is among the most climatically marginal regions of North America, the region lacks a well-constrained, continuous climate history over the last glacial cycle. Isotopic records from speleothems commonly preserve millennia-long, continuous, high-resolution records of temperature, precipitation, and/or vegetation history, and can be precisely dated using U-series methods. We present the first such record from speleothems from Cave of the Bells (elev. 1700 m) located on the eastern side of the Santa Rita Mountains southeast of Tucson, AZ. Calibration of the stable isotope record is underway; initial analysis of cave drip waters and rain from the cave site indicate that although there is a 5-6‰ seasonal cycle in rainwater $d^{18}O$ (in phase with temperature) there is only a 1‰ variation in cave waters. High resolution (~50 yr) $\delta^{18}O$ data from a sample spanning 9.5-55.7 ka BP indicate a stepwise deglacial shift (with dramatic changes occurring in less than 100 years) mirroring the Bølling-Allerød -Younger Dryas. Low-resolution U-series dates place these transitions around 15.3 and 10.5 ka BP and the LGM (isotopic minimum) at 22 ka BP. The $\delta^{18}O$ shift is about +3.5‰ (4.5‰ removing the ice volume effect) from cooler/moister glacial to warmer/drier Holocene. The climate change implied is qualitatively consistent with other reconstructions from the region. In the early part of the record (30-55 ka BP), millennial variations are similar to those seen in Greenland ice core records. The apparent coincidence of rapid changes in the desert southwest and the North Atlantic implies a coupling mechanism that most likely involves Pacific SST, which governs moisture supply and source for the southwest. Initial $\delta^{18}O$ data from a Holocene sample dating from 3.8-7.1 ka BP show pronounced century-scale variability and mean values comparable to early Holocene levels; analysis of this core is ongoing. This record will address the question of whether the Southwest was wetter or drier than present in the mid-Holocene; there is conflicting evidence from other proxies in this interval. The sensitivity of southwest climate to past large-scale changes implies a sensitivity to ongoing and future changes in anthropogenic forcing, and the rapid rates of change we observe imply that future changes may also occur abruptly.

38-7 BTH 101 Bedford, David R.

QUATERNARY GEOLOGY OF THE AMBOY 1:100,000-SCALE QUADRANGLE, CALIFORNIA

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A USGS project focused on the arid Southwest USA (http://deserts.wr.usgs.gov/) conducted surficial geologic mapping and process studies as critical elements in the study of landscape dynamics. The Amboy 1:100,000-scale Quadrangle is located in the eastern Mojave Desert, between Los Angeles, CA and Laughlin, NV along the Interstate 40 corridor. Landscape features include high-relief mountains, low pediments and intervening alluvial valleys. The area spans the transition from the tectonically inactive eastern Mojave Desert to the active central Mojave and as such each area has distinct geomorphic expressions. Surficial map units are broken out by field and remote sensing interpretations into depositional process and age classifications based on inset relationships, pedogenesis, pavement development, source lithology, elevation, and other geomorphic characteristics. The timing of deposition, geomorphic expression, and nature of alluvial, groundwater discharge, wash, and eolian systems were analyzed to determine landscape development patterns. These patterns include timing and rates of erosion and deposition, mountain front and stream profiles, and spatial and temporal relationships between mapped units. These characteristics are compared based on the influence of late Quaternary tectonics, and bedrock source lithology. Preliminary results show that the tectonically quiescent eastern Mojave portion of the map area developed symmetric valley networks at near consistent base levels through the late Pleistocene, followed by incision or burial in the Holocene. The tectonically active central Mojave portion of the map area consists of asymmetric northwest trending valleys and indeterminate timing of base level changes. Ongoing studies involve investigating the relationships between surficial geology, hydrologic and biologic systems.

38-8 BTH 102 Griffiths, Peter G.

PRESERVATION OF HOLOCENE WIND VECTORS BY VEGETATION AND VENTIFACTS IN AN EOLIAN SAND SYSTEM, NORTHERN COACHELLA VALLEY, CALIFORNIA, USA

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Sand is delivered to active sand dunes north of Palm Springs, California by a combination of fluvial and eolian processes. Fluvial sediment from headwaters in the San Bernardino and San Jacinto Mountains is delivered to depositional areas on the valley floor. Sediment is then entrained in a unidirectional wind field created by westerly flow through San Gorgonio Pass and is deposited downwind in transitory coppice dunes that become depleted as the supply of alluvial sand is exhausted. Wind energy in the Coachella Valley is abundant, and eolian sand transport is limited solely by the supply of suitable fluvial sediment. A long-term sediment budget for the Coachella fluvial-eolian system is estimated by linking models of watershed sediment yield and eolian transport to quantify the supply of fluvial sand and eolian activity. Data on wind velocities and directions are sparse despite extensive wind-energy development. At Palm Springs Airport, south of the center of strongest winds, sand-transporting winds (>19 km/hr) have a mean vector of 298°, indicating a dominant west-northwesterly pattern. One year of wind data at Edom Hill yielded sand-transporting winds of >23 km/hr with a mean vector of 282º. Desert plants and ventifacts preserve prevailing wind directions for periods that extend through the Holocene. Long-lived creosote bush (*Larrea tridentata*) is commonly wind sculpted and forms linear clonal mounds up to 18 m long that are hundreds to thousands of years old. In the center of the wind field, typical vectors on *Larrea* are about 311º±18º. Ventifacts are formed on boulders lying on surfaces mapped as early Holocene in age. At the center of the wind field, wind directions indicated by ventifacts have an average direction of about 293º±17º. On the margins of the wind field, the vectors diverge and some ventifacts appear to have preserved two directions, possibly suggesting a shift from westerly to northwesterly flow. Short-lived shrubs also preserve wind vectors that may markedly diverge from the other evidence. Vector evidence also preserves the divergence of wind around large landforms. A comparison of short-term historical records and long-term bio-indicators suggests that mean wind direction in the Coachella Valley has shifted in the Holocene.

38-9 BTH 103 Nichols, Kyle K.

THE SPEED AND HISTORY OF PIEDMONT SEDIMENT

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At the Chemehuevi Mountain piedmont in the Mojave Desert, we used *in situ*- produced cosmogenic ^{26}Al and ^{10}Be, analyzed in sediment, to quantify sediment supply rates to the piedmont, sediment speeds across the piedmont, and the timing of deposition, erosion, and surface stability of the piedmont surface over the 10^4 year time scale. ^{26}Al and ^{10}Be data acquired from numerous transects across distal, medial and proximal landscape positions suggest that sediment supplied to the Chemehuevi Mountain piedmont is mainly from the mountain source basins (4×10^4 kg km^{-2} y^{-1}) and the proximal bedrock pediment (3.3×10^4 kg km^{-2} y^{-1}). Relatively little of the sediment currently at the ground surface across the piedmont appears to be derived from erosion of incised alluvium and from the channel bed (0.2×10^4 kg km^{-2} y^{-1} and 0.3×10^4 kg km^{-2} y^{-1}, respectively). Nuclide activities of sediment collected from active channels increase steadily down the 12 km - long piedmont. Based on the sediment budget, the down piedmont increase in nuclide activity, and the thickness of sediment in active transport (~32 cm to ~17 cm from the rangefront to the distal piedmont, respectively) we modeled average sediment speeds of 8 to 39 cm y^{-1}.

Nuclide analyses and soil development of two soil pits, located ~6 km and ~12 km from the rangefront, suggest complex histories of sediment deposition, surface erosion, and surface stability. Nuclide analyses of sediment from the pit 12 km from the rangefront suggests sediment deposition rates of 20 to 37 mm ky^{-1} until ~8,000 years ago when deposition was replaced by sediment transport. This interpretation is consistent with the observed soil characteristics that indicate that late Holocene sediments overlie early Holocene sediments at this pit. Soil development and nuclide analyses of sediment from the pit ~6 km from the rangefront suggests a complex history of sediment deposition (18 mm ky^{-1}), surface erosion (truncated soil horizons), and surface stability (buried soils, as well as varnished pavement at the current ground surface) over the past ~70,000 years. By using cosmogenic nuclides we provide a new window into understanding the behavior of these enigmatic features over large spatial- and long temporal-scales.

38-10 BTH 104 Sponholz, Barbara

SANDSTONE KARST AND PALAEO-SANDSTONE WAETHERING - ITS PALAEOENVIROMENTAL IMPLICATION AND HOLOCENE IMPACT ON GROUNDWATER FLOW

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Many of the Central Saharan sandstone massifs are characterized by karst features, such as caves and dolines, that reach up to 3 vol.%. Some of them are widened by superimposed mechanical erosion, but thin section analyses give proof of mineral – and even quartz – dissolution sensu strictu. With regard to the present morphological position of the karst phenomena and the degree of transformation, the main karst processes are assumed to have taken place before the Quarternary dissection of the older peneplains. So they are contributed to important ground water flow and to warm and humid climate conditions that favorize intense chemical weathering. On the other hand, the very common silcretes – mainly positioned on the top surface of cuestas and hilly regions – are interpreted as correlate silica deposits. This interpretation is supported by comparison to Central Australian silcretes (Lake Eyre Basin), where they figure as reprecipitation of silica that was dissolved during weathering and dissolution of various silicate minerals in the surrounding highlands. The well cristallized Central Saharan silcretes are mainly precipitations out of groundwaters very poor in dissolved load (that implicates a long time of undisturbed solution and reprecipitation), whereas in the Southern Sahara the silica precipitation is more disturbed by the presence of iron-bearing minerals in the dissolution environment. The quarternary dissection and drainage of the karst systems lead to their fossilization in the higher morphological positions. In the lower parts, however, they are parts of the aquifers until today. Water filled karst galleries influence the present groundwater flow. Under the present arid climatic conditions without recharge of the aquifers, karst related high permeability must be considered for any groundwater and sustainability modelling in the Central Sahara.

38-11 BTH 105 Ewing, Ryan

DISTRIBUTION OF SAND DUNE SPACING, CREST LENGTH, AND DEFECT DENSITY IN SIMPLE, COMPOUND, AND COMPLEX DUNE FIELDS

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Many modern sand seas display compound and complex dune morphologies, which create some of the most interesting and least understood patterns in nature. Typically these dune fields display a range of dune spacing, crest length, and defect density spanning several orders of magnitude. The aim of this study is to quantify the distribution of these parameters in simple, compound and complex dune fields and understand the cause of these distributions. Several thousand measurements of sand dune spacing, crest length and defect density were measured on Landsat 7 ETM+ satellite imagery and Digital Ortho-Photo Quarter Quadrangles (DOQQs). Measurements were taken from White Sands, Algodones, Grad Desierto, Mauritania and Namibia. The measurements were plotted to show the distributions of spacing, crest length and defect density for each dune field. In dune fields with simple morphologies a single population is observed. In all dune fields that exhibit compound or complex morphologies, multiple populations in the distribution plots are observed. In one case, these different populations may just represent compound/complex bedforms and not distinct generations of dune activity in the dune field. However, in the Azefal, Agnetir, and Akchar Sand Seas of Mauritania, which display compound linear dune morphology, the distribution plots show three distinct populations, each representing the distribution of three dune trend classes with their own characteristic spacing, crest length and defect density. The different dune trend classes have been OSL dated and shown to have formed at different periods over the last 30 ka (Lancaster et al, 2002). The distributions of dune crest length, spacing, and defect density are characteristic of the different generations of dunes in Mauritania. Distribution plots are a potential means to discriminate between different generations of sand dunes for other dune fields as well, supporting the concept that the complex patterns observed in dune fields are composite features, the product of discrete punctuated events of dune construction.

38-12 BTH 106 Liu, Hongyan

AEOLIAN ACTIVITIES IN SEMI-ARID CHINA: COMBINING MODERN ECOLOGICAL PROCESSES WITH PALEOECOLOGICAL EVIDENCE

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The frequently occurred dust storms in northern China have attracted scientists not only from China, bust also from Korea, Japan and even North America, due to their long distance transportation. The semi-arid region in northern China has been undergoing strong desertification, particularly in recent 50 years. Has vegetation degradation contributes a lot to dust storm outbreak? Under what climatic and vegetational conditions did aeolian activities occur? How to distinguish the nature processes from anthropogenic ones in desertification? In our study, we try to give answers to the above scientific problems. We first study modern ecological processes with data of vegetation survey and soil analysis. Then combining paleoecological data, such as pollen, macrofossil, physical and chemical characteristics of four lake sediment sequences, we reconstructed the climatic changes, vegetation development and aeolian activities during Holocene in some selected key area in semi-arid China. The vegetation index (NDVI) from NOAA AVHRR data and intensity of dust storms are positively correlated, indicating that vegetation cover contributes to dust storm outbreak. 8 landscape types were further distinguished in a key study area in southeastern Inner Mongolia Plateau. In was demonstrated that the degrading typical steppe on stony mountains and cultivated land have the highest possibility of dust release. In contrary, moving dunes has low content of fine dusts and release little dusts in per unit area. The fixed sand dunes, lowland vegetation and meadow steppe also contributes little to dust storms due to their high vegetation cover. It was demonstrated that the aridity has been increased since 5900 a B.P. in semi-arid China. The transition from humid to an arid climate coincided with enhanced aeolian activity, and deciduous woodlands were replaced by pine woodlands and then by steppe in response to the climatic deterioration. Climatic changes are key driving factor for desertification and further aeolian activities in se

38-13 BTH 107 Yang, Bao

EVIDENCE FOR A WARM AND HUMID CLIMATE PERIOD AND ENVIRONMENTAL CHARACTERISTICS IN THE ARID ZONES OF NORTHWEST CHINA DURING 2.2-1.8 KABP

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Ice cores, tree rings, river and lake sediments, lake terraces, historical documents and palaeosols document aspects of climate changes in northwestern China during the Western and Eastern Han Dynasties (206 BC ¨C 220 AD). A reconstruction of decadal means of annual mean temperature and precipitation fluctuations were derived from variations of d18O and net accumulation rates in the Guliya ice core. The results show that during the period of interest vast areas of northwestern China experienced a period of higher temperatures and higher precipitation than today, lasting until the 5th century AD. These conditions resulted in a marked increase in discharge of several big endorheic river systems, such as the Tarim River, the Keriya River and the Manas River. As a consequence, water levels in appendant terminal lakes rose, e. g. at Lop Nur, Manas Lake and Baijian Hu. Lake surface areas expanded and lake desalting occurred also at lakes in intermontane basins such as Balikun Hu and Qinghai Lake. These warm and moist conditions during the Western and Eastern Han Dynasties might have been responsible for large-scale agricultural production activities and a local socioeconomic boom that is documented by the occurrence of the famous ruin groups of Loulan, Niya and Keriya. The following desiccation phase led to a deterioration of water resources, and most oases tended to fade and finally were abandoned. The appearance, development, flourishing and final abandonment of each great ruin group is closely associated with regional climate change at that time.

38-14 BTH 108 Lancaster, Nicholas

EOLIAN CHRONOLOGY AND PALEOWIND VECTORS IN THE NORTHERN RUB AL KHALI, UNITED ARAB EMIRATES

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The Quaternary history of northern parts of the Rub al Khali sand sea of Arabia exhibits a complex pattern of dune construction, reactivation, and stabilization in response to changes in sea level and climate. The complexity is manifested by: (1) multiple generations of dunes of different morphological types and (2) the stratigraphic record of partially to completely lithified carbonate-rich eolian sediments (eolianites), which underlies many areas of the dune system.

Stratigraphic evidence from exposed sections and clustering of OSL dates from the eolianites indicates that dunes were formed during the periods 129-164, 99-113, 34-64 and 22-18 ka from bioclastic sediments deflated from the shelf areas of the Arabian Sea during periods of low sea levels. Wind directions during these periods of dune construction were from the NW-NNW.

OSL dating of the large quartz rich E-W to SW-NE-trending linear dunes which are superposed on the eolianites, provides evidence for their formation in the periods 31-42, 15 –18, and 12- 9 ka. The change from a carbonate-dominated to a quartz-dominated eolian system after about 18 ka suggests depletion of sediment supply from the Arabian Gulf, perhaps accompanied by a change in the wind regime to a more westerly orientation.

In the Liwa area to the south, large quartz-rich compound crescentic dunes overlie inland sabkas. Stratigraphic and geomorphic evidence, together with OSL dating of eolian sands indicate periods of dune accumulation around 141, 106, 40, 26, 12, and 4-6 ka. The lack of coincidence of many of these dates with those from the eolianites closer to the Arabian Gulf suggests that dune activity in this area was controlled by climate rather than sea level. Radiocarbon and OSL dates indicate that the widespread calcareous-cemented interdune sediments in the Liwa area (many of which now cap mesas in an inverted topography) formed between 29 and 41 ka, when the water table in this area was several meters higher than present, possibly as a result of increased precipitation during MIS 3.

38-15 BTH 109 Al-Juaidi, Farhan

RESPONSE OF DESERT OUTWASH SURFACES TO ENVIRONMENTAL CHANGES DURING THE LAST 55 000 YEARS

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Evidence of climatic changes is preserved in central Saudi Arabia in the form of a series of outwash plains developed along the eastern edge of the Arabian Shield. The Al-Harmaliah is a fan-shaped outwash suggesting that the region had a considerably higher rainfall at some time during the late Quaternary. The evolution of this outwash fan during the last 55,000 years is analyzed based on data derived from OSL dating and supported by several published 14C data in the region. These data suggest wet phases at c. 55 to 47 ka BP., c. 40 to 19 ka B.P., c. 10 to 5 ka B.P. and c. 0.8 ka B.P. Periods of aridity probably occurred at c. 47 to 40 ka B.P., 19 to 10 ka B.P., and c. 5 to present.

The wetter conditions in central Saudi Arabia can probably be attributed to a shift of the monsoon northwards as a result of increased temperatures, a global rise in sea levels and increased evaporation of the oceans sometime during the late Quaternary.

38-16 BTH 110 Nicoll, Kathleen

HYDROCLIMATIC CHANGE IN THE EASTERN SAHARA: THE LITHOSTRATIGRAPHIC AND GEOCHRONOLOGIC RECORD FROM UMM AKHTAR PLAYA, SOUTHERN EGYPT

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Integrated lithostratigraphic and geochronologic studies of Umm Akhtar Playa, a dry lake located at N 22 deg 36' E 30 deg 18' in southern Egypt, indicate the accumulation and rapid desiccation of a sizeable (>65 sq km) standing water body during the Late Quaternary. More than twenty radiocarbon dates on hearths and incorporated organic materials bracket 'wet' phases from ~8915–8580 14C yr BP and ~7105–5955 14C yr BP. During these intervals, rapid incursions of sediment-laden flows discharged into the basin after seasonal or periodic floods, depositing lithic gravels (Qal) and massive muds (Qp) which are locally interstratified with ribbons of aeolian sand (Qd) along the paleoshore. The ponded water was formerly deep and persistent enough to create a beach berm of rolled pebbles, and to sustain cultural activities. Artifacts of the Early Neolithic-Neolithic tradition, including ostrich eggshell vessels, beads, lithics, and grinding tools, provide a context for reconstructing human occupation of the site through the close of the 6th millennium BP. Cultural abandonment, as well as increasing amounts of sand up-section, evaporite precipitation, and the formation of large (5 m) polygonal cracks, marked the final desiccation of the playa; optical dates on sands constrain the timing of rapid sedimentological transitions forced by hydroclimatic change. Comparison of the AMS dates from Umm Akhtar Playa to a compilation of 536 published radiocarbon dates from Egypt and northern Sudan corroborate a period of enhanced surface water storage from 8100-6000 BP. This 'wet' phase appears to lag the Northern Hemisphere seasonal insolation maximum centered at 10,400 BP, and the greatest frequency of African lake highstands (9500-8500 BP).

38-17 BTH 111 Greenbaum, Noam

EVIDENCE FOR LARGE PALEOFLOODS DURING LATE OXYGEN ISOTOPE STAGE 3 FROM NAHAL NETAFIM CATCHMENT, NEGEV DESERT, ISRAEL

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Sedimentological evidence for 27 large paleofloods were found in a cave in Nahal Netafim, a small catchment, in the hyperarid Southern Negev Desert. The sediments are fine-grained flood slackwater deposits which accumulated at elevations of 2.3-5.3 m above the sandy gravel channel bed. The elevation of these deposits represents the maximal stage of the flood. Eight sedimentary units were dated using the luminesence method, and their ages range from 34.3±1.4 to 27.1±1.0 ka. The Late Pleistocene elevation of the channel bed needed for the computations of peak discharges was determined using Fluvio-Pedogenic Layers (FPL)found near the cave. These red layers represent the base of the active layer in the channel. One FPL was found in the present channel at a depth of 1.1 m, dated to ~9 ka and the second within a low alluvial terrace (stratigraphically older) - 0.3 m above present channel bed. The upper FPL was correlated to FPL's in the nearby Nahal Yael catchment, dated to 20-30 ka. This FPL represents the Late Pleistocene channel bed of Nahal Netafim. The calculated peak discharges for these paleofloods range from 240 to 600 m3/s. The peak discharge of 10 out of the 27 paleofloods in the cave is higher than 500 m3/s and deviates from the envelope curve of paleofloods for the Negev Desert. This indicates that flood magnitudes during the late Pleistocene were much higher than during the middle-late Holocene. The average frequency of large floods in Nahal Netafim is about 250 years compared to about 1,000 years in other similar catchments during the middle-late Holocene. The hydrological regime of the late Pleistocene is characterized by high frequency of very large floods compared to the middle-late Holocene to present. This is probably related to slightly different climatic conditions with higher rainfall intensities and/or duration, though still arid. Comparing our data to other paleohydrological and paleoclimatological data sources supports this hypothesis.

38-18 BTH 112 McLaren, Sue

EVIDENCE FOR LATE QUATERNARY PALAEOENVIRONMENTAL CHANGES IN THE FEZZAN, SOUTHERN LIBYA

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The palaeogeomorphological work undertaken as part of the geoarchaeological Fezzan Project aims to further our understanding of climatic and environmental change in the Wadi el Agial area in the Fezzan, southern Libya as well as to provide a palaeoenvironmental framework within which the archaeology of the region may be interpreted. The archaeological record in the study area spans the past several hundred thousand years (lithic remains represent the Acheulian to the Late Neolithic periods) and therefore it is essential to gain an understanding of environmental change over this period of time.

Present day rainfall in the Fezzan is less than 20 mm per year on average, and exhibits high interannual variability. However, both geomorphological evidence and archaeological remains in the Fezzan indicate that this currently hyper-arid region experienced wetter phases in the past. For example, rock carvings and other archaeological remains attest to the existence of a more benign environment during the early to mid Holocene, when humans and large humid-climate fauna existed in currently inhospitable areas. Lake sediments and various geochemical crusts demonstrate the existence of open water bodies and a higher groundwater table during several phases of the Late Quaternary. Successive arid and humid phases were generally associated with episodes of northern hemisphere glacial advance and retreat respectively, but were not nec-

essarily synchronous throughout the Sahara. New information from data-sparse areas of the Sahara such as the Fezzan is therefore particularly welcome. Evidence of wetter past environments in the Wadi el Agial is briefly summarised in this paper, with the emphasis placed on records of lake high-stands.

38-19 BTH 113 Baumhauer, Roland

LATE PLEISTOCENE AND HOLOCENE PALAEOENVIRONMENTAL RECORDS OF TÉNÉRÉ, ERG OF TÉNÉRÉ AND ERG OF FACHI BILMA (CENTRAL SAHARA): NEW IMPLICATIONS FROM PALAEOECOLOGICAL DATA

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Late Pleistocene and Holocene deposits enable the reconstruction of the palaeoenvironmental development of the vast lowlands of southern Central Sahara. The environmental conditions are deduced from geomorphology, sedimentology, biological remains, palaeolimnological, palaeopedological and prehistoric evidence.

Geomorphology and biological remains (e.g. Lates niloticus, Hippopotamus amphibius, Crocodylus niloticus) suggest from 11,5 ka BP a wide-spread lakeland country with permanent freshwater lakes changing size, level and water balance. A rapid change of the environmental conditions occurs from 6,5 to 6 ka BP: The desiccation to ephemeral ponds with saline/alkaline superficial dilute/stratified waters to swamp environment. Artifacts confirm that the lakes had lost much of their size by the time of the neolithic settlement already. Palaeosoils (60 to 100 cm of preserved thickness) are classified as Chromi-Cambic/Cambic-Arenosols. In the shore area of the palaeolakes the terrestrial palaeosoils grade into hydromorphic Gleyic Arenosols. The former shorelines are marked by fringes of bog-iron accumulations.

The palaeolakes of the lowland areas of Central Sahara have reacted differently to the ground water fed lakes in endorheic depressions in front of cuestas: a more direct influence of the climatic tendencies superimposed on local topographic conditions and changes in geomorphology (e.g. dune activity). The palaeopedological approach shows a close correlation between the degree of rubefication as well as physical, chemical and mineralogical properties of the palaeosoils and the geographical position. The climatically determined gradient of decreasing weathering intensity from sw to ne has been modified only by local differences of the original mineral spectrum and by the influx of aeolian dust. Based on palaeoecological evidence, the annual precipitation rate is estimated at least at 400 mm at the end of Late Pleistocene and Early Holocene, combined with an interaction of monsoonal rains and northern cyclons. In Mid-Holocene this interaction was reduced and the character of precipitation became more frequently violent, indicating a stronger saisonality of climate as well as a reduction of the annual precipitation rate (150-200 mm), with a more and more stronger gradient from sw to ne.

38-20 BTH 114 Thomas, David S.G.

TIMING AND DURATION OF LATE QUATERNARY ARID EPISODES IN THE KALAHARI: RESOLVING UNCERTAINTIES IN THE DATED AEOLIAN RECORD

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Since the mid 1990s published luminescence chronologies (principally OSL (e.g. Stokes et al 1997, Thomas et al 2000); also TL (e.g. Eitel and Blumel 1998)) have been contributing a directly-dated record of dune building phases in the Mega Kalahari during the last glacial cycle. Multiple phases of dune construction have been proposed, at c.16-9 ka, 26-20 ka, 36-29 ka, 46-41 ka, 60-55 ka, 115-95 ka ago with regional variations that indicate a complex spatial and temporal history of aridity since 100 ka ago. A number of potentially problematic issues, however, have arisen within this record and its interpretation (Thomas and Shaw 2002, Bateman et al 2003), including record preservation in the sediment limited SW Kalahari, constraints on the general depth of sampling within aeolian units, the potential for clustering of apparent dune development phases to be an artefact of sampling strategies, and the compatibility of independently-derived arid and humid chronologies. We present an examination of recent and new data sources that help a reassessment of these issues. Data sources presented include integrated arid and humid chronologies from the N Kalahari, deep mine samples from the SE Kalahari, and linear and lunette full-depth cored chronologies from the SW Kalahari. We also consider the implications of recent offshore core data (Shi et al 2000) for interpretation of the terrestrial Kalahari record. Together these sources allow a better resolved picture of the duration and dynamics of last glacial cycle arid conditions in the Kalahari to be made.

38-21 BTH 115 Meadows, Michael E

REGIONAL PATTERNS IN THE LATE QUATERNARY PALAEOENVIRONMENTS OF THE SOUTHWESTERN CAPE, SOUTH AFRICA

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The southwestern Cape of South Africa experiences a winter-rainfall climate regime but is characterised by extreme environmental heterogeneity such that annual quantities and temporal distribution of precipitation are highly variable. Large expanses of the region are semi-arid. Elucidation of Quaternary palaeoenvironments is regarded as important because the region is associated with prolific levels of biological diversity, especially within a flora that has been designated as one of only six Floristic Kingdoms globally. The archaeological record provides an additional motivation to reconstruct environments of the past. Furthermore, long-term environmental changes in the region may provide vital clues as to the behaviour of the global thermohaline conveyor belt, which passes offshore in both directions and which is a major sub-Milankovitch scale mechanism of global climate change. Quaternary environmental reconstruction has been hampered by the absence of long, continuous terrestrial sedimentary archives, but many shorter, temporally fragmented, records exist for a variety of habitat types in the region. These records are employed in this paper to develop a model of evolving palaeoenvironments from the Last Glacial Maximum (LGM) and through the Holocene. They reveal that different geographical areas within the winter-rainfall region as a whole, may have reacted differently under dynamic environmental circumstances over the period in question. Nevertheless, there is an emerging pattern of cooler and wetter LGM conditions across much of the region, contrasting markedly with equivalent sites in the all-year and summer-rainfall regions of southern Africa. This may have particular significance in light of the implications of substantially reduced partial pressures of atmospheric carbon dioxide at the time. Holocene environmental conditions appear also to have been spatially and temporally variable. Since European colonisation, anthropogenic change has emerged as the dominant environmental signal. Evidence from the late Quaternary of the southwestern Cape may now be sufficiently resolved to facilitate its use, through comparison with regionally-downscaled climate model outputs, in developing climate change predictions.

38-22 BTH 116 Nash, David J.

EL NIÑO AND RAINFALL VARIABILITY IN THE KALAHARI, SOUTHERN AFRICA, 1840-1900

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This study uses a range of published and unpublished historical documentary sources to assess the nature of the relationship between El Niño-Southern Oscillation (ENSO) warm events and rainfall variability in the Kalahari region of central southern Africa for the period 1840-1900. Documentary data are used in two ways. Firstly, a chronology of annual rainfall patterns for the Kalahari is presented for the sixty-year study period, from which variations in inter-annual rainfall distribution during wetter/drier episodes and ENSO warm events are identified. Results indicate that, whilst a number of episodes of drought or wetter conditions can be broadly identified across the region, the distribution and onset of periods of above- or below-average rainfall was highly variable. Analyses further suggest that the broad relationship between ENSO warm events and rainfall variability identified for the 20th century, whereby ENSO events are preceded by wetter conditions during the austral summer prior to the ENSO year and succeeded by drought in the following summer, has held for at least the last 160 years. Droughts occur following at least fourteen of the eighteen single- and multi-year ENSO warm events between 1840-1900. Pre-ENSO wetter periods are less common, with only nine of the eighteen ENSO events during the study period preceded by above-normal rainfall. Secondly, the primary documentary data set is analysed to identify high resolution variations in the seasonal distribution of rainfall during ENSO warm events. Seasonal sequences of rainfall/drought appear to have closely followed contemporary patterns, with heavy rainfall commonly occurring late in the pre-ENSO year or early in the ENSO year, with drought at the start of the post-ENSO year. This relationship held most strongly for single-year ENSO events and for the first year of multi-year events, but rainfall conditions were more variable during the later years of multi-year events.

38-23 BTH 117 Nash, David J.

LATE QUATERNARY VALLEY CALCRETES IN THE KALAHARI

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Calcretes that form in non-pedogenic settings have been widely reported in the geomorphological and geological literature, yet their petrological characteristics are poorly understood in comparison with pedogenic varieties. This may be because there are assorted types of non-pedogenic calcrete (often referred to as groundwater calcretes, but encompassing groundwater, phreatic, open valley or confined channel calcrete types) forming within vadose and phreatic environments in different geomorphological settings. As a step towards expanding our knowledge of such calcretes, this study describes the petrology, micromorphology, and mode of development of one non-pedogenic calcrete type, namely that which forms within valley locations (but not in definite fluvial channels). Late Quaternary to Holocene valley calcretes are described from various dry valleys (mekgacha) across the Kalahari region of central Botswana, with the majority of samples collected from trunk and tributary valleys of the Okwa. Samples have been analysed in thin-section and under scanning electron microscope in order to determine the carbonate matrix type and calcrete micromorphology. In general, most samples consist of grains of quartzose Kalahari sand cemented by fine crystalline, often glaebular, grain-coating and pore-filling micrite. Cement types are fairly consistent and not as micromorphologically variable as has been noted for other Kalahari calcretes. Biological inputs are prevalent in many samples and include networks of calcified rootlets. These characteristics reflect the fact that the calcretes formed in a relatively near-surface environment with relatively high rates of evaporation. On the basis of these results, the Late Quaternary environmental context of calcrete formation is discussed

38-24 BTH 118 Fanning, Patricia C.

LATE QUATERNARY GEOMORPHIC HISTORY OF UPLAND VALLEYS ON THE MARGIN OF THE AUSTRALIAN DESERT

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This paper presents the results of investigations of the Late Quaternary geomorphic history of upland valleys on the arid margin of western NSW, Australia. Alluvial valley fills were investigated using standard stratigraphic and sedimentological techniques. A chronology of landscape evolution of the valleys was developed by using optically stimulated luminescence (OSL) and radiocarbon determinations from valley fill sediments.

A discontinuous record of landscape change extending back about 75,000 years is evident in the valley fill of Stud Creek, draining a 30 km2 catchment east of Tibooburra in far northwestern NSW. Five major sedimentary units provide a record of depositional episodes ranging from modern, or post-European, back to the Late Pleistocene, interspersed with long periods of erosion for which there is no remaining sedimentary record.

This pattern of episodic nonequilibrium in landforming events is common in the Australian arid zone, with similar patterns being observed in stratigraphic records elsewhere in the region. However, the record for Stud Creek is the most detailed so far published for this part of Australia. It provides insights into the behaviour of upland ephemeral stream systems on the desert margin of Australia throughout the Late Quaternary, and constrains the record of occupation of the Aboriginal hunter-gatherer people who once lived there.

38-25 BTH 119 Brunotte, Ernst

LATE QUATENARY CLIMATIC CHANGE IN NW-NAMIBIA: SEDIMENTOLOGIC, PEDOLOGIC AND ARCHEOBOTANIC EVIDENCE

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Northwestern Namibia (formerly Kaokoland) has been freely accessible to researchers only since independence in 1990. To date there are few studies of the climate history. A first reconstruction of the late Pleistocene vegetation and climate history of the former Kaokoland, northwestern Namibia, has been attempted using a synthesis of sedimentologic, archeobotanic and pedologic data. For the most part, the current knowledge stems from the activities of the Special Research Project 389: Cultural landscape changes and cultural innovation in Africa, of the Deutsche Forschungsgemeinschaft. From about 20.000 BP until early Holocene time, strong eolian processes have been documented for central Kaokoland. Charcoal analysis also supports an arid climate during this period. In addition, the late Pleistocene appears to have been cooler then

today. During this phase, characteristic species of mopane savanna are missing from the assemblage. Acacias dominated the woody vegetation. After about 6000 BP, the vegetation in the eastern part of Kaokoland resembled that of today. Charcoal samples from abris (rock shelters) in the arid western part of the area indicate two minor humid episodes during the mid and late Holocene, which might correlate with periods of soil formation in central Kaokoland. The most recent 3000 years once again were characterized by strong eolian processes, possibly caused by the thinning of the woody vegetation due to human influence. In opposition to the multiple climatic changes of northern Africa, the northwetern Namibia has less evidence for Late Quaternary climatic fluctuations. This has to be discussed in the sense of the large-scale synchronization of the climatic phases of the northern and southern hemisphere.

SESSION NO. 39, 1:30 PM

Saturday, July 26, 2003

T5. Glaciotectonic Map of Central Europe (Posters)

Reno Hilton Resort and Conference Center, Pavilion

39-1 BTH 41 Ber, Andrzej

GLACIOTECTONIC MAP OF CENTRAL EUROPE IN SCALE 1: 1 500 000

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The main goal of the Glaciotectonic Map of Central Europe project was to create the first European region-wide assesment of the types and distribution of glaciotectonic phenomena creating a unified GIS database for central Europe and a published map of the whole region. These works were performed since 1995 on the base of compilation of glaciotectonic national maps elaborated for Germany, Denmark, Poland, Czech Republic, Ukraine, Belarus, Lithuania, Russia (Kaliningradian District), Latvia and Estonia under the direction of Andrzej Ber. In the project of ten national leaders and also tens of specialists from national geological surveys or academies of sciences have been involved actively as coauthors. The project was under science supervision of James S. Aber (USA) and Jan A. Piotrowski (Denmark).

Glaciotectonic features were digitized from 1:250 000 or 1:500 000 in scale base maps for compilation into Glaciotectonic Map of Central Europe. These features are classified in four main categories: glaciotectonic landforms expressed in recent relief; glaciotectonic buried landforms; glaciotectonicly disturbed Quaternary sediments and glaciotectonicly disturbed pre-Quaternary sediments (in situ and rafts).

The compilation of the Glaciotectonic Map of central Europe in scale 1:1 500 000 resulted in:

- compilation of a comprehensive GIS database on glaciotectonic features for Central Europe,
- creation of the first region-wide assesment of the types and distribution of glaciotectonic phenomena in Central Europe

39-2 BTH 42 Ber, Andrzej

THE NATIONAL GLACIOTECTONIC MAPS OF CENTRAL EUROPE

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During the period of 1996-99 the Working group on Geospatial Analysis of Glaciated Environments (GAGE) at the INQUA Commission on Glaciation has undertaken a preparation of the glaciotectonic mapping project, as a base of the Glaciotectonic Map of Central Europe, in which geospatial analysis (GIS) has been utilized for compilation of databases and map production. The national glaciotectonic maps have been completed for the region from Germany and Denmark, across Poland and Czech Republic to Belarus, the Ukraine, Russia (Kaliningradian District) and Eastern Baltic countries (Estonia, Latvia and Lithuania). Scientists from universities, geologic surveys and academies of sciences devoted considerable time and effort to compile and prepare these glaciotectonic national maps using a common approach. The following national map leaders and their co-authors have been involved in the project realization: Hans-Jurgen Stephan (Germany), Peter R. Jakobsen (Denmark), Daniel Nyvlt (Czech Republic), Andrzej Ber (Poland), Vitaly Zagorodnikh (Russia), Andrei Matoshko (Ukraine), Alexander Karabanov (Belarus), Albertas Bitinas (Lithuania), Vitâlijs Zelès (Latvia) and Volli Kalm (Estonia). In compilation of national maps participated also graduate students Maris Rattas (Estonia), Paulius Aleksa (Lithuania) and Jânis Dzelzîtis (Latvia). The GIS work was under supervision and authorship of the Waldemar Gogolek and Jacek Kocyla (PGI, Poland). The project was supervised by James S. Aber (USA) and Jan A. Piotrowski (Denmark). Preliminary the national maps of Poland, Belarus, Estonia and Lithuania have been presented at the XV INQUA Congress in 1999 (Durban, South Africa). Owing to financial support of the INQUA Commission on Glaciation, most of the national glaciotectonic maps were completed in 2000. They were prepared on the common topographic base map.

39-3 BTH 43 Ber, Andrzej

GLACIOTECTONIC MAP OF POLAND IN SCALE 1: 500 000

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The idea of elaboration of the Glaciotectonic Map of Poland have been carried out in 1997 with initiative of Andrzej Ber and Hanna Ruszczynska-Szenajch – Polish members of the Geospatial Analysis of Glaciated Environments (GAGE) Work Group of the INQUA Commission on Glaciation. The project in which tens of specialists from Polish Geological Institute and academies of sciences have been involved as coauthors was under coordination and science supervision of Andrzej Ber. Glaciotectonic features in Poland are classified in two main categories: (1) glaciotectonicly disturbed landforms and sediments expressed in recent relief, (2) buried disturbed landforms and sediments, not expressed in recent relief. Within the first category there occur: - composite ridges, massives, ridges and hills, mainly within the marginal zones, built of disturbed pre-Quaternary and/or Quaternary sediments, - glaciodepressions and rafts of the pre-Quaternary substratum. Within the second category there occur: - buried glacial depressions, - buried glacial sediments and - buried rafts of pre-Quaternary sediments. Originally, on territory of Poland there are two groups of glacial dislocations: - landforms created by the active moving ice sheet and - deformations associated with plastic rock squeezing into stagnant ice, fissures, land sliding and subsiding processes.

39-4 BTH 44 Zelès, Vitâlijs

GLACIOTECTONIC MAP OF LATVIA

ZELÈS, Vitâlijs and DZELZÎTIS, Jânis, Department of Geography, Univ of Latvia, 19 Rainis Blvd, Riga, LV-1586, Latvia, vzelcs@lanet.lv

The glaciotectonic map of Latvia is an integral part of the INQUA GAGE Working Group project Glaciotectonic GIS Database and Map of Central Europe. The map and database were constructed using the ArcInfo system during the period of 1997-2001. Twenty-nine individuals have contributed information or assisted in preparation of the database. Glaciotectonic features were digitized from 1:50,000 (or 1:75,000) topographic maps and derived from interpretation of aerial photographs, papers, unpublished reports and personal communications. The glaciotectonic map is supported by a supplementary map of the lobate structure of the Scandinavian ice sheet in Latvia and three-dimensional visualizations of the pre-Weichselian and modern surface of Latvia. Most glaciotectonic features were formed during the Late Weichselian. Because Latvia occurs at the transitional zone between the areas of predominate glacial erosion and the inner margin of the depositional belt, mainly subglacial processes created the glaciotectonic features. As a result of deglaciation and subsequent geologic processes these structures and land systems were altered to some extent, and glaciotectonic, other glacial and non-glacial features were superimposed. Glaciotectonic ridges with crests parallel to ice movement direction occur mostly in glacial lowlands, while composite hills and ridges, as well as isometric glaciotectonic hills predominate in the interlobate areas. Transverse features are most common on the peripheries of glacial uplands or on lowland areas with hard bedrock. Large rafts of pre-Quaternary bedrock expressed in topography borders of lowlands and uplands. Buried deformed Pleistocene sediments and bedrock appear on plains but glaciotectonic hills capped by glaciolacustrine sediments are common in the central part of the largest interlobate uplands. The map displays the spatial image of how the development of glaciotectonic structures caused change in the original thickness of glacial, interstadial and interglacial deposits and disruptions in the continuous cover of till.

39-5 BTH 45 Kalm, Volli

GLACIOTECTONIC DEFORMATION PATTERN IN ESTONIA

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A set of glaciotectonic deformations in Estonia have been described in connection with different substratum lithology; a) bedrock dislocations associated with a rigid environment, and b) soft bed deformations associated with unconsolidated drift masses. Glaciotectonic features have been classified in five main categories. (1) Ridges, hills and composite massifs built of disturbed Quaternary substratum, which have clear topographical expression. Composite massifs are a system of individual glaciotectonic landforms and composed largely of unconsolidated Quaternary strata. Ice-shoved hills and ridges (push moraines, cupola hills, drumlins) are created at or near ice margins during ice-lobe advance or readvance denoting ice marginal positions of different stadials or oscillations. (2) Point samples of buried disturbed sediments are described in connection with buried dislocated interglacial (Holsteinian and Eemian) deposits. They have no morphologic expression in relief. (3) Point samples of disturbed pre-Quaternary substratum include bedrock dislocations, fracture disturbances, folds and fissures with no morphological expression. (4) Large glacial rafts, mostly with morphological evidence, are allochthonous masses of dislocated bedrock or Quaternary substratum. (5) Glacial depressions as typical ice scooped landforms are associated with concealed glaciotectonic deformations initiated by lateral pressure of the surged glacier near the outline of depressions. Glaciotectonic disturbances in hard rock appear due to pre-existing tectonic dislocations. Tectonically loosened bedrock blocks can easily be incorporated into the glacier sole and transported subglacially by shearing or proglacially by pushing. Glaciotectonically folded sequences with number of faults in poorly consonsolidated bedrock have a subglacial origin with thin deformed layer in till/sandstone continuum. Deformation in soft drift sediments are formed proglacially by compressive deformation represented by push moraines, either by subglacial ductile deformation by shearing movements represented by drumlins and hummocky moraine.

SESSION NO. 40, 1:30 PM

Saturday, July 26, 2003

T6. Glacier Extent and Ice Thickness in Eurasia at the Last (?) Glacial Maximum (Posters) (*Commission on Glaciation*)

Reno Hilton Resort and Conference Center, Pavilion

40-1 BTH 46 Akçar, Naki

MORAINES IN THE MOUNTAINS OF ANATOLIA: EVIDENCES FOR QUATERNARY ATMOSPHERIC CIRCULATION PATTERNS

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In a study of Quaternary climate change, Anatolia merits special attention for several reasons. As it lies between generally humid and generally arid areas, it has been extremely sensitive to minor changes in atmospheric circulation patterns. Anatolia is located in a tectonically and seismically active zone and it has experienced continuous settlement at least for 10–12 ky, and possesses a rich record of human occupation.

Anatolia is sensitively situated for paleoclimatic reconstructions and there the geological records of paleoglaciations are a key archive to quantify paleoclimate change in the Eastern Mediterranean region (EMR). Glacial deposits are located in the Black Sea, Taurus and Eastern Anatolian Mountains, Uludag and on isolated extinct volcanic cones in the interior parts such as

Mount Erciyes, Süphan, and Ararat. Currently, there is not sufficient information about the past glaciations in Anatolia.

The climate of the EMR is influenced by three main atmospheric systems: the main middle to high latitude westerlies, the mid-latitude subtropical high-pressure systems, and the monsoon climate. To understand the recent Anatolian climate, meteorological data of the last 30 years are analyzed in seasonal windows. Parameters examined are total precipitation, mean atmospheric pressure, mean sunshine intensity, mean temperature, mean moisture, mean vapor pressure and mean evaporation. The positions of the Taurus and Black Sea Mountains form a "weather divide" as well as a corridor. Definite precipitation maxima occur there also due to the orographic effects of these mountains. The focal point of precipitation lies in the northern part of the Eastern Black Sea Mountains and diminishes at a large scale towards south–southeast through the inner parts of the country. A pronounced rain shadow is noticeable in central Turkey and continentality increases from West to East.

The establishment of the jetstreams and jet maxima positions is crucial for our understanding of the moisture transport during a global cold period to the EMR. To reclaim the relevant information, amplitude and frequency of paleoglacier advances in Anatolia need to be quantified by mapping and dating the geometry of the former ice bodies. In this context, the glacial deposits of the Western Taurus and Kaçkar Mountains are the selected key archives.

40-2 BTH 47 Guobyte, Rimante

AN EXTENT AND AGE OF THE LAST GLACIATION IN LITHUANIA

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The reconstruction of the Late Nemunas (Weichselian) glacial limits is based on geomorphological evidence combined with geological data. The new geomorphologic image of Lithuanian surface obtained from aerial photos, does not confirm the traditional model of the Last Glaciation in which within the Late Nemunas Gruda, Ziogeliai and Baltija stadials were distinguished. The Late Nemunas ice advance is considered to comprise two stages, the older Gruda stadial and the Baltija stadial. The Baltija stadial is correllated with Pomeranian Stage. However, they can be distinquished solely on the lithostratigraphic criteria. The Late Nemunas maximum, i.e. Gruda stadial, is dated approximately to 25,000-22,000BP. The maximum extension of the Last Glaciation has been established in southeastern Lithuania. Here, the outhermost Late Nemunas Glaciation boundary has been traced to the foot of the Asmena Highland. In general, it corresponds to the boundary between different glacial landscape types. However, the precise position of the Last Glaciation maximum is still unknown. There are several marginal morainic complexes north-west of the prominent Baltija Highland, which may indicate three or even four ice front phases of the Baltija glacial advance. Well known Southern, Middle and North Lithuanian phasial limits have been traced geomorphologically. The Middle and North Lithuanian ice-marginal moraine ridges as well as the Pajuris ridge were formed at margins of the active ice, whereas, the South Lithuanian ice-marginal moraine ridge indicate ice front position of the retreating Baltija stage glacier. No sites with Late Nemunas interphase deposits have been discovered in Lithuania.

40-3 BTH 48 Kamp, Ulrich

QUATERNARY GLACIATIONS IN THE HIGH MOUNTAINS OF NORTHERN PAKISTAN

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Glaciological and glaciomorphological studies in the high mountains of Pakistan reflect a long research tradition. A comprehensive review of the current state of research on the Quaternary glaciations in this region is presented: Hindu Kush (Chitral, Swat, Ghizar Region), Karakoram (Hunza, Gilgit Region, Rakaposhi, Haramosh, Baltistan, K2 region) and West-Himalaya (Nanga Parbat, Kaghan Region, Deosai Plateau). Until today the results about the extent and the glacial chronologies differ, and especially the reconstruction of a former glacier in the Indus valley is still in discussion. Nowadays improved dating methods allow to revise older scientific views, and new models try to explain asynchronous chronologies, like a 'shift' of the monsoon during the Quaternary as an important regional climatic factor.

40-4 BTH 49 Sarikaya, M. Akif

LATE QUATERNARY GLACIATION OF THE ERCIYES VOLCANO, CENTRAL TURKEY

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Mount Erciyes (3917 m), highest stratovolcano of Central Turkey, is located in the northeastern part of the Cappadocian Volcanic Province. It is characterized by four valleys and one ridge that contain a small glacier and Late Quaternary glacial deposits on its flanks.

1. Aksu Valley is a northwest trending U-shaped valley with a cirque glacier nearly 400 m long. Lateral and terminal moraines together with young ablation moraines and sandur plains indicate three glacial epochs. The oldest and most extensive one is characterized by two well preserved 100 m high lateral moraines at altitudes 2800-2200 m. The next glacial epoch is represented by few lateral moraines and a vast sandur plain containing large andesitic blocks up to 4 m in diameter. The ablation moraines at 3300 m belong to the youngest glacial epoch and are in direct contact with the dead ice detached from the modern glacier.

2. Öksüzdere Valley is a northeast trending narrow glacial valley containing two lateral moraines between 2900-2300 m of altitude. Between these moraines, a younger hummocky moraine complex and a sandur plain is present.

3. Üçker Valley, situated on the east side of the mountain, is a wide cirque area originated from a volcanic amphitheatre. It contains a vast terminal moraine complex covering the present ski area. On the southern rim of the mountain several rock glaciers are also observed.

4. Kirkpinar Valley, situated to the west of Aksu Valley, is covered by a northwest oriented small terminal moraine complex between 2950 and 2750 m of altitude.

5. There are no glacial valleys on the southern side of the volcano. However, on the Topaktas Ridge a few small lateral and terminal moraines are present at altitudes between 3300 and 2500 m.The data available on the modern glacier indicate that the recent glacier retreat probably started at the beginning of the 20th century, becoming faster since the 1930's. Cosmogenic 36Cl dating, based on in-situ accumulation of 36Cl in boulders exposed to cosmic radiation, will be carried out on boulders collected from moraines in order to determine the age of the landforms and to better understand the magnitude and timing of Quaternary glaciations on the Erciyes volcano.

40-5 BTH 50 Schoeneich, Philippe

MAPS OF THE RHONE GLACIER FROM 1841 TO TODAY

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The first reconstruction map of the Rhone Glacier has been published as early as 1841, in the book of de Charpentier, one of the founding works of the glacial theory. Since then, many authors have published maps of the Rhone Glacier, introducting more and more informations: distinction of different glaciations, retreat stages, ice-surface reconstructions. The exhibition will show facsimile prints of the successive maps of the Swiss and French lobes of the Rhone Glacier, from 1841 to the well-known "Jäckli-map", and present the updating-project of the map for the new multimedia atlas of Switzerland. A CD of the scanned maps should be available.

40-7 BTH 52 van der Meer, Jaap J.M.

GLACIATION OF THE NETHERLANDS

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For a long time it was thought that The Netherlands had only been glaciated during the penultimate, Saalian glaciation. In establishing this there had been a discussion on whether differences in till constitution related to one or to two glacial events, but in the end the 'one event' option gained. The extent and characteristics of the Saalian glacial event have by now been well established, although additional information (e.g. on the structure of ice-pushed moraines, or on the timing of deglaciation) is still added. Mapping the extent of glaciation into the adjoining Dutch sector of the North Sea has revealed that the traditional view of the ice crossing over to England is no longer tenable. Instead the mapped ice front rapidly swings north to more or less run parallel to the presentday shore of continental NW Europe. The emerging outline of the former ice sheet forces rethinking of the processes and flow patterns that prevailed in the ice sheet.

By now it has been established that apart from indications related to glaciation in the early and (the early part of) the middle Pleistocene, the northern part of the country and the greater part of the North Sea have also been glaciated during the Elsterian. Mapping the extent of this glaciation has been hampered by the fact that it did not leave a marked outer limit. Mapping the Dutch sector of the North Sea has revealed that during the Weichselian ice stemming from the UK did cover the Northeastern part of that sector.

In the presentation we will present the material relevant to the three glacial events as well as discussing future directions of research.

40-8 BTH 53 Zelès, Vitâlijs

DEGLACIATION HISTORY OF LATVIA

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Latvia occurs at the inner margin of the depositional zone of the of the Scandinavian ice sheet where the main features of glacial topography were created by subglacial processes. During the last glaciation it was affected by the Baltic, Rîga and Peipsijärv ice streams. The ice streams terminated in lobes and tongues separated by interlobate zones. The insular uplands and interlobate ridges represent zones of collision of ice lobes and glacier tongues moving in different directions and through separate neighbouring lowlands. The formation and location of ice lobes and glacier tongues, and their dynamics were originally controlled by subglacial bedrock, but during the last glaciation mainly by the pre-Weichselian topography. The influence of the subglacial topography increased particularly during deglaciation, as ice thickness decreased. A very complex lobate structure, with many small glacier tongues and sub-tongues, existed at the onset of ice-sheet decay. During final phases of deglaciation the ice dynamics were simplified and only the largest radial ice lobes and glacier tongues remained active in the lowlands. This reactivation of the lowland ice lobes and glacier tongues was induced not only by climatic and environmental changes but was also caused by the melting and stagnation of the glacier in the adjacent uplands that improved ice mass balance in the lowlands. As a result of deglaciation of stagnant ice, a complex of superimposed glacial landforms in upland areas formed simultaneously with the glacial landforms continuum created by active ice fluctuations in lowlands. Later, related to melting of stagnant ice sedimentation and landform processes occurred in lowlands. The deglaciation of Latvia was controlled by different glacial geological processes interacting both spatially and temporally. Our recent investigations suggest that only four phases of the deglaciation can be reliably recognised in Latvia. In order of decreasing age, they are the Pomeranian, South Lithuanian, Middle Lithuanian, North Lithuanian and North Latvian phases. The ice sheet finally retreated from Latvia during the Late Weichselian Late-glacial Interstadial, about 14-12 ka BP, but periglacial conditions persisted until the beginning of the Holocene.

40-9 BTH 54 Zreda, Marek

THE EXTENT OF PLEISTOCENE ICE CAP, GLACIAL DEPOSITS AND GLACIOKARST IN THE ALADAGLAR MASSIF: CENTRAL TAURIDS RANGE, SOUTHERN TURKEY

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Recent work in the Aladaglar Massif (37°45' N, 35°15' E) in the Central Taurids Range, resulted in new observations on the extent of the Pleistocene glaciation in this area. The massif, comprising mainly of carbonate rocks of Mesozoic age, covers an area of 800 km^2 between 1100 m and 3756 m of altitudes. Many of the glacial landforms, such as moraines and ice-dammed lake deposits, are well preserved because the fluvial system is poorly developed on the highly permeable karstic bedrock. The ice cap once located in Yedigöller high plateau (3200 m) covered 40 km^2. Ice flowed into the valleys to the northeast, west and east. Based on the smoothed bedrock surfaces, the peak elevation of the ice cap during its maximum extent is estimated to be around ca. 3600-4000 m. Glacial landforms suggest the existence of 7 episodes of glacial advances and retreats. Young, fresh looking deposits are above 1800 m; older moraines extend further down to 1400 m. The Hacer valley has the largest number of moraines. Outwash deposits at the mouth of this valley extend down to 1200 m. Apart from the lateral and terminal moraines, dekameter-sized erratics are observed on top of the glacially sculpted bedrock. Today, a small glacier remnant, measuring ca. 1 km^2, exists in the southwestern part of the Yedigöller plateau; it is in the form of dead ice buried under rock debris. Numerous freshly formed kettle holes, ice caves, glacial meltwater streams, stone circles and girlands represent glacial and periglacial processes. On the

eastern flank of the Yedigöller plateau, at around 1800 m, moraines overly the doline fields of typical tropical karst (cockpit type). At higher elevations, all pre-glacial karstic landforms have been destroyed and many of the sinkhole type caves are blocked by till. However, the accesible caves in the form of vertical shafts usually terminate at till. Many of the open shafts above 2200 m contain snow, firn and ice that contains gas inclusions and layers of till. A thickest (up to 120 m) record of snow, firn and ice was discovered in a vertical karstic shaft located at ca. 3400 m. Preliminary results from our two years of field work in the Aladaglar show that the Pleistocene glaciation was much more widespread than previously thought. Future work will include cosmogenic ^{36}Cl dating of morainic boulders, ^{14}C dating of glacio-lacutrine material and U/Th dating of speleothems found within ice in the karstic caves.

SESSION NO. 41, 1:30 PM

Saturday, July 26, 2003

T12. Correlation of Ice, Marine, and Terrestrial Sequences using Tephrochronology (Posters) (*Commission on Tephrochronology and Volcanism*)

Reno Hilton Resort and Conference Center, Pavilion

41-1 BTH 78 Eastwood, Warren John

HIGH PRECISION TEPHROCHRONOLOGICAL APPLICATIONS USING LASER ABLATION ICP-MS

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Grain specific major and trace element geochemistry by EPMA and Laser Ablation ICP-MS on single volcanic ash shards from the ~3300 ^{14}C yr BP or mid-second millennium BC 'Minoan' eruption of Santorini (Thera) is presented in this poster. The analysed tephra was extracted from a sediment core retrieved from Gölhisar Gölü, a small intramontane lake in southwest Turkey at a depth of 275 cm. The importance of accurate grain specific major and trace element geochemical data is examined and discussed in light of new geochemistry results of ice embedded tephra from the GRIP and GISP ice cores.

41-2 BTH 79 Kuwabara, Takuichiro

MIDDLE-TO-LATE QUATERNARY VOLCANIC ACTIVITY REVEALED BY TEPHRA-LOESS SUCCESSION OF THE DEPOSITIONAL BASIN: AN EXAMPLE FROM OSORE-ZAN VOLCANO AND TANABU LOWLAND, SHIMOKITA PENINSULA, NORTHEAST JAPAN ARC

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The Quaternary volcano of Mt. Osore-zan of the northeast Japan arc exceeds 800 m in maximum height and is accompanied by the Usori Caldera of 5 km in diameter. Several previous works clarified the stratigraphic succession of the volcanic body, but these studies obtained no chronological data on the explosive volcanism. Using the tephrochronology, we therefore identify the explosive eruptions of this volcano and show their ages, behavior, and volumes as below.

The Tanabu Lowland of the northeast Japan arc is a tectonic basin on the east (the downwind side) of the Osore-zan Volcano. Upon the marine and fluvial terraces of this lowland, many tephra layers, which are traced to the Usori Caldera as source vent, and several paleosol layers, which were formed in loess, are accumulating. Five middle-to-late Quaternary eruption sequences named the Tanabu-D to Tanabu-A and Ohatagawa from older to younger ones are identified about the Osore-zan Volcano, through the recognitions of the loess as the sequence boundaries in the above tephra-loess succession.

During the Tanabu-D eruption cycle, one pumice-flow deposit erupted to eastern foot of the Osore-zan Volcano before MIS (marine isotope stage) 10.

For the eruption cycles of the Tanabu-C to Tanabu-A, the plinian eruptions supplied five pumice-fall deposits to the Tanabu Lowland and three pumice-flow deposits to the valleys 45 m deep at northern to eastern foots of the Osore-zan Volcano at MIS 8. The Usori Caldera had already been occurred before these eruption cycles, and is thus covered with these pumice-flow deposits. Also, seven stratified ash-fall deposits erupted to this lowland area through the phreatomagmatic eruptions. The eruption volumes of these sequences are estimated to be 1.9, 0.3, and 1.5 km^3, respectively.

The Ohatagawa eruption cycle provided northern foot of the Osore-zan Volcano with one lithic tephra layer of 0.1-km^3 volume after MIS 5.

The Osore-zan Volcano had repeated many explosive eruptions and supplied volcanoclastics of 3 to 4 km^3 in volume during MIS 8, but there are few explosive eruptions at this volcano after MIS 8.

41-3 BTH 80 Juvigné, Etienne

FIRST TEPHROSTRATIGRAPHICAL STUDY OF THE ICALMA–GALLETUE REGION (CHILE, 38° S –71° W) – TWO PUMICE LAYERS MARKING STRONGLY THE HOLOCENE LANDSCAPE

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This study, part of the S.S.T.C. project EV/10/12B 'A continuous Holocene record of E.N.S.O. ("El Niño Southern Oscillation") variability in Southern Chile', outlines the tephrostratigraphy of six outcrops and two peat bogs in Icalma and Galletue lakes' watersheds (Chile, 38° S –71° W) where several tephra layers have been detected and analysed. Two important pumice layers are unequivocally discernible in this landscape and have been studied using several techniques: polarising microscope, electron microprobe and isopach mapping. Plagioclase (andesine), orthopyroxene (hypersthene), clinopyroxenes (diopside and Ca–rich augite), titanomagnetite and fluorapatite are common to both pumice layers. Moreover, the lower pumice fall has also two distinct olivine populations, Fo32-35 and Fo82-85, one of which (Fo82-85) did not crystallise in equilibrium with the magmatic liquid. Glass shards from the upper fall–out deposit have a K–rhyolitic composition while glass shards from the lower one are rhyodacitic. Mineralogical differences and isopach's mapping allow us to propose different origins for the two pumice layers and to make correlations between the outcrops and peat deposits. The lower tephra erupted from Llaima volcano during it's second eruptive phase in the first half of the Holocene (Naranjo & Moreno, 1991), while the upper one, on the NW flank of Alpehué Pumice (Naranjo et al., 1993), erupted from Caldera Sollipulli at about 2900 y.B.P. Analyses of other thinner tephras complete this work and allow us to propose the first complete Holocene tephrostratigraphy of Icalma-Galletue area.

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41-4 BTH 81 Juvigné, Etienne

A HOLOCENE RECORD OF ENSO CHANGES IN LACUSTRINE SEDIMENTS FROM MERIDIONAL CHILE (38-40°S)

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The "El Niño Southern Oscillation" (ENSO) is one important process affecting the present-day climate of the Earth. A better understanding of the ENSO phenomenon requires detailed studies on past records in several contrasted areas. At present, the effects are not well-known for southern South America, although there are indications that El Niño induces precipitation anomalies in Meridional Chile. The aim of the Belgian ENSO-Chile team is to reconstruct the ENSO influence recorded in lacustrine sediments, and this through the Holocene. Two lakes from the Chilean Lake District (Icalma, Puyehue) were cored after seismic reconnaissance surveys. The sediments are analysed through a multi-disciplinary approach including physical properties, magnetic susceptibility, sedimentology, mineralogy, tephrochronology, palynology and micropaleontology. The age model is based on natural radioactive isotopes measurements (210Pb, 137Cs, 14C), calibrated by varve counting and tephrostratigraphy. Our hypothesis is that precipitation intensities affect the erosion rate in the watershed and, consequently the terrigenous supplies delivered to the lake. The temporal changes of the terrigenous supplies could be potentially recorded by different proxies (e.g., grain-size, magnetic susceptibility, detrital vs biological sedimentary content) that have yet to be tested. The present supplies delivered to the lakes have been calibrated using geological, geomorphological and botanical fieldworks in the watersheds (winter 2001-2002). Analyses are still in progress. We have now to convert the sediment cores into a continuous time record, taking out any punctual event like volcanic or seismic-induced layers that are particularly abundant in Icalma record. At present it seems that the sediments from lake Puyehue constitute the best (at least less disturbed) key-record for our paleoclimate purpose.

41-5 BTH 82 Boes, Xavier B.

RESEARCH FOR CONTINUOUS PALAEOCLIMATE RECORD OF ENSO IN SOUTHERN CHILE (LAKE DISTRICT)

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A research for a continuous Holocene ENSO record is actually carried out in Lake District area in southern Chile. Our purposes are to understand the sedimentological model deposition and, to build-up an age-model based on varve-counting. Overlapping thin-sections were prepared from the short cores by freeze-drying method. Their microscopic observations allow micro-sedimentological investigation and varve-counts at high resolution. The two selected lakes (Icalma Lake, 38°50'S; Puyehue Lake 40°40'S) present high-resolution laminated deposits. The sediment of Puyehue Lake is composed of couplets (light spring/summer layer and dark autumn/winter layer). Numerous tephras are interbedded so that they can be dated using varve chronology, with a calibration study of tephra thickness. Tephras in Icalma Lake is much more developed than in Puyehue Lake. The core ICA-I contains about 26 tephra beds (interflow site), whereas only 3 tephra beds were recognized from the thin-sections in PUII (interflow site). Consequently, we focused on the Puyehue Lake interflow site (PUII), because this coring site shows a more continuous "varve" record along with a few tephra beds. In addition, PUII core also present a liquefied facies (between 3.5 and 8.5 cm depth) that has to be taken in consideration before to build-up an age-model. According to varve chronology this homogeneous event is related to the major regional 1960's palaeoseismic event (9.5 magnitude), that reworked 5 cm sediment thickness (c.a.67 years). Based on this correction, an age-model was adjusted until AD 1330, and annual accumulation rates were calculated (0.4 to 1.2 mm.yr-1). Theses results have to be compared with those obtained by other dating methods (210Pb, 137Cs, 14C), and with the historic data.

41-6 BTH 83 Thouret, Jean-Claude

LATE PLEISTOCENE AND HOLOCENE TEPHROSTRATIGRAPHY AND CHRONOLOGY IN SOUTHERN PERU

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Late Pleistocene tephras have been dated on the west flank of Nevado Sara Sara between ca. 49,200 and 44,500 yr BP, and on the south flank of Yucamane ca. 44,000 yr BP. Tephra from Coropuna was found in a soil section that yielded 14C ages of ca. 27,200-37,370 yr BP. The Misti edifice comprises a stratovolcano termed Misti 1, overlapped by two stratocones termed Misti 2 and 3 (°Ü112 ka), and a summit cone Misti 4 °Ü11 ka. Sustained explosive eruptions have delivered at least 12 pumice falls during the past ca. 50,000 years. Late-Glacial and Holocene tephras were found in various peat-bogs. Seven tephra-fall deposits from Huaynaputina, Misti, and Ubinas were deposited over the past 15,000 years. Two recent tephra-fall deposits are present around the Ticsani domes (a dacitic pumice-fall deposit of 0.4 km3 has been dated ca.11,600 yr BP; bombs and pumice preceeding the youngest dome overlie the AD 1600 Huaynaputina tephra. The recent explosive behaviour of Ubinas produced several tephra-falls, including two widespread plinian pumice falls. The pumice-fall deposit >7840 yr BP and the ca. 980 yr BP-old pumice-fall deposit have a volume >1 km3 and may be linked to the formation of the summit caldera. The peat sequence in the Sallalli peat-bog 10 km SE from the Nevado Sabancaya includes 4 tephra-fall layers: the AD 1600 Huaynaputina ash, an AD 1200-1400 Sabancaya/Ampato ash, a thin black ash probably from Misti ca. 2,370 yr BP, and a Sabancaya/Ampato ash of ca. 8,550 yr BP. Recent tephra beds were also found that were deposited : a) during the Inca Empire (Misti eruption); b) in AD 1600 Huaynaputina plinian eruption produced voluminous (12 km3) pumice-fall deposits, along wit pyroclastic flows, and surges that disrupted life ~60 km around the volcano. Persistent eruptions of Nevado Sabancaya have dispersed a small volume of ash from May 1990 until 1998 as far as 20 km towards the east.

41-7 BTH 84 Pyne-O'Donnell, Sean D F

THE FACTORS AFFECTING DISTRIBUTION AND PRESERVATION OF MICROTEPHRA PARTICLES IN LATEGLACIAL SEDIMENTS

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Tephrochronology offers great potential for the precise correlation of late Quaternary sedimentary sequences. It is especially useful during the last glacial-interglacial transition (LGIT) (14-9 14C ka BP) where radiocarbon dating is hampered by a number of radiocarbon 'plateaux'. Recent years have seen a number of new discoveries in the extent of LGIT tephra distributions throughout Europe. Many of these advances are due to new techniques in the extraction of far-travelled microscopic tephra (microtephra) particles of <100 micrometres in size. The work presented here stems from these discoveries where it was noticed how widely one particular and highly visible tephra varied in its within-basin distribution.

A number of field sites of varying catchment sizes have been examined in Scotland: two sites on the Isle of Skye (Loch Ashik and Loch Druim) and a site on Mull (Loch an t'Suidhe). The principle hypotheses being examined in this work are that tephra distributions and concentrations are controlled by catchment size and proximity to basin inputs. Loch Ashik and Loch Druim represent two extremes in lake area to catchment ratio: Loch Ashik has an extensive catchment with two main input areas and a single output, while Loch Druim is an isolated basin possessing virtually no catchment and no inputs/outputs.

A three-dimensional depositional model based on data gathered from these sites is in development that can be used to predict coring positions for optimal tephra shard recovery in other basins. The Loch an t'Suidhe site will make a good test of this model as it has a catchment size between that of Loch Ashik and Loch Druim with shard concentrations predicted to reflect this.

A number of consistent peaks in tephra concentration have been found throughout the cores examined thusfar, though positive identification by electron probe microanalysis (EPMA) has yet to be performed. From their stratigraphic context, however, it is reasonable to assume they are the Borrobol Tephra (12.26 14C ka yr BP), the Vedde Ash (10.3 14C ka yr BP or 11.98 ka GRIP ice core yrs BP) and Saksunarvatn Ash (9.0 14C ka yr BP or 10.24 ka GRIP ice core yrs BP. Additionally, there is one further as yet unidentified Holocene tephra.

41-8 BTH 85 Turney, Chris

DEVELOPING A IRISH TEPHROCHRONOLOGICAL FRAMEWORK FOR THE LAST GLACIAL-INTERGLACIAL TRANSITION (LGIT; 14-9 KA 14C BP)

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The last glacial cycle drew to a close in a series of very abrupt and pronounced climatic oscillations, terminating in a sustained shift to warmer conditions at the start of the present (Holocene) interglacial. High-precision correlation of ice, marine and terrestrial sequences from this period is hampered by problems inherent in radiocarbon dating, especially because of marked fluctuations in atmospheric 14C content. Tephrochronology offers the potential to solve some of the geochronological and correlation problems, because it provides time-parallel horizons that can test ideas about the correlation of sequences independently of the radiocarbon method. It can also be used to establish the magnitude or errors associated with the radiocarbon method. Recently, innovative new approaches have been developed for the detection of tephra horizons within sedimentary sequences that are not visible to the naked eye (microtephra or cryptotephra horizons). As a result, the provenance of known eruption events have been significantly expanded. Furthermore, these methods have led to the detection of previously unidentified eruptive events, which increase the scope for using tephrochronology for correlation purposes. Here we report on the application of these approaches to the investigation of LGIT sites in Ireland. Data are presented for three LGIT sequences in Northern Ireland: Roddans Port, Long Lough and Loch Nadourcan. Several tephra horizons have been detected, some of which are new finds for the British Isles. The potential for correlating Irish palaeoclimatic datasets to those developed throughout the North Atlantic region will be discussed.

41-9 BTH 86 Hoek, Wim Z.

A COMBINED BIO- AND TEPHROSTRATIGRAPHIC CORRELATION OF LATEGLACIAL PALYNOLOGICAL RECORDS IN THE NORTHWEST EUROPEAN LOWLAND REGION

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Biostratigraphy and 14C dating have been the major tools for the correlation of numerous Lateglacial palynological records from the northwest European lowland. Detailed changes in spatial vegetation patterns over time can be constructed based on these correlations. The region is characterised by the occurrence of a predominantly sandy substratum, consisting of glacial, glacio-fluvial, fluvial, and aeolian sediments. This is the type region for the sub-division of the Lateglacial, where the classic Bølling and Allerød interstadials have been recognised since the late 1940s. The extensive dataset suggests that vegetation changes, at least in this region, occurred synchronously, but is this really the case?

Biostratigraphic correlations are, naturally, not the way to reveal a-synchronous shift in vegetation, and due to the limitations associated with radiocarbon dating such as 14C-plateaux the incomplete extension of the dendro-calibration curve and site-specific factors, this method is not the most reliable method to give accurate age estimates during this time-period. Therefore, other methods are required for time-stratigraphic correlation to evaluate synchroneity between palynological records. Unfortunately, laminated sequences are rare in this region, but the few sites that show annual resolution are investigated in great detail, and if vegetation changes appear to have occurred synchronously, biostratigraphy can be used for correlation between these sites.

The recent discovery of Lateglacial micro-tephra horizons in this region opens up a new potential for the precise correlation of sequences in widely separated localities, and accordingly for testing the synchroneity of vegetation changes. In this way, the value of biostratigraphy as a tool for time-stratigraphic correlation can be evaluated. Biostratigraphy can also be used to trace known micro-tephra horizons that have been previously undiscovered in this region. Thus, by interlinking terrestrial sites that have annual laminations, detailed biostratigraphy, 14C time-control, and isochronous marker horizons such as one or more known tephras, a comprehensive picture of vegetation changes can be compiled which can then be directly compared to other European palaeoclimatic records including marine and ice core sequences.

41-10 BTH 87 Davies, Siwan M.

RADIOCARBON DATING THE BORROBOL TEPHRA IN SWEDEN AND THE DETECTION OF NEW EARLY HOLOCENE TEPHRAS

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Analyses of two infilled lakes in Blekinge, south east Sweden indicate the presence of at least three tephra horizons of Termination 1 and early Holocene age. Geochemical analyses confirm the presence of the Borrobol Tephra, the Askja Tephra (10,000 ^{14}C yr BP) and one previously unreported tephra of Icelandic origin. The relatively unknown Askja Tephra and the newly discovered Hässeldalen Tephra are stratigraphically placed at the Younger Dryas/Preboreal transition. The Borrobol Tephra is a recently identified ash layer that has been outlined as a potentially significant marker horizon for assessing the precise timing of the initial warming in different parts of Europe at the start of Greenland Interstadial 1. Until now, the distribution of this tephra was confined to Scotland and the Icelandic plateau. Extending the geographical limits to Scandinavia illustrates that the Borrobol Tephra is far more widespread than previously realised. This poster demonstrates the suitability and success associated with the extraction techniques for tracing micro-tephra horizons in areas distal to volcanic sources.

The age of the Borrobol Tephra, however, is poorly constrained with current radiocarbon age estimates from a site in northern Scotland and a marine record from the Icelandic plateau showing significant differences. New results obtained from a comprehensive radiocarbon dating exercise on terrestrial macrofossils from one of the sequences in south eastern Sweden are presented for the first time, enabling a rigorous underpinning of the age of the Borrobol Tephra. By wiggle matching the series of ages to the Cariaco Basin data-set, using a Bayesian probability approach we derive an age estimate of c. 13.9 Cariaco varve ka BP for this volcanic event which is considerably younger than previous age estimates. According to the Cariaco record, such an age estimate places this tephra within the early Allerød/GI-1c or the Older Dryas/GI-1d. A number of important questions are raised and outlined in relation to these new results, which require further investigation if tephrochronology is to be used successfully as a precise correlation tool during this time period.

41-11 BTH 88 Mortensen, Anette K.

ASH LAYERS FROM THE LAST GLACIAL TERMINATION IN THE NGRIP ICE CORE

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Deposits from explosive eruptions leave marker horizons – important for correlating terrestrial, marine and ice records. Ice cores contain the chemical trace of eruptions, but in the absence of historical records these are difficult to correlate. Where ash particles are present, chemical analysis of the juvenile material (glass) makes correlation more significant and source volcanoes can often be identified.

A number of ash layers were identified in the GRIP core and some correlated with other occurrences. More recently a systematic study was done on the transition zone (ca 16-10 thousand years BP) in the NGRIP core. Based on continuous sulphate, calcium and dust profiles, 95 samples were selected, each covering an area of about 1 cm2 and spanning 1-2 year accumulation. Samples were examined and analysed using SEM-EDS and WDS methods. Twelve samples had a number of ash grains up to 50 micron in diameter and eight samples had one ash particle. Two of the layers, Saksunarvatn 10180 and Vedde 11980 ice core years in age, can be correlated with the GRIP core.

All the layers appear to be of Icelandic origin – providing a valuable extension of Icelandic tephrochronology with 5 rhyolitic, 4 basaltic and 3 intermediate layers. The frequency of ash layers found in the NGRIP core is 2,4 –3,5 layers/ky in Bølling-Allerød and Younger Dryas, but only one layer was found in the first 1300 years of the Holocene. This may indicate a significant activity

decrease in explosive volcanism due to the decreased Iceland ice cover or change in the prevailing wind patterns in the early Holocene.

There is marked difference in the excess sulphate in the ice – considered to be the volcanic signal – between the B/A and the colder periods, GS-2 and Y-D. During the B/A the excess sulphate is low for both basaltic and rhyolitic eruptions, but during the colder periods it is significantly higher. In the light of the importance of sulphates in climatic forcing it is important to establish, if this is genuine or a reflection of how excess sulphate is estimated.

41-12 BTH 89 Fukuoka, Takaaki

MICRO TEPHRA PARTICLES IN H15 ICE CORE, ANTARCTICA -POSSIBLE TEPHRO-CHRONOLOGICAL DATING FOR ANTARCTIC ICE CORE-

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Antarctic glacier ice records the information of climate change, huge volcanic activity in the world etc, during more than 350 thousand years in Quaternary period. However the accurate age of ice cannot get easily. Tephra particles precipitate on surface snow of Antarctica in short period. Snow convert into ice gradually. Tephra in glacier ice move with the ice. Therefore we can get the age of ice form the eruption age of tephra. To get the eruption age, we have to know the source volcano of tephra, because amount of tephra grains lacks for the direct age determination. Size of ice core is too small to collect enough amount of tephra grains for dating the eruption age. When we found micro tephra particles in ice cores and prove the source volcanoes for those particles, we can get the age of ice. So, we have to confirm the existence of such tephra particles in ice cores for establishment of this ice core dating method.

We found 10 micro m size micro tephra particles in the several positions of H15 ice core(~60 m long), Antarctica. SEM observations indicate these particles have typical shape of pieces of broken glass. And also EDS analyses of these particles show strong Si peak. The most positions of micro tephra layers in the core are correlate to the high electric conductivity peaks on the ice core scan and to the points of high SO42- contents (volcanic signals) in the ice core. These micro tephra particles were possibly derived by worldwide volcanic activity such as 1991 eruptions of Pinatubo volcano, Philippine.

41-13 BTH 90 Wastegård, Stefan

TOWARDS A HOLOCENE TEPHROCHRONOLOGY FOR SWEDEN

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Studies of peat sequences in south and central Sweden have yielded a detailed tephrochronology framework for the middle and late Holocene. Seven tephra layers of Icelandic origin have been detected and geochemically characterised so far. All layers are invisible to the naked eye and extraction techniques involve combustion and acid digestion.

Rhyolitic tephra from Plinian eruptions of the Hekla volcano on SW Iceland dominates and the most significant isochrones are Hekla-4 (c. 4260 cal. yr BP), Hekla-Selsund/Kebister (c. 3750 cal. yr BP), Hekla-3 (c. 3000 cal. yr BP) and Askja AD 1875. These tephras seem to be widespread in Sweden, possibly together with the Hekla-5/Lairg A tephra (c. 7000 cal yr BP). This tephra has been geochemically confirmed in one site, the Klocka bog in central Sweden which so far is the most complete site with five geochemically characterised tephra layers. These well-dated tephras have been used in combination with radiocarbon dates in order to construct age-depth models for cores and sections from ombrotrophic bogs. The Askja-1875 tephra is especially useful for dating recent peat sequences.

Two new late Holocene tephra horizons (the Stömyren tephra, c. 2100 cal .yr BP and the Gullbergby tephra; c. 2700 cal. yr BP) were identified in single sites and are so far less valuable as marker horizons, but are potentially important for the future. The Gullbergby tephra may be an important tephra for correlating peat sequences in Sweden. It is situated at a distinct transition from highly humified peat to less humified peat, which may coincide with the climatic deterioration at the Subboreal/Subatlantic boundary. The source of this tephra is the Torfajökull volcano. The source of the Stömyren tephra is as yet unknown.

Table 1. Geochemically confirmed tephras horizons found in peat in Sweden.

Name of tephra	Age (AD/cal yr. BP)	Source volcano
Askja-1875	AD 1875	Askja
Stömyren	c. 2100 BP	?
Gullbergby	c. 2700 BP	Torfajökull
Hekla-3	c. 3000 BP	Hekla
Kebister/Hekla-S	c. 3750 BP	Hekla
Hekla-4	c. 4260 BP	Hekla
Hekla-5/Lairg A	c. 7000 BP	Hekla

41-14 BTH 91 Margari, Vasiliki

IMPROVING MEDITERRANEAN TEPHRA STRATIGRAPHY: RESULTS FROM A LONG TERRESTRIAL SEQUENCE ON LESVOS ISLAND, GREECE

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A 40.2m lake sediment core was recovered from Megali Limni on Lesvos Island, Greece. Six tephra layers have been identified and their chemical composition determined using electron probe microanalysis on single glass shards. The composition of the first tephra layer (1.8m depth) suggests an origin from the island of Santorini with its best corresponding eruption being the Cape Riva (or Y2) at cal. 18 ka BP. The second tephra layer (7.6m) originates from the Campanian area in Italy and corresponds to the most widespread eruption in the Mediterranean (the Y5 tephra layer), the Campanian Ignimbrite eruption at cal. 39 ka BP. The next two layers (10.5m and 12.0m) originate from the Island of Nisyros in Greece and correspond to the Upper Pumice and Lower Pumice eruptions, respectively. In the marine record of the Mediterranean Sea the chronological position of the 'Nisyros Ash' has been calculated by linear extrapolation of the sedimentation rate in the stratigraphy of the Y zone, between the Y2 and Y4 tephra layers, i.e. between 21 and 30 ka. The recovery of the Y5 tephra layer and the Nisyros Ash for the first time in the same sequence has important implications for establishing the chronological framework of the Nisyros eruptions. The fifth tephra layer (24.25m) corresponds to "the most distinctive tephra layer found in deep-sea cores" (Keller, 1981), correlated with the Green Tuff eruption (or Y6) on the island of Pantelleria at cal. 50 ka BP. Due to chemical weathering following the deposition of the last tephra layer (28.41m) its origin could only be determined qualitatively from the Hellenic Arc with no specific corresponding eruption found. At present, this core represents the longest distal tephra sequence found in a terrestrial setting in the eastern Mediterranean. The findings of, in particular, Campanian and Pantelleria ashes in this locality considerably extend the confirmed Northerly and Easterly distribution of these ash units. Studies based on Mediterranean deep-sea sediments, as well as continental areas, have been undertaken for at least three decades and today a detailed tephrostratigraphy with about thirty tephra markers exists. However, the identification and analysis of these six tephra layers in a single sequence has provided very important evidence for their stratigraphic position and chronology.

41-15 BTH 92 Pyle, David M

Y5 TEPHRA FROM THE CAMPANIAN IGNIMBRITE ERUPTION: A KEY CHRONOSTRATIGRAPHIC MARKER FOR THE MEDITERRANEAN AND EASTERN EUROPE

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The ca. 39 to 41,000 yr BP eruption of the Campanian Ignimbrite from the Phlegrean Fields, Central Italy, left a widespread tephra marker (known as the Y5 ash) that has been recognised in marine sediment cores across the Eastern Mediterranean. Recent work in the north-eastern Aegean and in south-western Russia confirms that a considerable portion of the Y5 ash was dispersed towards the North and East during this eruption, with fine-grained tephra deposited more than 2500 km from the known source region. In the Don River region of south-west Russia, deposits that are correlated with Y5 on the basis of detailed chemical analysis are found both in well-characterised archaeological contexts (the Paleolithic sites of Kostenki-Borschevo), and in undisturbed geological contexts nearby. The extent of dispersal of ash during the Campanian Ignimbrite eruption confirms this event as the largest known volcanic eruption in Europe of the past 100,000 years.

The Y5 ash represents a key event in the linking of marine sediment and terrestrial archaeological records. We present the results of ongoing work on the chemical and physical characterisation of the volcanic ash, and our interpretations of the significance of the ash-layer for the long-range transport of ash in large volcanic eruptions, and the chronology of the Upper Paleolithic.

41-16 BTH 93 Palmer, Alan S

ELUCIDATING THE EARLY PLEISTOCENE HISTORY OF THE EASTERN WANGANUI BASIN, NEW ZEALAND USING MAJOR SILICIC TUFFS FOR TIME AND ENVIRONMENTAL CONTROL

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Thick and sandy or gravelly silicic tuffs are a feature of Early Pleistocene deposits in the southwest of the North Island of New Zealand. They were sourced from major eruptions of rhyolitic tephra and ignimbrite from Mangakino, 50 km northwest of the most recently active Taupo volcanic centre.

The Early Pleistocene of the western and central part of the Wanganui Basin has been well documented. The stratigraphy and chronology has been interpreted in both sequence stratigraphic and climatic frameworks. In brief, low stands were terrestrial erosion or beach gravels and sands, transgressions were inner shelf sands, and high-stands outer shelf muds. No such framework exists for the eastern basin.

The tuffs have been correlated using their distinctive glass chemistry, to dated events at ca. 1.6, 1.5, 1.29, 1.05, 0.85 and 0.7 Ma. The first arrival of the water borne pumice, if concentrated and voluminous, closely follows the dated eruption.

The tuffs allow a basin-wide chronology to be developed. Prior to 1 Ma, the eastern basin was a wide wave-dominated, shallow sea in interglacial periods and a sand dominated fluvial plain in glacial periods. Although the basin was subsiding, the accommodation space was constantly reduced by rapid sedimentation. The Potaka Pumice at 1Ma was responsible for considerable progradation of the coastline. By 0.85 Ma, although subsidence continued, the sea rarely transgressed over the coastal foreland except for development of estuaries. Subsidence continued until at least 0.7 Ma, but now the environment was fluvial gravel aggradational braid-plains in the glacial periods, and fluvial over-bank sands muds and lignites in the interglacials. Uplift began soon after 0.7 Ma, and from 0.5 Ma to the present day , fluvial aggradation terrace systems have developed.

Over the last 0.7 Ma, the sediments have been rapidly uplifted, faulted, folded and tilted up to 70 degrees as several asymmetrical anticlines have grown.

41-17 BTH 94 Suzuki, Takehiko

TEPHROCHRONOLOGICAL STUDY OF THE MIDDLE PLEISTOCENE FLUVIAL SURFACES IN THE KANTO PLAIN, CENTRAL JAPAN: A KEY GEOMORPHIC SURFACE OF MARINE ISOTOPE STAGE 17 TO 16

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Two middle Pleistocene tephras HBP and KMT derived from the volcanoes in the Hida Mountains are favorable marker tephras for the chronological study of this time in the Kanto Plain. On the basis of many radiometric ages and stratigraphic positions in the marine sediments of the Boso peninsula, the ages of HBP and KMT are estimated at 0.38-0.41 Ma (MIS 11) and 0.58-0.69 Ma (MIS 17.3-15.3), respectively. Judging from the stratigraphic relation with KMT, dissected fluvial surfaces, that is, the Azuyama and Sayama surfaces in South Kanto and the Kitsuregawa upper surface in North Kanto are correlative, and it is assumed that they were formed a few tens of thousands of years preceding the deposition of KMT. Preservations of these surfaces are well, and initial alluvial fans of them seem to be broad. Referring to the geomorphic development of late Pleistocene, alluvial fan deposits constituting these surfaces are most likely formed during the period from MIS 17.3 to 16.2 of a transition from interglacial to glacial. This term is specific for the geomorphic development of middle Pleistocene, characterized by the long duration keeping the stable conditions for the formation of broad fans.