



## XVII INQUA Congress (2007)

### Introduction

We need no reminder that the Quaternary provides us with enormously rich records of past environmental and climate changes at time scales ranging from sub-annual to several million years. Knowledge of the Quaternary past is relevant more than ever before, as rising greenhouse gases drive climatic boundaries beyond the Quaternary envelope while rising tides of humanity push the ecosphere towards an impoverished and uncharted state. The world approaches a crossroad.

In uncharted seas, sailing directions are taken from historical knowledge: the longer history of climate, the biosphere and humankind is very much the realm of the Quaternarist. The challenges are clear; our goal is that INQUA 2007 enhances our global ability to meet them.

Every 4 years the international Quaternary community gathers together for the INQUA Congress. The XVII event will be the third INQUA Congress in the southern hemisphere, this time in Australia, which owing to its latitude and lack of tectonics, is the flattest, reddest and overall the driest continent. Australia's Quaternary deposits, although thin by comparison with those in active tectonic regions, are of high significance for understanding the evolution and fragility of our environmental resources. The same is probably true for most nations, although their Quaternary records may differ in extent, character and chronology. In this light, we particularly welcome the international exchange of scientific knowledge and culture that will take place throughout the XVII INQUA Congress.

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Congress email address: [inqua2007@icms.com.au](mailto:inqua2007@icms.com.au)

Abstracts

INQUA 2007 Abstracts

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**Environmental Responses to Holocene Climate and Cultural Changes in South-central Chile**

Ana M Abarzúa<sup>1</sup>, Mario Pino<sup>2</sup>, Tom Dillehay<sup>3</sup>

<sup>1</sup>*Instituto de Geociencias, Universidad Austral de Chile, Chile*

<sup>2</sup>*Instituto de Geociencias, FORECOS, Universidad Austral de Chile, Chile*

<sup>3</sup>*Department of Anthropology, Vanderbilt University, United States*

The Araucanian Chilean Region represents an interesting area to evaluate the human impact in the landscape, relationships with the climate changes during the Holocene. The present work describes the environmental changes in Purén-Lumaco valley (38°S) in answer to the climate change and the intensive occupation by indigenous people (pre-Mapuche and Mapuche populations) during the Holocene.

Sedimentological, palynological, and charcoal results from sediments cores of Purén peat-bog site, shows the vegetation and land use changes in the landscape previous to human occupation. The valley floor constituted an extent lake surrounded by closed Lauraceae forests, associated to plans of pollen of *Nothofagus obliqua* type until ~10,500 <sup>14</sup>C years BP. The most evident environmental change in the Purén record is the expansion of a Myrtle forest, drained abruptly the lake into a swamp/bog, reflecting the dry/warm climate condition of early Holocene in south-central Chile. Later, the sediments indicate lacustrine levels with high variability, the increase of charcoal particles, and the presence of aquatic species, associated to species of Valdivian forests, with climatic conditions similar to present ones. This pollen spectrum contrasts with a strongly disturbed landscape of the area. Actually, the valley floor constitutes a complex peat-bog system dominated by grasses species and exotic forest species (*Pinus radiata* and *Eucalyptus* spp.).

Some archaeological antecedents in the area document the human development as of 7000 <sup>14</sup>C years BP. The greater archaeological characteristic present in the valley is the “kuel” (a Mapuche concept that means ceremonial human earth accumulation). The presence and extension of almost 300 “kuel” in the valley reflect a certain level of social and economic development that, partly, explains why the region was a center of resistance to Spanish colonization in the XVI–XVII centuries.

The influence of climate and other natural processes, and human impact on Holocene environments provide a better basis for understanding and managing the present landscape in the area, and prediction and modeling of future changes in the climate. Almost the absence of native forests in the area makes urgent strategies for the recovery and rehabilitation of a relict ecosystem that today represents their regional analog only in the tops of the Chilean Coastal Range, locally called Cordillera de Nahuelbuta.

0503

**The Potential Application of Trace Element Analysis to Distal Tephrochronology**

Peter M Abbott<sup>1</sup>, Siwan M Davies<sup>2</sup>, Nicholas J G Pearce<sup>3</sup>, Jørgen

Peder Steffensen<sup>4</sup>, Stefan Wastegård<sup>5</sup>

<sup>1</sup>*Swansea University, United Kingdom*

<sup>2</sup>*Department of Geography, Swansea University, United Kingdom*

<sup>3</sup>*Institute of Geography and Earth Science, University of Wales, Aberystwyth, United Kingdom*

<sup>4</sup>*Department of Geophysics, University of Copenhagen, Denmark*

<sup>5</sup>*Department of Physical Geography and Quaternary Geology, Stockholm University, Sweden*

The majority of distal tephrochronological studies rely upon the characterisation of the major element composition of glass shards, using electron microprobe analysis, to correlate tephra horizons between sequences. However in some situations this information cannot be used adequately to discriminate between tephra horizons. This issue is becoming more pertinent due to the increased use of tephrochronology as a tool to link diverse climatic records and the continual recognition of new tephra horizons. One of the potential solutions to this problem is improving the geochemical characterisation of tephra horizons using trace element analysis. Laser ablation inductively coupled plasma mass spectrometry (LA-ICP-MS) is ideal for this purpose and can provide concentration data for up to 30 trace elements. This technique has a high potential, but has rarely been applied to the analysis of single glass shards from distal tephra horizons.

Here we report on preliminary experiments using a newly installed Coherent GeoLas 193nm Excimer laser ablation system at the University of Wales, Aberystwyth. To date, LA-ICP-MS has produced reliable trace element data from shards as small as 40µm in diameter. Current instrumentation has the potential to produce trace element compositions for shards ~20µm in diameter and concentrations for some trace elements from shards ~10µm in diameter. Successful application of trace element analysis to distal tephrochronology relies on two major factors, the ability to gain reliable trace element characterisations from small glass shards and a lack of spatial variation of trace element composition within individual tephra horizons deposited over a wide geographical extent. We present the results of experimental work to assess the capabilities of the Excimer system, which involved analysing basaltic and rhyolitic tephra shards between 60–10µm in diameter from Greenland ice core and North Atlantic marine sequences. The trace element compositions of these samples, previously correlated using major element geochemistry, are also explored to ascertain if consistency in trace element composition occurs within these widely dispersed tephra horizons.

0477

**Eolian processes in the NE of the Pampean Sand Sea (Late Quaternary), Argentina**

Daniela M Kröhling

*CONICET- Facultad de Ing. y Ciencias Hídricas (Univ. Nac. del Litoral), C.C.217 (3000) Santa Fe, Argentina*

The research covered an area of 9,500 km<sup>2</sup> of the leeward margin of the exposed Pampean Sand Sea (PSS; 33–38°S and 59–67°W). This area is in contact to the northeast with the desert–loess transition belt. The history of the PSS involves the generation of longitudinal megadunes (Late Pleistocene) with SSW–NNE and S–N orientations followed by general remobilizations in dry periods alternating with humid phases of stabilization. The study comprised geomorphologic mapping, stratigraphic studies and a drilling programme complemented with granulometric and mineralogic analysis of cores. Two typical formations representing dissipated dune fields of different ages were formally described. In order to discriminate the sedimentary process occurred, particle size analysis of cores were carried out by contrasting methods (classical sieving and laser diffraction). The main drilled column (Teodelina; 34°11′S and 61°31′W) begins with the Carcarañá Fm correlated to the MIS 3 (12–15.2 m depth). It is composed of sand (50%), with abundant silt (43.3%) and scarce clay (6.7%). The grain size distribution is unimodal (Mo: 76–89 μm) with marked positive skewness (Mz and Md ca. 63 μm). The deduced saltation and suspension mechanisms had a similar participation. The mineralogy of the modal sand fraction is dominated by Andean volcanoclastic materials with subordinated alterites, feldspars, quartz and litoclasts. A soil truncated by erosion, enriched with translocated clay and carbonate segregation, was identified at the top of the unit. The Teodelina Fm (3.5–12 m depth) lies on a marked erosive discordance. It is a sandy silt (61.7% silt, 26.6% very fine sand and 11.8% clay), with unimodal distribution (Mo: 56–65 μm for the lower part and Mo: 48–56 μm for the upper section) and positive skewness (Mz>Md, both in the coarse/mean silt fractions). Eolian suspension represents between 66 and 80% of the identified transport mechanisms in this unit, being saltation processes subordinated (mainly modified saltation). Siliceous minerals of volcanoclastic nature dominate in the coarse silt and very fine sand fractions. The unit is correlated to the MIS 2. Laboratory data from both formations are consistent with field information suggesting that the incorporation of dust during the dissipation processes altered the initial composition of the dunes. It explains the predominance of the deduced suspended mechanisms of transport, mainly the long-term suspension. The main morphogenetic phase preserved in the present landscape occurred during the Late Holocene dry period that produced the development of parabolic dune fields (San Gregorio Fm).

0696

**Advances in tropical loess research. The Uruguay river basin as a case study (SE South America)**

Daniela M Kröhling, Martín H Iriondo

*CONICET- Facultad de Ing. y Ciencias Hídricas (Univ. Nac. del Litoral), C.C.217 (3000) Santa Fe, Argentina*

Tropical loess is a dark red fine eolian deposit, covering large areas of tropical South America. Advances were made in the upper Uruguay basin (NE Argentina and SE Brazil; 26°30′–29°S and 49°30′–56°W). Tropical loess there forms a discontinuous mantle on a Cretaceous basaltic meset, especially in areas dominated by the Velhas Surface

(Middle Tertiary; 400 masl). In south Misiones (Arg.) it was formally defined as Oberá Fm, a dark red loam to silty loam, powderish, friable, porous and massive. It forms steep slopes in gullies, with columnar disjunctions. Fine-medium ferrimanganiferous concretions and nodules are frequent. It is 3–8 m thick, lying on erosive unconformity on the basaltic hills of the Velhas cycle. An Ultisol is preserved in the middle section of the outcrops. The sand mineralogy is dominated by subrounded quartz with scarce volcanic glass, alterites and amorphous silica. Common heavy minerals are magnetite and ilmenite. The clay fraction is composed of kaolinite and quartz with subordinate hematite and gibbsite. Oberá Fm extends discontinuously in neighboring areas covering the west of SC Brazil (Guaçu do Sul, Mondai, Chapecó and São Carlos) and forming a nearly continuous mantle with maximum outcropping thickness of 8–10 m in “das Missões” area (SL.Gonzaga, Ijuí, Carazinho). The sediment there is more sandy, massive, friable and dusky red in colour. Tropical loess covers the upper fluvial terrace of the Brazilian tributaries. Southward, Oberá Fm is a thick and continuous cover on basalts and ferricretes of the Apóstoles Peneplain (Pliocene; 200 masl) that extends on the SE of Misiones and the NE of Corrientes provinces (Arg.) and also on the SW of RS Brazil. The SW border of the continuous mantle near the Uruguay river occurs in NW–SE direction (Santo Tomé – São Borja – S.A. das Missões). The mantle appears as patches in the middle Uruguay basin up to 32°S (Tres Cerros, Rosario do Sul, Dom Pedrito, Rivera). The tropical loess is a red loam, friable, massive, with a thickness of 2–5 m mantling the top of hills formed by Cretaceous sandstones. The lower part of Las Arenas Fm in northern Uruguay is correlated to the Oberá Fm. Geochemical and sedimentological data indicate that the main source of the sediment were the alluvial plains of Paraná, Paraguay and Uruguay rivers. Grain size and thickness trends suggest that the dominant dust-transporting winds during the LGM were from the SW. The sediment evolved under savanna environments.

1279

**Human-environment interaction in the Eastern Sahara during the Holocene**Stefan Kröpelin<sup>1</sup>, Rudolph Kuper<sup>2</sup>

Geological and archaeological archives in the now hyper-arid Eastern Sahara of Egypt, Sudan, Libya and Chad suggest a consistent model of how past environmental changes, over a coherent region of sub-continental scale, have affected human societies throughout the Holocene. After the onset of semi-arid conditions in the north and semi-humid conditions in the south at c. 8500 B.C.E., the desert margin shifted up to 800 km north to latitude 24° N, bringing monsoonal rainfall to most of the former desert. This fundamental climatic change from terminal Pleistocene hyper-arid conditions to savannah-type vegetation, and the formation of lakes and temporary rivers resulted in the rapid dissemination of wild fauna and the swift reoccupation of the entire Eastern Sahara by prehistoric populations. Relatively stable semi-humid environments prevailed over the following 3200 calendar years between 8500–5300 B.C.E. The subsequent southward retreat of monsoonal precipitation can be tracked to the present by the discontinuance of aquatic deposits at decreasing latitudes and by the distribution of occupation sites which both indicate gradual desiccation and environmental deterioration, notwithstanding transitory climatic perturbations at the desert margins. The southward movement of human settlement implied significant changes in the pattern of behaviour and land-use as a response to regional environmental differences. Mobility was the key to survival and has driven prehistoric societies from foraging to a multi-resource economy and specialized

pastoralism. The desiccation of the Sahara triggered the emergence of pharaonic civilization along the Nile, influenced the spread of pastoralism throughout the continent, and affects sub-Saharan Africa to the present day.

1342

### **The Saharan lakes of Ounianga Serir (NE Chad): a unique hydrogeological system**

Stefan Kröpelin

*Universität zu Köln, Collaborative Research Center 389 (ACACIA), Germany*

The deflation basin of Ounianga Serir in remote and almost rainless northeast Chad contains the Sahara's largest bodies of water. The lakes are almost exclusively fed by the regional aquifer which was last recharged during the early Holocene humid phase and which continuously replaces the massive evaporation losses (> 6 m / yr). During the last millennia, the constant trade winds have driven dunes into the depression that have subdivided the once continuous freshwater lake into separate compartments presently hosting 10 lakes with a total surface of about 20 km<sup>2</sup>. With the exception of the central salt lake, Lake Teli, they are largely covered by thick mats of floating reed which significantly reduces evaporation.

The exposed central lake therefore undergoes major evaporation and thus functions as a evaporation pump which affects the lowest lake level. As a consequence of the resulting gradient, freshwater is drawn from the more elevated peripheral lakes through the permeable dune barriers before they become saline. This very special mechanism results in persisting freshwater lakes – a paradox under hyperarid conditions. There are no comparable freshwater systems in the Sahara or any other desert. Only the combined geological, hydrological, climatic and biological factors, i.e. (a) a vast fossil groundwater reserve; (b) the specific position, morphology and orientation of the lake basin; (c) continuous winds from a perpendicular direction; (d) a source of aeolian sand; (e) extreme evaporation driving the central evaporative pump; and (f) the floating reed covers that receive their nutrients from aeolian dust; have created the unique ecological system of Ounianga Serir. It has conserved the genetic heritage of the Sahara's humid past over more than 3000 years of dryness, including several species of fish and gastropods.

Due to severe aeolian erosion, only very limited remains of the deposits of earlier lake stages are preserved at positions up to 80 m above the present lake bottom. They have been radiocarbon-dated to the early Holocene and mainly consist of thinly laminated diatomites and mollusc-bearing carbonates. These high-resolution sedimentary archives are expected to correlate with the sub-bottom varve records of Lake Yoa at Ounianga Kebir. Differential precision surveying of the uppermost lacustrine deposits and "virtual flooding" of digital elevation models allows to outline the extent of the Ounianga palaeolake during the early and mid-Holocene.

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### **Cromerian interglacial deposits and pre-Cromerian glacial deposits in Western Denmark**

Charlotte F Krohn, Christian Kronborg

*Department of Earth Sciences, University of Aarhus, Denmark*

The project comprises the investigation of Cromerian (Harreskovian) interglacial deposits and pre-Cromerian glacial deposits in Western Denmark as found in outcrops and boreholes. The main locality of

the present survey, Lind (Herning), comprises, apart from outcrop localities, 3 examined cored drillings, 2 of these containing Cromerian (Harreskovian) interglacial sediments and underlying glacial deposits.

The interglacial deposits are determined by palynological analyses. The underlying glacial deposits are described by petrography (fine gravel analysis of the 2–4 mm fraction), mineralogy (x-ray diffraction of clay fraction and bulk samples) and sedimentology (grain size analysis and description) as well as fabric in designated outcrops. The petrographical and mineralogical composition assumes a fingerprint for each ice advance and is used as a correlation tool to characterize the orientation, architecture and relations between the sediment bodies identified in the area.

Based on the petrographical and mineralogical composition, the pre-Cromerian glacial deposits can be divided into 5 groups with different characteristics and at least 2 of the groups show signs of glacial deformation. The Cromerian (Harreskovian) deposits themselves are in areas affected by deformation and heavy erosion from later glacial events.

At Lind in Western Denmark we have indications of presumably 5 glacial events prior to the Cromerian (Harreskovian) interglacial period. These old sediments will in the future be incorporated in the regional stratigraphical scheme, which is under revision these years.

0220

### **The Middle Neopleistocene biogeocenosis of Ukraine (from data of fossil small mammals)**

Aleksey Krokmal

*Institute of Geological Sciences of NAS Ukraine, Ukraine*

Purpose of research is the exposure of conformities to the law of development of natural process in Neopleistocene of Ukraine, prognosis of development of this process in the future. Microteriological method in researches is used. The basic sites of microteriofauna are located in two regions: Lower Danube and South-West Pridnepromor'e (I) and Middle Pridnepromor'e (II). Three stages of development of fossil small mammals are selected: (a) fauna with *Arvicola mosbachensis* and *Microtus arvalinus* (early Middle Neopleistocene); (b) fauna with *Arvicola mosbachensis* and *Microtus arvalis* (middle Middle Neopleistocene); (c) fauna with *Arvicola chosaricus* and *Microtus arvalis* (late Middle Neopleistocene). We will consider the sequence of development of biogeocenosis in space and time from ancient to more young. Ia - forest-steppe species with the two-bit of intrazonal elements at the beginning of interval (locations Ozernoye 2, Nagornoye (2) are widely represented, the representatives of steppe associations at the end of interval were widespread (Morozovka 2, Krasnoselka 2 locations). Iib - at this time the gradual change of associations of small mammals in the following sequence: steppe species with participation of intrazonal-meadows (Chigirin) → increase of forest-steppe elements (Gunki) → sharp increase of quantity of meadow species and abbreviation of quantity of steppes ones (Demidovka) → presence in the equal parts of steppes, forest-steppe, meadow and intrazonal species of microteriofauna (Pivikha). Ic and Iic - the forest-steppe landscapes at the end of Middle Neopleistocene on south and in the center of the Ukraine there were. The representatives of steppe and forest associations of small mammals dwelt in these landscapes. Meadow and intrazonal species had a low quantity (locations the Ozernoye 1, Matveevka). Steppe and tundra species prevailed in the north. Thus, the start and finish of the Middle Neopleistocene of the South-West of Ukraine the forest-steppe biogeocenosis were characterized. In the middle of the Middle