Laboratory of Soil Science and Geology

Laboratory of Soil Science and Geology
P.O Box 37, NL-6700 AA
The Netherlands
Tel; +31 317484400
Fax: +31 317482419

IGCP 449 Final plenary meeting, Malaga, Spain

Field Conference Malaga Basin 2004

IGCP449 GLOBAL CORRELATION OF LATE CENOZOIC FLUVIAL DEPOSITS
End of Project Meeting

Campanillas, Malaga, 12th – 18th of December 2004

Program

Book of Abstracts

Edited by Dr. David R. Bridgland (University of Durham, UK), Dr. Darrel Maddy (University of Newcastle, UK), Prof. Dr. Ir. A. Veldkamp (Wageningen University, The Netherlands) and Dr. Jeroen M. Schoorl (Wageningen University, The Netherlands)

University of Durham

ENVIRONMENTAL SCIENCES GROUP
WAGENINGEN UR

UNIVERSITY OF NEWCASTLE UPON TYNE

IGCP 449 Final plenary meeting, Malaga, Spain

Field Conference Malaga Basin 2004

Overall Programme

Sunday 12th	Arrivals (from 15:00 hours), Icebreaker (21:00 hours)
Monday 13th	Field excursion Tortonian (9:00 to 17:00 hours)
Tuesday 14th	Conference papers & posters; Business Meeting 8 (9:00 - 18:30 hrs)
Wednesday 15th	Field excursion Pliocene (9:00 to 17:00 hours)
Thursday 16th	Conference papers & unfinished business (9:00 -18:30 hrs)
Friday 17th	Field excursion Quaternary (9:00 to 17:00 hours)
Saturday 18th	Departures (up to 12:00 hours)

Tuesday 14th - Conference papers & posters; Business Meeting 8

9.00 – 9.15 Welcome and introduction - David Bridgland and Jeroen Schoorl

Lecture session 1: Key studies

9.15 – 9.45 Shallow to deep deposits of the 'Manche' palaeoriver (NW Europe) - **Jean-François Bourillet**, Sébastien Zaragosi, Gilles Lericolais , Laurence Droz & Pascal Le Roy

9.45 – 10.15 Fluvial evidence for post-Pliocene uplift in the Wau-Bulolo region of Papua New Guinea – **Bob Findlay**

10.15 – 10.45 AAR in calcite: an amino acid revolution? – **Kirsty Penkman**, Maddy, D., Keen, D.H., Preece, R.C. & Collins M.C.

Coffee break & poster session - 10.45 - 12.00

12.00 – 12.30 The Early Pleistocene terraces of the Gediz river around Kula, western Turkey: an uplift-driven, climate-controlled system? – **Darrel Maddy,** Demir, T., Bridgland, D.R., Veldkamp, A., Stemerdink, C., Van der Schriek, T. & Westaway, R

12.30 – 13.00 Evidence for Elsterian-type glacial melt-water deposits from MIS 8 and 16 within the Rhine sequence in the Netherlands – **Meindert van den Berg**

Lunch break

14.15 – 14.45 Late Cainozoic fluvial terrace record of Tana river, Kenya - **Tom Veldkamp**, E. Buis, D.O. Olago, E.H. Boshoven, M. Marée, P.T. Gicheru & J. Wijbrans

14.45 – 15.15 Erosion modelling of stratigraphic sequences - **Aleksey Sidorchuk**

15.15 – 15.45 Activity and achievements of IGCP 449: a geographical perspective - **D.R. Bridgland**

15.45 – 16.00 Discussion

Tea break - 16.00 - 16.30

16.30 – 18.30 Business Meeting 8

Thursday 16th - Conference papers & posters

Lecture session 2: Regional syntheses

9.00 - 9.30 Fluvial terraces systems from northern France, new results and synthesis - Pierre Antoine, **Nicole Limondin-Lozouet**, Christine Chausse, Jean-François Pastre, Jean-Jacques Bahain, Christophe Falgueres & Pierre Voinchet

9.30 - 10.00 A preliminary assessment of the Late Quaternary fluvial evolution of the Lower Tagus valley near Muge (Portugal) - **Tim van der Schriek** and David G. Passmore

10.00 - 10.30 Fluvial history in the Czech Republic **- Jaroslav Tyráček** & Pavel Havlíček

10.30 - 10.45 Discussion

Coffee break 10.45 - 11.15

11.15 - 11.45 The role of the Érmellék-Berettyó-Körös depression in the river course development of the Great Hungarian Plain - Árpád Magyari, **Annamária Nádor**, Edit Thamó-Bozsó, Zsolt Kercsmár & Edit Babinszki.

11.45 - 12.15 Correlation of the Late Cenozoic fluvial events within the East European Plain - **A. Matoshko**, P.Gozhick & G.Danukalova

12.15 - 12.45 Geomorphic diversity, stratigraphic development and fluvial response to monsoonal fluctuations: examples from the Gangetic basin, Himalayan foreland, India - **Rajiv Sinha**

12.45 - 13.00 Discussion

Lunch break

14.00 – 14.30 The late Pleistocene fluvial record of large South American fluvial systems - **E. Latrubesse** & J. Stevaux

14.30 – 15.00 Review of Some Alluvial Sequences in the Continental United States - **M. Blum**

15.00 – 15.30 Quaternary fluvial archives from eastern Turkey and the Middle East - **T. Demir**, A. Seyrek, I. Yesilnacar, M. Kartal, B. Celik, R. Westaway, I. Kopar & D.R. Bridgland

15.30 - 16.00 A Quaternary terrace uplift record for the northern Waitakere Ranges, New Zealand, based on marine-terrestrial correlations - **L. Claessens** & A. Veldkamp

Tea break 16.00 - 16.30

Papers on crustal themes

16.30 – 17.00 Rheological modelling of crustal deformation as evidenced by Late Cenozoic fluvial sequences: results from IGCP 449 – **R. Westaway**

17.00 – 17.30 The role of tectonic and climate in the development of Tertiary continental sequences; southeastern edge of the Atlas Mountains (Morocco) **- Mohammed Ben Brahim**

17.30 – 18.00 Unforeseen patterns in the disposition of fluvial archives: key findings from IGCP 449 - **D.R. Bridgland** & **R.W.C. Westaway**

18.00 - 1830 **Discussion and unfinished business**

Posters:

The British fluvial archive: East Midlands drainage evolution in the context of the British and NW European record - Andy Howard, Peter Allen, Martin Bates, Becky Briant, **David Bridgland**, Philip Gibbard, David Knight, Simon Lewis, Darrel Maddy, John McNabb, Jim Rose & Rob Westaway

Late Cenozoic fluvial deposits of the river Allier Basin (France). Correlations with the Massif Central volcanism **- Jean-François Pastre**

Late Quaternary fluvial evolution of the different reaches of Tisza River on the Great Hungarian Plain **- G. Gábris & B. Nagy**

A preliminary interpretation of Pleistocene fluvial evolution in Lithuania **- Petras Sinkunas** & Vaida Seiriene

Last Glacial – interglacial cycle in the evolution of river valleys in Poland - Piotr Gębica & Leszek Starkel

Late Cenozoic fluvial sequences in SW Bulgaria: coupling between surface processes and lower crustal flow **- R. Westaway**

The northern Peri-Aegean Region in the Neogene and Quaternary: onset and evolution of the fluvio-lacustrine systems - Ivan Zagorchev

The Late Glacial history of Moscow River in Moscow- **Aleksey Sidorchuk**

The Pliocene - Quaternary fluvial records of Morocco **- A. Ait Hssaine**

Direction of geomorphological research in Morocco and the Maghreb **- A. Ait Hssaine**

Long term dynamics of soil, vegetation and landscape; A case study for KwaZulu/Natal, South Africa **- A. Temme**

Climate and flow regime changes in Australia from ~750 ka - G.C. Nanson & D.M. Price

The Kotovka, Late Pleistocene: predators' activity and composition - L.V. Popova

Mammalian records from fluvial contexts: contributions to the IGCP 449 biostratigraphy subtheme - Danielle Schreve

Middle Pleistocene malacofaunas from Northern France: new results - **Nicole Limondin-Lozouet**, Pierre Antoine, Jean-Jacques Bahain, Christine Chausse, Christophe Falgueres & Pierre Voinchet

Molluscan evidence from fluvial sediments: contributions to the IGCP 449 database - David Keen, Nicole Limondin-Louzouet & Richard Preece

Evidence of human activity from Pleistocene fluvial deposits: findings during the course of IGCP 449 - Mark White, Sheila Mishra & **David Bridgland**

Global Correlation of Late Cenozoic Fluvial Deposits: IGCP 449: 2000 – 2004 **- D.R. Bridgland** & **R.W.C. Westaway**

THE PLIOCENE - QUATERNARY FLUVIAL RECORDS OF MOROCCO

Ali Aït Hssaine

Département de géographie, Université Ibn Zohr, Agadir, Maroc. E-mail: Aithsaine@yahoo.fr

Recent Moroccan geomorphological and Quaternary studies have benefited from advances in dating and other analyses, in marked contrast to the major works of the 1960s and '70s, which, because of the lack of precise geochronology, were limited to description and classification as a means of building localized relative chronologies. In the absence of the material or technological means for dating beyond the 40 ka available from 14C, researchers on the terrestrial sequences have been obliged to apply multiple methods in order to establish a relative chronology. In contrast, dates from the Moroccan littoral record extend beyond 200 ka (260 ka at Agadir: Weisrock, 1986) thanks to the wealth of datable material in the sediments. But despite their paucity of datable material, the analysis of continental sediments provides a rich source of palaeohydrological and palaeoclimatic information. Moroccan fluvial records thus yield valuable information, as can be simmarized as follows: In the Pliocene - Quaternary, in the final period of uplift of the Atlas mountain chain, there was strong fluvial energy as a result of the tectonic activity and the humid climate. The climate in the mountains was extremely severe, as evidenced by the formation of large piedmont fans, comprising angular clasts, on both sides of the Atlas. On the plains, in contrast, active pedogenesis led to the formation of thick red soils (Mamora, Atlantic plains, Tadla, etc.). The fluvial regime on the Atlantic side was more regular and in equilibrium. It was less on the Saharan side, but the extent of the sediments to more than 100km from source and the transport of large material indicates abundant discharge and highly active aggradation. The sediments at the foot of the Atlas and in the largest wadis reveal an unmistakably fluviatile regime with visible sorting. The other, narrower wadis retained a purely torrential regime. The coarse sediment suggests sparse flanking vegetation, but in the absence of palynological data it is not possible to expand on this. This was the first phase of piedmont building, testimony to its vast extent being the height of its dissected terrace remnants.

As fluvial activity saw the first phases of embankment and overdeepening, chemical alteration took place on the calcareous aggradations, taking the form of calcrete crusts capping the terraces and fans of this period, although undoubtedly formed during a subsequent phase of extreme aridity. All the evidence (coarse sediment and calcareous precipitation) indicates abundant sediment supply from the valley sides and high fluvial discharge, with highly active pedogenesis on interfluves. Shape analysis of the clasts forming the fluvial gravels indicates that rock material was broken up by frost. All interpretations of the Moroccan record agree that this transitional period (including the Early Pleistocene) was characterized by a tropical, humid climate on the Atlantic seaboard with contemporaneous cold in the mountains, the latter resulting in the typical landscapes of the Atlas range, with cirque glaciers, grezes, moraines, nivation hollows, etc.

In the Middle Pleistocene (MIS 21 or 19 on the curve illustrated by Porter, 1989), the wadis continued to transport coarse material, but with less intense activity than in the preceding period. This activity followed an erosional hiatus that without doubt coincided with a major marine regression, probably in MIS 22. The lower energy fluvial deposits of this period form inset spreads of less coarse-grained material, although there was some reworking of the older very coarse gravels. During this period a fluvial landscape was formed that persists under present-day climatic conditions. Known in Morocco as the 'Tensiftian', it was disturbed by a period of cold, as is confirmed by signs of flattening of certain terraces. This resulted in the alluvial landscape also being covered with a widespread calcareous crust, formed as a result of active dissolution of calcareous clasts under cold conditions. This period saw the formation of calcareous soil profiles on the plains, while fluvial regimes were disrupted and wadis flowed less regularly, although with an advanced morphological equilibrium. This was the period of valley formation.

The phase separating this period from the Late Pleistocene is poorly known. Without doubt, given their thickness, the Tensiftian formations (terraces and piedmont fans) represent cumulative aggradation during the 600 ka of the Middle Pleistocene. Within this period, there were numerous oscillations of sea-level (seven marine regressions) in response to climatic fluctuation. On the basis of existing evidence, not all these fluctuations have left their mark in the landscape, but it is possible to recognize two main divisions within this 600 ka period, one of aggradation and one of erosion, together giving rise to a complete morpho-sedimentary and morpho-climatic cycle.

By the Late Pleistocene (130 - 10 ka), valley formation had already taken place, the wadis were incised and their flow greatly reduced in comparison with earlier periods. Despite the climatic amelioration that marked the beginning of the Late Pleistocene (the Last Interglacial), with abundant rainfall that favoured active pedogenesis, wadi activity became irregular, within the Mediterranean climatic regime that was already apparent in the Tensiftian. After a phase of erosion, during which large parts of the Tensiftian formations were removed, sedimentation resumed. On land, it is only the later part of this period - the last 40 ka - that is well known as a result of geochronology. Throughout Morocco this period is known as the 'Soltanian' or the period of 'limon rose' (pink mud). As with the earlier periods, sedimentation differed between the plain, where fine material ('limon rose') from sheet-wash is associated with the fluvial terraces, and the piedmont, where coarser deposits accumulated. Sedimentological and mineralogical analyses indicate a mild environment, becoming cold at altitude. Fluvial energy was much diminished, in parallel with tectonic activity, which had virtually ceased. The wadis reworked material from earlier terraces at the same time as producing some new alluvial material., as is shown by petrological, morphometric and mineralogical analyses. This period is characterized by the absence of calcareous crusts, although such material is present in soil profiles in the form of small rounded concretions (in terraces and fans). The Soltanian can be divided into two periods. The first of these, between 40 and 20 ka, is marked by a lithic industry known throughout North Africa as the Altérian. This was a mild episode with soil rubefication, coinciding with a sea-level rise at 30 ka, forming the Soltanian silts, which are pink ('limon rose') everywhere in Morocco except desert margins. The second, terminal period, between 20 and 10 ka, coincided with the LGM at 18 ka and the glacial melting at high and middle latitudes towards the end of the period. This period is represented by erosion of the Soltanian terraces. Dating of the sedimentary record allows the climatic variations of this final part of the Late Pleistocene to be reconstructed.

In the Holocene, as global climatic amelioration took place, fine sedimentation dominated. On the piedmonts is seen a scattering of non-course material in a fine-grained matrix. In valleys and along the major drainage arteries, the Holocene terraces (in Morocco called 'Rharbian terraces) can be summarized as consisting of two major lithostratigraphic units: a basal or lower unit formed essentially of coarse material (boulders, cobbles and pebbles in a sandy matrix) and an upper fine-grained unit (silt, sand and clay). This seemingly simple stratigraphy can, in detail, contain many facies denoting climatic changes (humid/arid) or seasonal variations. Within the upper unit the alternation of fine deposits with gravel beds may simply correspond with a depositional episode starting with high-energy (gravel) and ending with waning (fine-grained) sedimentation activity. This type of deposition had already begun in the Soltanian. The only distinction between the sediments of these two

periods is based on colour and concretions, such that the Soltanian is red and rich in concretions and the Rharbian is fresh grey in colour and lacking in concretions.
The Moroccan Holocene is very well known, there having been many applications of geochronology and other analyses. Its stratigraphy represents a complexity of climatic variation. At the level of the terraces is seen a fluvial regime that differs little from that at the present day, with alternation between arid and humid episodes or simply between years with rain and dry years. There is an increasing trend towards aridity from the early Holocene to the present, which is confirmed by the increasing occurrence of palygorskite upwards through the stratigraphy and by the presence of dunes or dune sand. As everywhere, this is the period of greatest anthropogenic influence, particularly over the past 3000 years. Throughout Morocco a general deforestation occurred at the beginning of the 17th Century (after Capot Rey, 1976), confirmed by dates from Taroudant and backed up by evidence for intense soil erosion at this time. Fluvial regimes were very much disrupted and numerous wild animals disappeared.

At the present time, in the context of global climate change, the Moroccan climate is becoming very severe. Aridity becomes increasingly prevalent, the frequency of rain becomes less from one year to the next and its amount diminishes. These effects are of particular severity to the south of the Atlas, where the processes of desertification are active (erosion and sand encroachment). Humans have greatly contributed to these changes and to the disturbance of morphogenetic systems.

DIRECTION OF GEOMORPHOLOGICAL RESEARCH IN MOROCCO AND THE MAGHREB

Ali Aït Hssaine

Département de géographie, Université Ibn Zohr, Agadir, Maroc. E-mail: Aithsaine@yahoo.fr

In Morocco and in the wider Maghreb, research in the earth sciences, and in geomorphology in particular, has made a great deal of progress in the last twenty years. Numerous theses have been submitted, others are in the course of completion and many projects have come to fruition, thus covering the whole of this region. Chosen themes have moved away from classic geomorphology and process studies, with a tendency towards applied studies in relation to land management and impact of geomorphological processes on environment and infrastructure. Two paradoxical morphogenetic provinces can be distinguished and call for the attention and involvement of geomorphologists, at the scale of the Maghreb, to which can be added the coastal zone:

- A humid montane province, the Rif and the Tell being of special interest, in which slope processes are highly active (land slips, solifluction, etc.).

- An arid province, near-Saharan and Saharan, covering the area south of the High Atlas, in which aeolian processes are important in association, at the foot of the Atlas, with subaerial [areolar] erosion. Here too there is strong interest from geomorphologists. Marginal areas, above all in the High Atlas, the Middle Atlas, the Saharan Atlas, the interior plains and the piedmonts, are today suffering from a breakdown in morphological balance as a result of anthropogenic impacts (land clearance, for farming and urbanization) and are also the topic of numerous studies.

The littoral domain is another favoured by geomorphologists because of the morphological changes it has undergone, and the increasing speed of these changes, which are linked to different factors: amongst others, urbanization and suburbanization of the coast (at Agadir, for example, development of tourist infrastructure is at the expense of active dunes and upon both ancient and modern beaches). Construction and extension of harbours and dykes affects the coastal regime of both oceanic and Mediterranean shorefaces. The construction of upstream barrages has greatly contributed to beach starvation as well as to disturbance of fluvial regimes etc. Modern society is increasingly facing the development of a geomorphology of natural or socio-natural hazards. This relates to problems of maintained spaces. Here the coastal zone is important because of its suburbanization which in turn has greatly modified the littoral morphology over several decades. Human coastal developments seldom respect the natural morphology and sometimes contribute to its destruction. This situation is an ongoing challenge for geomorphologists, although this does not mean that palaeo-environmental geomorphology is negelected; on the contrary, the majority of theses completed in Morocco draw not on classical geomorphology or process study but, as already mentioned. on present-day morphogenesis, in the context of global climate change. This compels researchers to take account of morphogenetic processes and development, particularly in the light of the seriousness of certain phenomena (sand encroachment, erosion). Many Moroccan researchers have become involved in international management programmes.

In the Maghreb at the present time the governmental authorities and society at large are beginning to appreciate the value of geomorphology and of geography in general in land management. Some research institutes and municipalities involve geomorphologists in certain projects studying impacts and management (e.g. work by laboratories in Agadir (Morocco) and Sfax (Tunisia) on the impacts of quarrying etc.).

At present the Geomorphology Laboratory in Agadir has submitted three projects for funding: to produce a geomorphological map of the Souss Depression, the study of potential hospital waste-disposal (burial) sites in the Souss valley and the impact on the urban environment of the hydrographic network that crosses the city of Agadir. A fourth will be devoted to the morphological changes in the Bay of Agadir and the evolution of this stretch of coastline, which will perhaps form the topic for a doctorate.

FLUVIAL TERRACES SYSTEMS FROM NORTHERN FRANCE, NEW RESULTS AND SYNTHESIS

Pierre Antoine [1], Nicole Limondin-Lozouet[1], Christine Chausse[1], Jean-François Pastre[1], Jean-Jacques Bahain[2], Christophe Falgueres[2] & Pierre Voinchet[2]

1- CNRS, UMR 8591, Laboratoire de Géographie Physique, "Environnements quaternaires continentaux, dynamique naturelle et anthropisation", 1 Place A. Briand, 92195 Meudon cedex, France. (Pierre.Antoine@cnrs-bellevue.fr / Nicole.Limondin@cnrs-bellevue.fr/ chausse@cnrs-bellevue.fr / pastre@cnrs-bellevue.fr)
2 - Institut de Paléontologie Humaine, Laboratoire de Préhistoire du Muséum National d'Histoire Naturelle, UMR 6569 du CNRS, 1 rue René Panhard. 75013 PARIS France (E-mail : bahain@mnhn.fr / pvoinch@mnhn.fr).

During periods of low sea level (Pleistocene cold stages) the main rivers of northern France (Seine, Somme & Yonne) were tributaries of the River Manche which was exporting sediments into the central deeps of the Channel. These rivers exhibit well developed terrace systems recording incision that began at around 1 Ma. The uplift rate, deduced from the study of these terrace systems, is of 55 to 60 m/Ma since the end of the Lower Pleistocene.

Generally the facies and sedimentary structures indicate that the bulk of the deposits in these rivers accumulated in braided river environments under periglacial climates in all the area. Evolution of the rivers reflect their responses to climatic change, local geological structure and long term tectonic activity. In this context the Middle Somme valley is characterised by a regular pattern in which incision occurs at the beginning of each glacial period (Early-glacial) within a general background of uplift. In the same area (southeast of the Paris Basin), the Yonne valley shows a stepped system including eleven Pleistocene alluvial formations above the modern valley bedrock. A cyclic morphosedimentary pattern driven by the climatic changes of glacial-interglacial or glacial-interstadial cycles very close to those of the Somme basin is evidenced. According to the chronostratigraphical interpretation and ESR dating, the total balance of incision is of about 20m for the last 300 ka and therefore of the same order than those of the Somme and Seine valleys (5-6m/100ka). In the Somme and Paris basins the new data from the Lateglacial and Holocene sequence of the present day valley allows a detailed reconstruction of the modification of the fluvial morphology and sedimentation in relation to climatic variation during the Lateglacial and the Early Holocene. This comprises: incision and passage to a transitional system during the Bølling, single meandering channel during the Allerød with organic overbank silt deposition, infilling by calcareous silts during the Younger Dryas and, finally, a new major incision phase at the beginning of the Holocene. In the Somme valley, this is followed by the lowering of the fluvial dynamic and the infilling of the whole valley by peat during the first half of the Holocene, whereas valleys of the Paris basin exhibit higher fluvial dynamic. These results provide an interesting model for the interpretation of the Middle Pleistocene alluvial sequences from the terraces and especially demonstrates that incision occur during transitional climatic phases (Early-Glacial for the main incisions separating the alluvial terraces / Lateglacial and Early Interglacial for the "minor " incisions within one alluvial formation).

Within this global studies we now focuses on the response of fluvial systems during Pleistocene interglacials and especially on the tufa deposits that are the only deposits able to record full interglacial conditions (CNRS, SITEP Program). These new investigation allow to provide new data for MIS 11 and 5e interglacial from the Seine (La Celle) and Somme Basin (St. Acheul, Caours). The objective of this research is now to define a reference succession of well-dated interglacial sequences for Northern France from MIS 11 to 5e.

THE ROLE OF TECTONIC AND CLIMATE IN THE DEVELOPMENT OF TERTIARY CONTINENTAL SEQUENCES; SOUTHEASTERN EDGE OF THE ATLAS MOUNTAINS (MOROCCO)

Mohammed Ben Brahim

Department of Geomorphology. Mohamed 1st University. B.P. 457. 60000. Oujda. Morocco.
benbrahim@lettres.univ-oujda.ac.ma

The southeastern Atlas Mountains (Morocco) and adjacent foreland (Boudenib Basin) exhibit complex continental Tertiary morphosequences whose developments are related to tectonic and/or climatic control.

The studied area has a particularly significant location because it straddles the hinge zone between the mobile area of uplift of the Atlas Mountain in the north and the stable domain, west Sahara craton, in the south. Both ranges are bound up with extended fractures zone which belong to the South Atlas Fault system (SAF). These tectonic directions have controlled the deposit and the morphological evolution of the area during the Tertiary During Senonian time, the Boudenib Basin began to subside rapidly and fill with detritus derived from the adjacent highlands uplift. The sequence is mainly clastic, comprising fine grained facies of red beds (sandstones, marls, argilites and gypsum) attributed to a lagoonal-continental environment. In the eastern perimeter of the basin, the sequence passes increasingly upward into gravel and conglomerate which represent the principal sedimentary response to tectonic and record the initial stages of deformation (phase atlasique **1**) affecting the Eastern Atlas Mountain. These conglomerates are observed southward at the base of the Boudenib Hamada **I** (Lower Eocene).

This unit is characterized by rather confined pedogenic calcrete, rich in dolomite and palygorskite, and caped by pedogenic silcrete that record a period of tectonic stability and alternating dry and wet climate.

The reactivation of pre-existing structures during Middle to Late Eocene in the Boudenib Basin led to a differential distribution of Hamada de Boudenib **II** deposits which are characterized by a rather confined environment (occurrence of palygorskite and rich dolomite and calcretes) indicative of dry climatic conditions.
During the Lower to Middle Mioce, tectonic rejuvenation occurred in response to the major Atlasique Phase (phase atlasique **II**) which is recorder in the border (alluvial fans) and the Basin by coarse conglomerate deposits, that prograde southward and marked an unroofing surface at the base of the Hamada du Guir sequence. In the Basin, the conglomerate deposits cover several areas, that correspond to paleovalleys converging on the basin, and thicken (100 m of thickness at 35 km from the Atlas border). The Hamada de Boudenib is composed mainly of gravel, sad and clay that evolved in fluvio-palustrine-lacustrine environments, under climate control responsible of the development of calcrete and silcrete phenomena.

EVIDENCE FOR ELSTERIAN-TYPE GLACIAL MELT-WATER DEPOSITS FROM MIS 8 AND 16 WITHIN THE RHINE SEQUENCE IN THE NETHERLANDS.

Meindert W. van den Berg

Netherlands Institute for applied geo-sciences- TNO/ Geological Survey, P.O. box 80015, 3508 TA Utrecht, The Netherlands. (m.vandenberg @nitg.tno.nl)

Two sites in the northern Netherlands: Exmorra and Noordbergum, have played a key role in the construction of the Mid-Pleistocene stratigraphic framework of the Netherlands.
Here we present a reinterpretation, based on continuously-cored borehole information and cone penetration tests, supported by sedimentological, heavy mineral, pollen, dinocyst and diatom data. The studied sequences show the presence of at least two Elsterian-type glaciations at different stratigraphic levels with respect to river Rhine deposits. These glaciations can be attributed to MIS 8 and MIS 16 respectively. The age -approximation relies upon on the first appearance of the dinocyst Selenopemphix Quanta and of volcanic minerals in Rhine sediments.

This finding suggests that the great similarity in the type of de-glaciation sediments, causes great difficulties in separating one glaciation from another, especially in areas that were repeatedly covered by the Scandinavian ice-sheets. If one accepts the German Elsterian to correlate with MIS 12, then it follows that the formation of deep elongated depressions and associated fill deposits (a.o. Pot-clay / Lauenburger Ton) by the collapsing ice-sheets was the rule rather than the exception during the Brunhes. The previous stratigraphic concept suggested that this was the exception rather than the rule.

SHALLOW TO DEEP DEPOSITS OF THE 'MANCHE' PALAEORIVER (NW EUROPE)

Jean-François Bourillet[1], Sébastien Zaragosi[2], Gilles Lericolais[1] , Laurence Droz[3] & Pascal Le Roy[3]

1 – Ifremer –Laboratoire Environnements Sédimentaires BP 70 – 29280 Plouzané France
2 – Université Bordeaux I, UMR 5805 "EPOC", av des Facultés, 33405 Talence France
3 – Institut Universitaire Européen de la Mer, UMR 6538, 29280 Plouzané France

Bathymetric, seismic and coring surveys have been carried out since the beginning of the 1990s on the outer shelf, the slope and the continental rise of the Western Approaches margin (Bay of Biscay-NE Atlantic). Most of the studied sedimentary features belong to a sedimentary system built up since the Oligocene and fed by a palaeoriver, the "Fleuve Manche" that flowed in the English Channel during eustatic lowstands. A geomorphological map details the spatial distributions of the palaeovalleys on the outer shelf, the drainage basin-like organised canyons on the slope and the turbidite channel-levees and lobes complexes on the rise. The obvious channel-canyon connections and the assessed palaeovalley-canyon links demonstrate that the 'Fleuve Manche' continental drainage basin (Seine, Somme, Solent and momentarily (temporarily) Meuse, Rhine, Thames) was the single source for terrigeneous fluxes of the Armorican Deep Sea Fan. The Celtic Deep Sea Fan was fed by both the 'Fleuve Manche' and parts of the glaciated margin of Ireland and UK.

Interpretation of seismic records shows that the initiation of the deep deposits occurs at the same time than the set up of the prograding prism on the outer shelf (Lower to mid Miocene). The maximum of preservation on the shelf occurs during the Pliocene followed by the incision of a network of palaeovalleys. The courses of their thalwegs are fully mapped from the shelf-break to the landward pinch out and the age of the incision is estimated at about 2.9My.

The recent SEDICAR cruises on board the R/V *Marion Dufresne* provided giant cores located along the northern margin of the Bay of Biscay on mid-slope spurs and on turbidite channel-levee systems. Shallower targets (sand bank, palaeovalleys infill) remain unsampled. First analysis allow to improve the stratigraphic framework for the last 3 glacial cycles and particularly their terminations characterized by millimetric laminations resulting from a cascading sinking of melt-waters and a deposit of ice rafted detritus. The upper and mid-slope is characterized by the interplay of several combined sedimentary processes (hemipelagic, turbiditic, contouritic and ice-rafting) when the channel-levee systems at the foot of the slope present an exceptional sedimentation rate (up to 7.5 m/ky) for the LGM which allows resolution of yearly terrigeneous sedimentation and quantification of the rates of the various sedimentary processes.

ACTIVITY AND ACHIEVEMENTS OF IGCP 449: A GEOGRAPHICAL PERSPECTIVE

D.R. Bridgland

Department of Geography, Durham University, South Road, Durham DH1 3LE UK

IGCP 449 participants have spent the past five years compiling fluvial records from all over the World. This has involved countries as widely separated as Australia, Brazil, Canada, India, Morocco, Russia, South Africa and Turkey. It was always known that the project would be building upon an already well researched body of European data, to which has been added significant quantities of data from pre-existing research in the former Soviet Block (the countries of central and eastern Europe, the Russian Federation and Siberia). Extending documented research on fluvial sequences beyond these core areas has been fundamental to the project's success in achieving a coverage that can be considered as truly global. This level of coverage has been achieved (although not without gaps), partly by holding and/or sponsoring meetings in target areas. Highlights in this respect have been meetings in India, Morocco and Brazil. Other highlights have been the recognition of important long-timescale fluvial records in the Middle East and Turkey. Significant gaps remain, such as China, where important records are known to exist but where all attempts to organize the meeting that would have instigated project activity were thwarted. It is hoped that the proposed follow-up project will make good this and other shortcomings and continue the task of data collection initiated by IGCP 449, as well as the further compilation of the internet database.

In this summary paper, project activity in various regions will be reviewed.

UNFORESEEN PATTERNS IN THE DISPOSITION OF FLUVIAL ARCHIVES: KEY FINDINGS FROM IGCP 449

D.R. Bridgland[1] & R.W.C. Westaway[2]

1 - Department of Geography, Durham University, South Road, Durham DH1 3LE UK
2 - Faculty of Mathematics and Computing, The Open University, Eldon House, Gosforth, Newcastle upon Tyne NE3 3PW, UK

River terrace staircases, providing records of surface uplift, are an almost universal feature of continental crust the World over. The only exceptions are subsiding depositional basins and cratonic areas. The former have been widely recognized for many years and include fault-bounded and other tectonic basins, at various scales, from the great foreland basin of the Himalayas to the infills of areas undermined by subterranean movement of salt, such as the well-known Schöningen sequence in central Germany. In such areas fluvial sediments from the recent geological past are stacked one above another. The absence of terrace staircases in cratonic areas was not well known hitherto. Sporadic fluvial deposits on valley-sides, seemingly preserved as terraces, are in fact to be found in cratons. Often, however, they can be shown to be much older than their disposition relative to the river would normally imply. Thus Lower Pleistocene fluvial terrace deposits are generally to be found at least 50 m (and often more) above the modern river, whereas on cratonic crust it is possible to find sediments of this age, indeed of a wide range of ages, in close vertical proximity to the valley floor. This phenomenon, now observed in numerous cratonic areas (as will be documented below), is taken to indicate that such areas have not experienced significant surface uplift during the Quaternary - in marked contrast, clearly, to the post-Archaean crust with its widespread terrace staircases.

GLOBAL CORRELATION OF LATE CENOZOIC FLUVIAL DEPOSITS: IGCP 449: 2000 – 2004

David Bridgland[1] & Rob Westaway[2]

1. ***Department of Geography, University of Durham, South Road, Durham DH1 3LE, UK.***
d.r.bridgland@durham.ac.uk
2. ***The Open University, Eldon House, Newcastle-upon-Tyne, NE3 3PW, UK***
r.w.c.westaway@ncl.ac.uk

IGCP 449 has been engaging the fluvial community, especially those interested in long fluvial sequences, since 2000. It started in NW and Central Europe and by its completion, in December 2004, will have been represented at meetings on every major continent (See Box 1). Results to date can be summarized under the following headings:

Key sequences

These are the river systems with lengthy fluvial archives benefiting from multiple lines of dating evidence. Targeted for inclusion within the project database, they include:

NW Europe: Thames, Seine, Somme, Maas, Rhine.
Central Europe: Wipper, Ilm, Vltava, Svratka, Danube
E. Europe: Dniester, Dnieper, Volga, Don,
Middle East: Orontes, Euphrates, Nahr el-Kebir, Ceyhan, Tigris
Africa: Nile, Souss, Vaal/Orange, Sundays,
India: Ganges, Narmada, Pravura
China: Yellow River
North Asia: Lena, Kolyma, Yenisey
Australia: Murray/Darling, Shoalhaven
North America: Susquehanna, Mississippi, St Lawrence, Ohio
South America: Parana, Amazon

Patterns of fluvial sedimentation and valley evolution over Neogene and Quaternary timescales

The data thus far assembled has revealed clear differences between fluvial records in different areas, apparently related to different types of continental crust with different uplift/subsidence histories. These fall into three groups:

1. Typical uplifting pattern, with extensive terrace staircases, climatically forced. Early and pre- Quaternary terraces are >100m above existing valley floor. Requires young (post-Archaean) crust. Cause of uplift is the subject of debate; mechanism must explain the near ubiquity of this situation. Examples: Thames (Fig. 1), Wipper (Fig. 2), Dniester (Fig. 3), Yellow River (Fig. 4).

2. Subsiding pattern, with stacked fluvial sediments (Box 2). Generally requires young crust, subsiding because within or peripheral to sedimentary accumulation basin (sediment loading). Examples: Lower Rhine, Körös Basin, offshore Mediterranean coastal rivers such as the Gediz, Büyük Menderes, Axios & Seyhan. Subsidence and stacked sequences are also possible on Archaean crust (in response to sediment loading - e.g. Ganges), but the wavelength of flexure is much greater due to greater crustal rigidity.

3. Stable pattern, with terrace preservation a factor of diversion events and/or change in discharge rather than significant incision (Box 3). Early and pre-Quaternary deposits occur within a few metres of modern river level. Restricted to ancient cratonic crust, apparently experiencing minimal Late Cenozoic uplift or downwarping. Examples: Narmada, Pravura, Vaal, Lower Volga.

Glacio- and hydro-isostatic effects can be overprinted on these patterns, providing a further link to Quaternary climatic fluctuation.

A QUATERNARY TERRACE UPLIFT RECORD FOR THE NORTHERN WAITAKERE RANGES, NEW ZEALAND, BASED ON MARINE-TERRESTRIAL CORRELATIONS

L. Claessens & A. Veldkamp

This study correlates marine and fluvial terrace sequences for the northern region of the Waitakere Ranges, North Island, New Zealand. Field surveys and the analysis of aerial photography yielded an inventory of 13 fluvial and 14 marine terrace levels. Due to poor exposure of distinct field evidence in the form of e.g. wave cut platforms or river sediments, planar landscape morphology was the main criterion for terrace remnant identification. Based on the record of terrace height spacings, sparse tephra age control and correlation with global paleoclimatic records, an attempt is made to reconstruct the regional Quaternary uplift rates. Because no hard chronostratigraphic marker is present within the fluvial terrace sequence, fluvial terrace levels are linked to the marine sequence by using the mean uplift rates calculated from the marine terraces (0.35 mm/y from 0- 0.1 Ma and 0.26 mm/y from 0.1-0.3 Ma). Both sets of terraces are then correlated with oxygen isotope fluctuations and the astronomically tuned timescale from ODP Site 677 and the Vostok ice core paleoclimatic records. Oldest marine and fluvial terrace levels are estimated 1.21 Ma and 0.242 Ma respectively. Although there seems to be some form of controversy about the uplift history and especially the preservation of terraces in the study area, a general regional uplift, superimposed on glacio-eustatic sea level changes, is substantiated as the only possible mechanism leading to the maintenance of a considerable relief and active denudation processes inland. Furthermore, since terrace research is now mainly conducted in geological settings where formation and preservation of terrace surfaces and sediments are most likely, this work can possibly motivate future researchers to work more on terraces in less obvious rapid uplifiting settings as well.
.

QUATERNARY FLUVIAL ARCHIVES FROM EASTERN TURKEY AND THE MIDDLE EAST

T. Demir[1], A. Seyrek[2], İ. Yeşilnacar[3], M. Kartal[4], B. Çelik[5], R. Westaway[6], I. Kopar[7] & D.R. Bridgland[8]

[1]*Department of Geography, Harran University, 63300 Şanlıurfa, Turkey (e-mail: tdemir@harran.edu.tr)*
[2] *Department of Soil Science, Harran University, 63300 Şanlıurfa, Turkey (e-mail:aseyrek@harran.edu.tr)*
[3] *Department of Environmental Engineering, Harran University, 63300 Şanlıurfa, Turkey*
[4] *Department of Archaeology, Ankara University, 06100, Ankara, Turkey (e-mail: kartal@humanity.ankara.edu.tr)*
[5] *Department of Archaeology, Hacettepe University, 06532, Ankara, Turkey (e-mail: bcelik@hacettepe.edu.tr)*
[6] *Faculty of Mathematics and Computing, The Open University, Eldon House, Gosforth, Newcastle-upon-Tyne, NE3 3PW, U.K. (e-mail: r.w.c.westaway.ncl.ac.uk)*
[7]*Department of Geography, Ataturk University, 25240,Erzurum,Turkey (e-mai: ikopar@atauni.edu.edu.tr)*
[8] *Department of Geography, University of Durham, Durham DH1 3LE, UK. (e-mail: d.r.bridgland@durham.ac.uk)*

Many rivers in the Asian part of Turkey and the Levant have long terrace staircases. Best known amongst these is the sequence from the Euphrates, which now benefits from new dating work based on K-Ar geochronology of basalts overlying terrace gravels in the Syrian part of its course. Similar work has been undertaken in SE Turkey, on the Tigris at Diyarbakır and the Ceyhan at Düziçi. Other new work has arisen from archaeological projects in Syria, on the Orontes and Euphrates, in the former case leading to the recognition of a new long-timescale terrace staircase. It can now be established that the Orontes sequence dates back to the Early Pleistocene and that the Euphrates first developed in the latest Pliocene, although its early course was punctuated by lacustrine basins, which provide important sedimentary records. Preliminary studies have also been undertaken of rivers draining from Turkey into the Black Sea, including the Sakarya, Kızılırmak and Çoruh.

A consistent pattern has emerged from all these studies, one of staircases in which Middle Pleistocene terraces are typically found up to 100m above river level. Terrace formation is believed to be climatically forced, but enabled by surface uplift. Even though the region is in a plate boundary zone, the uplift indicated by the terrace altitudes is comparable to that in other, tectonically less active regions, such as NW Europe. In areas with high erosion rates, such as the Black Sea coast, terraces of particular age are higher, perhaps because uplift is, at least in part, an isostatic response to the erosion. It seems that, in most rivers, the main Middle Pleistocene cold stages, those resulting in glaciations in northern Europe, are represented by terraces in Turkey and the Middle East: notably MIS 22, 16, 12, 8, 6 and 2. However, the timing of terrace aggradation within the Milankovitch climate cycle is poorly understood.

LATE QUATERNARY FLUVIAL EVOLUTION OF THE DIFFERENT REACHES OF TISZA RIVER ON THE GREAT HUNGARIAN PLAIN

Gyula Gábris & Balázs Nagy

Eötvös University of Budapest, Department of Physical Geography

The Tisza – as the largest river of the Great Hungarian Plain – presents different geomorphological characteristics. For the reconstruction of surface evolution, detailed geomorphological research was carried out. As a part of the investigation a geomorphological map was prepared along a 150 km long river section displaying its approximately 10-20 km wide neighbouring area, on a scale of 10 000. Based on sedimentological data, surfaces of different origins, materials and age were separated. Using borehole-profiles, abandoned channels of different size, origin and age were classified. Considering the latter data it was possible to create general conclusions for the processes – triggered locally by vertical crustal movements and generally by climate change – and for the chronology of the events for the whole reach of River Tisza. Riversections characterised by accumulational surfaces and valley-like erosional reaches characterised by levels with different age were identified. The location and chronology of Late Quaternary flow-direction changes of the Tisza were defined. Late Quaternary fluvial style changes were reconstructed in the area of the major alluvial fan in the Tisza region. Results of this investigation are comparable to the behaviour of the European lowland rivers.

LAST GLACIAL – INTERGLACIAL CYCLE IN THE EVOLUTION OF RIVER VALLEYS IN POLAND

Piotr Gębica* and Leszek Starkel**

** Rzeszów University, Rzeszów, Poland*
*** Institute of Geography, Polish Ac. Sc., Kraków, Poland*

The last glacial – interglacial cycle in the former periglacial zone of Poland is represented by the formation of 2-3 separate Vistulian terrace steps with several cut and fills and lateglacial – Holocene incisions, in which also several fills may be distinguished.

The Eemian interglacial was favourable for erosion, both in the mountain reaches where early Vistulian alluvia overlie rock benches, as well as in their foreland and in the Polish Lowland, where fossil channels slope down 10-20 m below the present river beds. During the early Vistulian (115-75 ka BP) the fan agradation at the mountain foreland reached a level of 5-10 m above present channels. These deposits were later buried by loess and solifluction deposits.

In the lower Pleniglacial (75-58 ka BP) a thick gravely/sandy member was aggraded to 5-6 m above the present channel and was overlain by interpleniglacial finer alluvia. This middle Pleniglacial unit (58-25 ka BP) is characterised by several alternate cooler and warmer climatic oscillations. The deposits of that age form the basic – central part of two terrace sequencies (25-20 and 18-13 m high) recognised in some lowland periglacial river valleys of central Poland as well in the valleys of loess plateaus in the south. The progressing aggradation was disturbed by episodes of dissection. Before 40 ka BP the lateral erosion with formation of erosional benches followed and channel avulsions were registered, dated between 46 and 36 ka BP.

The next fill of the middle terrace, 13-18 m high, includes an interstadial member dated 32-28 ka BP and at some localities also younger deposits. After that in the conditions of progressing aridisation and loess deposition the incision by braided river channels followed again. Before the maximum extent of the ice sheet (20-18 ka BP) the deposition of new sandy member started, forming a terrace level 8-11 m high. This surface was reworked by aeolian processes during the Lateglacial. The high rate of aggradation between 25 and 15 ka BP may be connected in some valleys either with the redeposition of older glacifluvial sands or, in the Carpathians flysch, with intensified solifluction.

In the mean time the Scandinavian ice sheet dammed the middle section of the Vistula valley, creating a lake in the Warsaw Basin. Simultaneously with the ice retreat and glacial rebound, a deepening by tens of meters of the successive ice free sections followed so fast that the level of the Holocene floodplain was reached before 14 ka BP. In the Carpathian foreland, about 15-13 ka BP, the incision phase continued, registered in paleochannel fills buried deeply below the Holocene floodplains.

The late Vistulian (13-10 ka BP) is characterised by prevailing deepening of the lowland valleys, connected partly with a rapid lowering of base level and upstream with climatic warming. The multi-phased incision caused the formation of several erosional/depositional terrace steps in the middle part of the Vistula valley.

Starting in the Bölling and even earlier, the river channels changed their pattern from braided to large meanders. Only in some tributary valleys with mountain headwaters was the braided pattern preserved until the early Holocene. The cool oscillation of the Younger Dryas caused an increase of bed load and shifting of large paleo-meanders (3-5 times wider and with greater radius) and even a trend to breading was registered again. This phase was accompanied by strong eolian activity reflected in systems of dunes. The rapid warming and expansion of dense forest cover at the beginning of Holocene has ceased the sediment load and reduced the size of mean-ders.

The Holocene period is characterised by alternate phases, relatively wetter and drier with various frequency of extreme floods. These phases are registered in separate cuts and fills expressed in meandering reaches by several steps of floodplains or by continuous aggradation, burying older members. In the lowland valleys at first the tendency to downcutting prevailed, connected with formation of new postglacial river network and low base level. Later followed the trend to aggradation and overgrowing by peat of ice marginal streamways.

Deforestation and soil cultivation, especially since the late Roman and mediaeval periods, is manifested in the acceleration of aggradation in the overbank facies and during the Little Ice Age even in the tendency to braiding of meandering channels.

The detailed examination of young Quaternary alluvial fills shows how complicated is the model of glacial-interglacial cycle of river valley evolution, in which climatic fluctuations of various orders are reflected.

THE BRITISH FLUVIAL ARCHIVE: EAST MIDLANDS DRAINAGE EVOLUTION IN THE CONTEXT OF THE BRITISH AND NW EUROPEAN RECORD

Andy Howard[1], Peter Allen, Martin Bates, Becky Briant, David Bridgland, Philip Gibbard, David Knight, Simon Lewis, Darrel Maddy, John McNabb, Jim Rose and Rob Westaway

1 - Institute of Archaeology and Antiquity, University of Birmingham

This poster seeks to fill the last significant gap in the British long-timescale fluvial archive, by providing a summary of the presently accepted chronology proposed for the Trent catchment. The Trent sequence, put together from evidence in the middle and lower reaches of the system, is relatively poorly constrained by age indicators. Limited biostratigraphy exists at a small number of sites and there are Palaeolithic assemblages from some of the terraces, although the age implications of these require investigation. The Trent has probably experienced more than one Pleistocene drainage diversion, a reflection of its northerly location, which has led to disruption during the main Quaternary glaciations.

Comparison is made with the other main British and NW European sequences. In contrast to most systems further south, it is difficult to trace the history of Trent drainage back before the Anglian (Elsterian) glaciation, although it is clear that in pre-Anglian times much of the catchment drained towards East Anglia by way of the Bytham/Ingham system. The Fenland rivers, draining to the Wash, have been initiated following Anglan deglaciation and their sedimentary sequences are stratigraphically above the Anglian glacial deposits. The other major Midland drainage system, the Severn-Avon, has also been glacially disrupted more than once.

A pre-Anglian precursor system can be recognized, however. The Thames was also disrupted by glaciation, but just once, during the Anglian. Its record extends back to the early Quaternary, when it probably drained the Midlands, before the Seven-Avon and Bytham systems were fully established. The one large fluvial system to have completely escaped glacial disruption, that of the Solent, has suffered late Quaternary marine breaching instead. There are significant long-timescale records in smaller extra-glacial systems, such as those draining the Weald, amongst which the Wey, Medway, Stour and Arun are probably the most important. Further west, the Bristol Avon and the Axe have important Palaeolithic records but very different modes of terrace development, perhaps related to different crustal histories. The Somme, in northern France, has a similar terrace record to many British systems, but with apparent differences in its relation to climatic fluctuation. The Seine and Maas/Meuse, on the other hand, both have large-scale extra-glacial terrace systems that represent the major Quaternary climatic cycles on an approximate one to one basis. Generally there is a widespread pattern across NW Europe that shows terrace systems with terraces formed in broad synchrony with 100ka climatic fluctuation. The depth of post-Middle Pleistocene fluvial incision is also broadly comparable across this area, with the obvious exceptions of the subsiding Lower Rhine basin and the extreme depth of the Rhine gorge, which requires up to 200m of incision since the end of the Early Pleistocene. In the northern fringes, where rivers have been glacially disrupted, the uplift and incision history are also likely to be atypical, as is indicated by the Thames record from west of London.

MOLLUSCAN EVIDENCE FROM FLUVIAL SEDIMENTS: CONTRIBUTIONS TO THE IGCP 449 DATABASE

David Keen[1], Nicole Limondin-Louzouet[2] & Richard Preece[3]

1 - Institute of Archaeology and Antiquity, University of Birmingham
E-mail: david_h_keen@hotmail.com
2 - CNRS, UMR 8591, Laboratoire de Géographie Physique, "Environnements quaternaires continentaux, dynamique naturelle et anthropisation", 1 Place A. Briand, 92195 Meudon cedex, France
E-mail: Nicole.Limondin@cnrs-bellevue.fr
3 - Department of Zoologyy, University of Cambridge, Downing Street, Cambridge, CB2 3EJ, UK
E-mail: rcp1001@cus.cam.ac.uk

The value of molluscan assemblages for interpreting fluvial sequences is well established; with terrestrial, freshwater, brackish and marine representatives, molluscs can record nearby land habitats as well as, in the lower reaches of rivers, the transition to the marine environment. Thus they allow sea-level changes at the downstream ends of river courses to be detected (Markova & Mihailescu, 1994; Bridgland *et al*., 1999, 2001). The Mollusca supply important biostratigraphical and palaeoenvironmental information (Lozek, 1964a, 1964b; Horacek & Lozek, 1988; Keen, 1990, 2001; Kovanda *et al.,* 1995; Preece, 1995, 1999, 2001; Antoine & Limondin-Louzouet, 2004) and, in recent years, have provided the raw material for the powerful geochronological method based on the epimerization of amino acids within mollusc shells (Miller *et al*., 1979; Bowen *et al*., 1989, 1995; Bates, 1994; Penckman *et al*., 2003). Molluscs are also extremely important climato-stratigraphical tools, since they provide reliable evidence for palaeoclimate and palaeoenvironmental conditions.

As part of IGCP 449, molluscan assemblages have made importasnr contributions to data from a number of areas, notably northern France (Antoine & Limondin-Lozouet, 2004), central Germany (Meyrick & Schreve, 2002) and Ukraine (Matoshko et al., 2002, 2004).

This poster includes a gazetteer of molluscan data from the project.

References:

Antoine P. & Limondin-Lozouet N. (2004). Identification of MIS 11 Interglacial tufa deposit in the Somme valley (France): new results from the Saint-Acheul fluvial sequence. *Quaternaire*, **15**, 41-52.

Bates, M.R. (1994). Quaternary aminostratigraphy in northwestern France. *Quaternary Science Reviews*, **12**, 793-809.

Bowen, D.Q., Hughes, S.A., Sykes, G.A. & Miller, G.M. (1989). Land-sea correlations in the Pleistocene based on isoleucine epimerization in non-marine molluscs. *Nature*, **340**, 49-51.

Bowen, D.Q., Sykes, G.A., Maddy, D., Bridgland, D.R. & Lewis, S.G. (1995). Aminostratigraphy and amino acid geochronology of English lowland valleys: the Lower Thames in context. In: Bridgland, D.R., Allen, P. & Haggert, B.A. *The Quaternary of the lower reaches of the Thames*, Quaternary Research Association Field Guide, Durham, 61-63.

Bridgland, D.R., Field, M.H., Holmes, J.A., Mcnabb, J., Preece, R.C., Selby, I, Wymer, J.J., Boreham, S., Irving, B.G., Parfitt, S.A. & Stuart, A.J. (1999). Middle Pleistocene interglacial Thames-Medway deposits at Clacton-on-Sea, England; reconsideration of the biostratigraphical and environmental context of the type Clactonian Palaeolithic industry. *Quaternary Science Reviews*, 18, 109-146.

Bridgland, D.R., Preece, R.C., Roe, H.M., Tipping, R.M., Coope, G.R., Field, M.H., Robinson, J.E., Schreve, D.C. & Crowe, K. (2001). Middle Pleistocene interglacial deposits at Barling, Essex, UK: evidence for a longer chronology for the Thames terrace sequence. *Journal of Quaternary Science*, **16**, 813-840.

Horacek, I. & Lozek, V. (1988). Paleozoology and the Mid-European Quaternary past: scope of approach and selected results. *Rozpr. Cs. Akad. Ved.R. mat. prir. Ved.*, **98**, 1-102.

Keen. D.H. (1990). Significance of the record provided by Pleistocene fluvial deposits and their included molluscan faunas for palaeoenvironmental reconstruction and stratigraphy: case study from the English Midlands. *Palaeogeography, Palaeoclimatology, Palaeoecology*, **80**, 25-34.

Keen. D.H. (2001). Towards a late Middle Pleistocene non-marine molluscan biostratigraphy for the British Isles. *Quaternary Science Reviews*, **20**, 1657-1665.

Kovanda, J., Smolikova, L. & Horacek, I. (1995). New data on four classic loess sections in Lower Austria. *Sbor. geol. Ved. Antropoziokum*, **22**, 63-85.

Lozek, V. (1964a). Quartärmollusken der Tschechoslowakei. *Rozpr. Ustr. Ust. geol.*, **31**, 1-347.

Lozek, V. (1964b). Neue Mollusken aus dem Altpleistozän Mittleeuropas. *Arch. Molluskenkunde*, **93** (5/6), 193-199.

Markova A.K. & Mihailescu C.D. (1994). Correlation of Pleistocene Marine and ContinentalDeposits from the Northwestern Black Sea Region. *Stratigraphy and Geological Correlation*. Vol. **2**, Nr.4. Moscow, 87-95.

Matoshko, A. (2004). Evolution of the fluvial system of the Prypiat, Desna and Dnieper during the late Middle-Late Pleistocene. *Quaternaire*, **15**, 117-128.

Matoshko, A., Gozhik, P. & Ivchenko, A. (2002). The fluvial archive of the Middle and Lower Dnieper (a review). *Geologie en Mijnbouw/Netherlands Journal of Geoscience*, **81**, 339-355.

Meyrick, R.A. & Schreve, D.C. (2002). *The Quaternary of Central Germany (Thuringia & Surroundings)*. Field Guide, Quaternary Research Association, London, 59-78.

Miller, G.H., Hollin, J.T. & Andrews, J. (1979). Aminostratigraphy of UK Pleistocene deposits. *Nature*, **281**, 539-543.

Penkman, K.E.H., Maddy, D. & Collins, M. (2003). Racemization in a box; does a closed system improve kinetics? *Geological Society of America Abstracts with Programs*, Vol. 35, No. 6, September 2003, p. 273.

Preece, R.C. (1995). Mollusca from interglacial sediments at three critical sites in the Lower Thames. In: Bridgland, D.R., Allen, P. and Haggart, B.A. (eds) *The Quaternary of the lower reaches of the Thames*. Field Guide, Quaternary Research Association, Durham, 55-60.

Preece, R.C. (1999). Mollusca from the Last interglacial fluvial deposits at Trafalgar Square, London. *Journal of Quaternary Science*, **14**, 77-89.

Preece, R.C. (2001). Molluscan evidence for differentiation of interglacials within the 'Cromerian Complex'. *Quaternary Science Reviews*, **20**, 1643-1656.

THE LATE PLEISTOCENE FLUVIAL RECORD OF LARGE SOUTH AMERICAN FLUVIAL SYSTEMS

Latrubesse, E.M[1]. & Stevaux, J.C[2]

1 - Federal University of Goias-LABOGEF, Goiania, Brazil, latrubes@terra.com.br)
2 - Maringá State University, Maringá, Brazil, jcstevaux@uem.br

Six of the ten largest rivers of the world in terms of water discharge are in South America. They are the Amazon, Orinoco, Negro, Madeira, Paraná and Japura, and they discharge to the oceans ~28% of the global river water.

Here we present results on the impact of global changes on the largest fluvial South American basins during the Late Pleistocene. Recent research on fluvial deposits, vertebrate paleontology, palynology, together with geomorphological studies, demonstrates that the tropics of South America suffered drastic climatic, palaeogeographical and plaeoecological changes during the Late Pleistocene.

The best record of fluvial deposits in the large basins is related to the Middle Pleniglacial (~55-28 ka) when more torrential deposits were in general deposited throughout the sub-continent. Climate was characterized by highly seasonal rainfall, indicating that a climatic deterioration began before the Upper Pleniglacial.

The Upper Pleniglacial (28-14ka) is characterized by a scarcity of fluvial data. Apparently low discharges and dissection were the fluvial response to the climatic changes during the Last Glacial Maximum. Aeolian activity spread on the large South American plains such as the Pampas, Llanos del Orinoco, Chaco and part of the Amazon basin.

A recuperation of fluvial activity is noted during the Lateglacial (14-10ka). Well developed terraces with fine sediments are frequent in tropical rivers and the recuperation of tropical rainforest happened at this time.

MIDDLE PLEISTOCENE MALACOFAUNAS FROM NORTHERN FRANCE : NEW RESULTS

Nicole Limondin-lozouet[1], Pierre Antoine [1], Jean-Jacques Bahain[2], Christine Chaussé[1], Christophe Falgueres[2], Pierre Voinchet[2]

1- CNRS, UMR 8591, Laboratoire de Géographie Physique, "Environnements quaternaires continentaux, dynamique naturelle et anthropisation", 1 Place A. Briand, 92195 Meudon cedex - France. (E-mail: limondin@cnrs-bellevue.fr/ antoine@cnrs-bellevue.fr / chausse@cnrs-bellevue.fr)
2 - Institut de Paléontologie Humaine, Laboratoire de Préhistoire du Muséum National d'Histoire Naturelle, UMR 6569 du CNRS, 1 rue René Panhard. 75013 Paris - France (E-mail: bahain@mnhn.fr / pvoinch@mnhn.fr)

Although continental Mollusca have proved to be of great interest as a biostratigraphical tool, references on most of Middle Pleistocene Interglacials are still scarce in Northern France. Recently a new faunal list have been published from Soucy in the Yonne valley. Dates between 345 and 365 Ka (ESR and U-Th ages) obtained on the alluvial units together with stratigraphical interpretation have allowed to allocate fine fluvial sediments containing the malacofauna to MIS 9. At their maximum of development in the sequence molluscs assemblages provide 61 species including 39 terrestrial from which 16 are closely related with forested biotopes. Among those, several appear to be out of their modern range and one is an extinct species: *Aegopis klemmi* Schlickum and Lozek, 1965. Occurrences of these central european taxa suggest more continental climatic conditions than today.

At Caours in the Somme basin, new investigations have been undertaken on a tufa deposit allocated to MIS 5. From the base of the sequence, development of open-ground molluscs is followed by expansion of shade-loving species up to 70 % of the assemblages. Allochtonous species are also recorded during the full temperate episode (*Platyla polita, Ruthenica filograna, Pagodulina pagodula, Daudebardia*) mostly from modern central European range. The upper part of the deposit is characterized by the return of more xerophilous gastropods.

Indeed the best identified malacofauna from French Middle Pleistocene Interglacial deposits is linked to MIS 11. Saint-Acheul in the Somme basin have provided malacological assemblages from a tufa layer located at the top of a Fluvial sequence. Molluscan communities appear very rich and although dominated by populations of open grassland species, contain up to 23 forest taxa. This high diversity in thermophilous molluscs allows to identify full temperate climatic conditions. Moreover, occurrence of an extinct Zonitidae belonging to the genus *Retinella* (*Lyrodiscus)* together with several species out of their modern range (*Platyla polita, Ena montana, Ruthenica filograna Clausilia pumila, C. dubia, Macrogastra ventricosa, Perforatella bidentata, P. incarnata, Belgrandia marginata, Hygromia limbata*) allow to correlate the Saint-Acheul assemblage with malacofaunas recovered in other stage 11 tufa deposits from the Somme and the Seine valleys. This chronological allocation is reinforced at Saint-Acheul by stratigraphy and ESR quartz age of the underlying fluvial deposits (403 ± 73 kyrs BP). Besides, taxonomical reassessment of the *R. (Lyrodiscus)* species shows that *R. (Lyrodiscus) skertchlyi* Kerney, 1976 is a junior synonym of *Retinella* (*Lyrodiscus) elephantium* (Bourguignat, 1869). Reappraisal of the French malacological lists improves their similarity with British malacofaunas of Hoxnian age. These new results strenghtened the originality and biostratigraphical value of the "*Lyrodiscus* assemblage".

THE EARLY PLEISTOCENE TERRACES OF THE GEDIZ RIVER AROUND KULA, WESTERN TURKEY: AN UPLIFT-DRIVEN, CLIMATE-CONTROLLED SYSTEM?

Maddy, D[*]., Demir, T.[#], Bridgland, D.R.[$], Veldkamp, A[&], Stemerdink, C.[*], Van der Schriek, T.[*] and Westaway, R[+].

[*]*Department of Geography, University of Newcastle, Daysh Building, Newcastle upon Tyne, NE1 7RU UK.*
corresponding email: darrel.maddy@ncl.ac.uk
[#]*Department of Geography, Harran University, 63300 Sanliurfa, Turkey*
[$]*Department of Geography, Durham University, South Road, Durham DH1 3LE UK*
[&]*Wageningen University & Research Centre, Duivendaal 10, 6701 AR Wageningen, PO Box 37, 6700 AA Wageningen, The Netherlands.*
[+]*Faculty of Mathematics and Computing, The Open University, Eldon House, Gosforth, Newcastle upon Tyne NE3 3PW, UK*

Recent investigations of the Pleistocene sequence of the Gediz River around Kula, western Turkey, have revealed a unique and unparalleled record of Early Pleistocene river terraces. Preserved beneath surface lava flows and progradational alluvial fan deposits, sediments of the palaeogediz form a flight of terraces, which reflect uplift-driven, climate controlled, high-frequency aggradation-incision cycles. This terrace flight, not only represents the most complete sequence yet described from the Mediterranean basin but may also preserve the most compelling evidence yet for Early Pleistocene climate-control of river systems.

The Gediz river valley north-east of Kula lies upon the uplifted northern rift shoulder of the Aleşehir Graben (which lies some 30km to the south), the result of Late Cenozoic extensional tectonics. The preservation of a complete sequence of terraces is considered to result from appropriate uplift rates that neither destroy nor mask the cyclic nature of sedimentation during progressive valley incision. High-frequency, obliquity-driven (~41ka) climate changes during the Early Pleistocene are reflected in changing river hydrology and sediment budgets. Cyclic changes appear to result in cold climate sedimentation in both the river and its adjacent alluvial fans. Warmer phases promote accommodation of the regional uplift via incision in the trunk river and fan-head entrenchment of tributary fans resulting in progradation of the fan-toe onto the lowered trunk river floodplain.

The blanketing of this sequence by subsequent basaltic lava flows has protected the areas lying within the limits of the flow from subsequence denudation. Erosion around the outer limits of these early lava flows has led to topographic inversion, with the former valley floor now perfectly preserved beneath high-level basalt plateaux.

THE ROLE OF THE ÉRMELLÉK-BERETTYÓ-KÖRÖS DEPRESSION IN THE RIVER COURSE DEVELOPMENT OF THE GREAT HUNGARIAN PLAIN

Árpád Magyari, Annamária Nádor, Edit Thamó-Bozsó,
Zsolt Kercsmár & Edit Babinszki

Geological Institute of Hungary, Stefánia ut 14, H-1143 Budapest, Hungary
(e-mail:magyari@mafi.hu)

During the Pleistocene, due to the regional subsidence of the central part of the Pannonian Basin, the ancestors of the Danube and Tisza rivers and its tributaries have been filling up the basin in an overall aggradational style, resulting in the formation of the Great Hungarian Plain (GHP). The Pleistocene hydrography was mainly controlled by the differential local subsidences of the basin. For most of the Pleistocene a two-axis drainage system may have existed. The Paleo-Danube was flowing from NW to SE across the GHP towards the central part of the basin, which was an actively subsiding area. At the same time the Paleo-Tisza was flowing from NE towards the same depression along the NE-SW striking Érmellék-Berettyó-Körös line. At the end of the Pleistocene a third river (Palaeo-Bodrog) appeared parallel to the Érmellék-Berettyó-Körös line to the north, occupying a rejuvenated depression in the foreland of the North Midmountain chain. This resulted in the formation of a three axis drainage system (Gábris, 2002). During the Lateglacial, a significant local subsidence (Bodrogköz) dragged the Paleo-Tisza to the north, and thus it abandoned its former course along the Érmellék-Berettyó-Körös line, and occupied the position of the Paleo-Bodrog and formed its present course.

The aim of our study was to investigate the control of the Érmellék-Berettyó-Körös line on river course development of the GHP through the detailed study of the Körös-Berettyó rivers, which form a major eastern tributary system of the Tisza. The modern Berettyó-, Sebes-, Fekete- and Fehér-Körös rivers display a transverse fan-shaped pattern, orientated approximately east-west, draining the Apuseni Mountains in Romania, and confluencing with the axial Tisza river in the central part of the Pannonian Basin.

We have identified various ancient channel planforms on the Hungarian lowland area of the Körös-Berettyó system, based on a detailed analyses of airborne photographs covering about 4000 km^2. The reconstruction of the most important morphological features (channels, levees, terraces, marshes) showed, that the area can be subdivided into three roughly E-W striking sub-parallel zones which are found at slightly different morphological levels: (1) on the north, roughly along the Érmellék-Berettyó depression, large, well developed meanders are found at an average height of 87 m asl, (2) the central part is characterised by a dense pattern of small-scale former meanders, resembling to an anastomosing river at the lowest topographic position at 85-86 m asl, (3) on the south, a braided pattern can be seen at the highest morphological level at 88-89 m asl. Earlier studies (e.g. Mike 1991) suggested that the large meanders are remnants of the Paleo-Tisza, the anastomosing channels are attributed to the ancestors of the Körös rivers, while the southern braided planform is the northernmost remnant of the former Maros alluvial fan, south from the area.

In order to study the origin of the various planforms we have drilled altogether 8 full-cored boreholes with an average depth of 7 m in each zones in the autumn of 2004. Together with some other samples from nearby sand and clay pits, we have performed a detailed sedimentological analysis of the sediments, including heavy mineral studies to unravel source areas, as well as OSL and ^{14}C dating. Some preliminary results are summarised herein.

There is a striking difference in the lithological logs of the boreholes. Two boreholes, drilled in the braided zone expose 4 m thick fine-medium grained, well sorted sands, underlain by silt and clay. Another two boreholes in the zone of the large meanders expose similar fine-medium grained sand in a depth interval between 3 and 7 m, overlain by silt and clay. Four boreholes in the anastomosing zone mostly expose clay and silt, some fine-grained sand interbeddings are found at various depths.

The heavy mineral studies of 14 sand samples from pits showed a fairly similar composition, however there are some differences in their proportion from the three morphological zones. On the area of the large, well developed meanders the main heavy minerals are pyroxene, garnet and amphibole, with a varying dominance of one of them. In the region of the dense pattern of small meanders we mainly found pyroxene-rich sands with amphibole, magnetite, garnet, etc. In the braided zone the pyroxene is the most frequent heavy mineral in the sands too, which is followed by amphibole and magnetite. We are going to evaluate heavy mineral data by statistical methods in details to detect the similarities and differences between them and the recent river sediments of Tisza, Körös-Berettyó and Maros rivers.

OSL dating of 4 samples so far shows, that on the area of the large meanders the sands are about 25±1 and 40±2 ka old at a depth of 1,7 and 4,0 m below the recent surface. On the area of braided pattern morphology sands are older as they are about 39±3 and 50±4 ka old at 0,6 and 1,1 m below the surface. Another 15 samples will be measured from the boreholes in January 2005 which will give a more detailed time constrain.

According to our hypothetical model, the first stage of river development was characterised by a braided pattern as shown by its highest topographical position and oldest OSL age. Then the next stage of river development occurred at a lower topographic level, characterised by a meandering river style, i.e. this meandering river was flowing on the subsided former braided plain. Sands from the meandering zone show a younger OSL age. In the boreholes they are found at a depth of 3-7 m and are probably identical with the nearsurface sands of the braided zone. The next stage of development occurred at a further lowered level and led to the formation of the present lowest part of the alluvial plain, which formed a minor depression between the former braided and meandering zones. This was occupied by a river system of an anastomosing pattern, which was probably flowing on the subsided former meandering plain, underlain by the oldest braided plain remnant. Borehole logs in the anastomosing zone expose thick clay sequences with some sand interbeddings at various depth, which can be identical with the meandering and/or braided sands. This deepest zone had a very low gradient and could have represented a very similar pattern to the historical times with swampy environment. The question if the change from braided to meandering and to anastomosing was caused by climate change and/or by tectonics still needs further investigation.

This research is supported by the Hungarian National Research Fund (OTKA 46307). First OSL measurements were carried out together with Andrew Murray (RISØ National Laboratory Radiation Research Department, Denmark).

CORRELATION OF THE LATE CENOZOIC FLUVIAL EVENTS WITHIN THE EAST EUROPEAN PLAIN - MAIN RESULTS

A.Matoshko[1], P.Gozhick[2], G.Danukalova[3]

[1] *Institute of Geography, National Academy of Sciences of Ukraine, 44 Volodymyrska Street, 01034 Kiev, Ukraine (e-mail matoshko@iptelecom.net.ua)*
[2] *Institute of Geological Sciences, National Academy of Sciences of Ukraine, 55B Gonchara Street, 01054 Kiev, Ukraine (e-mail ignnanu@geolog.freenet.kiev.ua)*
[3] *Institute of Geology, Ufimian Scientific Centre, Russian Academy of Sciences, 16/2 Karl Marx Street, 450 000 Ufa-centre , Bashkortostan, Russian Federation (e-mail danukalova@anrb.ru)*

The reviewed published materials and the latest data collected by the authors about the occurrence, structure and stratigraphy of alluvial deposits and fluvial landforms of the Eastern European rivers Dniester, Dnieper, Don and Volga, and their development from the Miocene to Holocene, form the basis for this study. The main Late Cenozoic fluvial formations occur as alluvial accumulations (infills, 'sheets' and fans/deltas) and incisions, giving rise, in the modern relief, to plains, valleys and terraces. Part of fluvial formations are buried under different continental and marine deposits. The principal alluvial units are distinguished on the basis of mode of occurrence and lithological features of alluvial dynamic facies (channel, overbank, abandoned channel and some others) naturally formed depositional suites which in places are combined in successive series. The stratigraphic position of the identified suites and series is established with reference to marker beds (marine and glacial deposits, waste mantles) and to palaeontological (mammals and molluscs), palaeo-magnitostratigraphic, geomorphological (recognizing river terraces and correlating them by their height above river level), geochronological and archaeological evidence. The first long-term stratigraphical correlation scheme of alluvial units of the studied area is presented. All these data are used for correlation of the main fluvial palaeo-events and factors that caused fluvial development.

Groups of alluvial series and suites of the platform rivers: Dnieper, Don and Volga record several predominantly discordant erosion-aggradation cycles of different duration from the Miocene to the Middle-Late Pleistocene and one subsequent erosion phase (except Lower Dnieper) that is still continuing. During this time the total valley incision has been 160-200 m. It reached its maximum at the beginning of the Middle Miocene (Don) and at the end of the Miocene (Middle and Lower Volga and Dnieper). In the Carpathian piedmont (the Dniester) one full cycle in the Late Miocene - Early Pliocene has instead been followed by 250-270 m of incision to the present. Despite the temporal discordance of cycles within the basins of different rivers, there were two important time-spans when the development of all river systems changed substantially: the end of the Late Miocene (Messinian) and the Middle Pleistocene.

It is supposed that variations in crustal movements within different tectonic structures has caused the main cycles of erosion-accumulation in the different river basins to be out of phase. Each alluvial suite corresponds to the elementary phase of relative tectonic stabilisation or subsidence. The river terrace staircases are interpreted as the result of uplift pulses. Crustal movements have controlled changes of drainage pattern and have determined local areas of predominant aggradation or scour. Climatic oscillations through the changes of run-off, river regime, suspension/bedload, however, have influenced the channel and overbank processes, as is reflected in the structure, thickness and composition of the alluvial suites as well as in the relief of the river terraces. The regression-transgression cycles of the Caspian Sea, Azov Sea and Black Sea led to corresponding cycles of aggradation and erosion within a restricted part of the lower valley, depending on the scale of sea-level rise.

CLIMATE AND FLOW REGIME CHANGES IN AUSTRALIA FROM ~750 KA

Gerald C. Nanson & David M. Price

School of Earth and Environmental Science, University of Wollongong, NSW, 2522

Sediments from the Channel Country of the Lake Eyre basin provide evidence of major climate changes and the variable supply of water to the continent from the tropical oceans from the Mid Quaternary to Holocene. More than one hundred and fifty luminescence dates have been obtained from quartz sand in five depositional settings: floodplain alluvium; gorge alluvium; fluvial source-bordering dunes; lacustrine source-bordering dunes; linear dunes. Extensive deposits of coarse sand and fine gravel indicate powerful rivers reworking extensive areas of alluvium some 15 to 30 m below the present floodplain surface from ~750 to ~400 ka. The limited resolution of dates prevents an interpretation of whether the Mid Quaternary was an episodically or continuously wet period, but abundant carbonised wood suggests extensive riparian forests. The transition between oxygen isotope Stages 8 and 7, as well as the period in the middle of Stage 6, were particularly wet and enabled huge rivers to rework entire floodplains. A notable absence of fluvial activity occurred between ~145 and ~120 ka corresponding to the penultimate glacial maximum and the onset and peak of the last interglacial (Stage 5). Fluvial activity recommenced later in Stage 5 and again in Stage 3 but reworked far less floodplain than during the dramatic fluvial episodes prior to Stage 5. These less energetic rivers formed numerous source-bordering dunes and were associated with a system of terminal lakes. Flow confinement through the Innamincka Dome amplified an alluvial record that faded after Stage 3, identifying a period of enhanced flow in the early to mid Holocene.

Alluvial deposits on New South Wales (NSW) coastal rivers provide evidence of flow-regime and depositional changes affected by variations in moisture from the temperate oceans from about 100 ka to the present and correlate closely with fluvial phases on the westerly-flowing rivers of the Riverine Plain in the Murray basin (Fig. 1). Stage 5 gravels date between 110 and 90ka in the eastern portion of the Cranebrook Terrace and correspond to the Coleambally Phase deposits on the Riverine Plain that date between 105 and 80 ka. A younger and more-extensive mid-western gravel unit dates at about 85-73 ka. The basal gravels in the most western portion of the Cranebrook Terrace were deposited at about 50 to 40 Ka and correspond to the Stage 3 Kerarbury Phase on the Riverine Plain that dates from about 55 to 35 ka. The Kerarbury Phase was probably a lesser event (in magnitude and/or duration) than the combined periods of the Coleambally, for it reworked just part of the terrace. The Yanco Phase was even less erosive, only reworking the upper fines on the western portion of the terrace in the period 20 to 15 ka. No recognisable equivalent to the Gum Creek Phase (35-25 ka on the Riverine Plain) has been located on the Nepean River. Clearly, the Wollondilly-Nepean River was a powerful, actively-migrating river when it formed and reworked the Cranebrook Terrace in Stages 5 and 3, yet today it is a very inactive system with no ability to erode its extensive former-floodplain. The Cranebrook Terrace reflects the remarkable changes in Quaternary flow-regimes for temperate Australian rivers not affected by headwater glaciation.

On the north coast of NSW, small catchments such as those of the Nambucca and Bellinger Rivers have experienced similar precipitation and flow-regime changes to those of the much larger rivers in NSW. However, their confined nature has meant that they have not retained their earlier Quaternary alluvium but instead have acted as amplifiers of recent Holocene changes that were much less pronounced than those occurring throughout much of the Late Pleistocene. A Yanco Phase flow-regime (20 to 13 ka) is widely preserved as the oldest major terrace systems in these smaller coastal valleys. The early to mid Holocene (12-3ka) (Nambucca Phase) was marked by much lower flows than those of the late Pleistocene, but they were certainly more pronounced than those of today. Since about 3-2 ka, many of the rivers of coastal southeastern Australia have been laterally stable with floodplains vertically accreting along side well-vegetated channels. It was these low-energy, laterally stable rivers that European land clearance have so dramatically destabilised in the past 200 years.

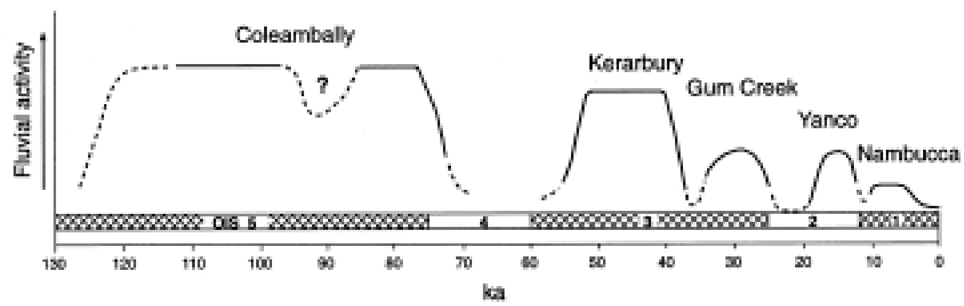

Figure 1: Schematic timeline of the intensity fluvial changes during the Late Quaternary in southeastern Australia.

LATE CENOZOIC FLUVIAL DEPOSITS OF THE RIVER ALLIER BASIN (FRANCE). CORRELATIONS WITH THE MASSIF CENTRAL VOLCANISM

Jean-François Pastre

Laboratoire de Géographie Physique, UMR 8591 CNRS, 1, place Aristide Briand, 92195, Meudon cedex, France, pastre@cnrs-bellevue.fr

The fluvial deposits of the river Allier Basin offer one of the most complete alluvial succession of western Europe. The volcanism has preserved several deposits from erosion and gives petrographical and mineralogical data used to correlate the fluvial deposits with K-Ar and Ar-Ar dated eruptions. The pyroclastic emissions of the Mont-Dore strato-volcano (3 – 0.25 Ma) have particularly influenced the mineralogical composition of the fluvial sands. Typical heavy minerals assemblages and markers like quartz, feldspars and pumices, provide useful tools for sedimentological correlations used to build a more or less precise chronostratigraphy.

In the middle part of the Limagne graben, the stepped deposits succession reaches an elevation of 200 m above the present river bed where the oldest ones are preserved by basaltic flows aged between 5 and 4 Ma. The most complete terrace succession occurs in the northern part of the Limagne graben. The upper Allier gorge incised in the basement shows a different record, heavily linked to the basaltic effusions of the Devès area and comprising several Early Pleistocene deposits close to the present-day river bed.

In order to detail correlations in the frame of the IGCP 449 project, new tephras studies and dating were performed in the Mont-Dore area, and new stratigraphical and sedimentological researches have been realised in the Upper and Middle Allier Basin. They evidence, in the northern part of the Limagne (Limagne bourbonnaise), a first main sedimentary phase prior to 3.5 Ma. Several high sedimentary input episodes follow during the Late Pliocene – Early Pleistocene, possibly in relation to the first glacial stages which seem to have played a major role around 2.6 Ma. After 2 Ma, most of the Limagne terraces can be correlated to major climatic cycles, but the mineralogical data show that each "morphological" terrace comprise several cut-and-fill units. The main ones are followed by 1, 2 or 3 "replica" which cannot be easily distinguished on the field. In the central part of the Limagne succession (from Issoire to Vichy), only minor morphostratigraphic differences are noticed. However, in the upper and lower parts (Limagne de Brioude, Limagne bourbonnaise), clear reductions in altitude and thickness occur, because of tectonic movements. The frequent destruction of several units, even of some main ones like the Saalian terraces, underlain the lacunar trend of this system. Planned further K-Ar dates on basalts, Ar-Ar on tephras and ESR dating on quartz will provide a more precise chronological frame.

AAR: AN AMINO ACID REVOLUTION?

Penkman, K.E.H.[1,2]*, Maddy, D. [2], Keen, D.H.[3], Preece, R.C.[4] & Collins M.C.[1]

1: BioArch, Biology S Block, University of York, PO Box 373, York, YO10 5YW
2: University of Newcastle, Newcastle-upon-Tyne, NE1 7RU
3: Birmingham Archaeology, University of Birmingham, Birmingham, B15 2TT
4: Department of Zoology, University of Cambridge, Downing Street, Cambridge, CB2 3EJ

The application of amino acid racemization (AAR) as a chronological tool for the Quaternary in Europe has been most successful with mollusc shells. Earlier studies have mainly been based on the D/L ratio of one amino acid in the total protein fraction. New work uses multiple-amino acid D/L and composition determinations combined with the isolation of an "intracrystalline" fraction. This ensures only original amino acids are analysed and allows the identification of bacterial contamination and post-depositional recrystallization. Attempts to isolate a closed system within gastropod shells have successfully discriminated marine isotope stages for the last 400 ka, but these findings have been eclipsed by results obtained from the analysis of *Bithynia* opercula, common fossils in Quaternary freshwater deposits. Preliminary results indicate that within a single site multiple opercula yield consistent results (5% -10% at 2 σ, n = 30), and the sites fall into discrete clusters. As a consequence, the AAR of opercula can be used to resolve not only stages but sub-stages within the Quaternary, and the separation of individual temperate events within the Cromerian Complex. The analysis of over 100 single opercula from 22 UK sites are reported, showing a very high correlation (R^2 = 0.96) between the Free and the Bound amino acids. This coherent calcitic intra-crystalline system within the opercula is maintained up to at least 700ka, with the apparent potential to discriminate further back in time. The results obtained generally support the original amino acid framework for the UK, with some significant exceptions.

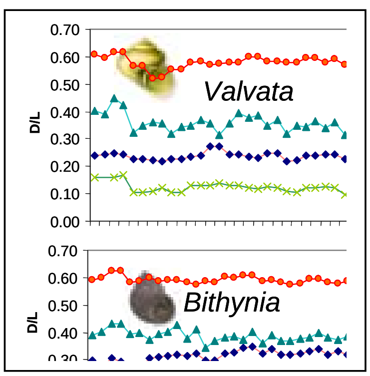

Figure 1. Comparison of D/L ratios from free amino acids in bleached shell powders of *Valvata* and *Bithynia* (above) and *Bithynia* opercula (below). Note the variation in relative rates of amino acids between the three samples (such as the difference between Glx and Ala) and the much greater consistency in the measurements obtained from opercula. Each of the measurements is from a single shell or operculum (shown actual size). Variation in hydrolysed samples was smaller for opercula.

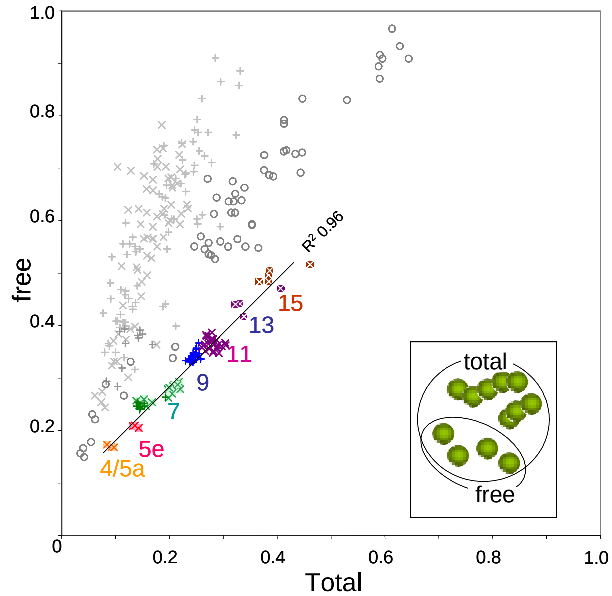

Figure 2. Correlation between free and total DMK (derived from multiple D/L amino acid ratios) for opercula (n=109) from UK Pleistocene sites (coloured points). Free vs. total aIle / Ile for glacial mollusc shells from Scotland (crosses, Bowen *et al*., 2002) and ostrich eggshell (circles, Miller *et al*., 2000) are plotted for comparison. Note lower than expected values for total (see Fig.1). Eggshell (a closed system) is more highly correlated than mollusc, but opercula are better still, and form discrete clusters (of interglacial isotope stages?). The strong correlation between amino acid pairs (in this case Glx and Val) is illustrated in the inset. The high degree of consistent difference between amino acids (see also Fig. 5) is used as the basis of the DMK estimate. Complete racemization yields DMK values of 1; the low levels of DMK values in stage 15 sites suggests that it may be possible to date to earlier in the Quaternary in the UK.

Bowen D. Q., Phillips F. M., McCabe A. M., Knutz P. C., and Sykes G. A. 2002. New data for the Last Glacial Maximum in Great Britain and Ireland. Quaternary Science Reviews 21(1-3), 89-101

Miller G. H., Hart C. P., Roark E. B., and Johnson B. J. 2000. Isoleucine epimerization in eggshells of the flightless Australian birds Genyornis and Dromaius. In *Perspectives in Amino Acid and Protein Geochemistry* (ed. G. A. Goodfriend *et al.*), pp. 161-181. Oxford University Press

LATE PLEISTOCENE PREDATOR ACTIVITY AND COMPOSITION: KOTOVKA VERTEBRATE SITE, UKRAINE

Popova, L.V.

National Taras Shevchenko University of Kyiv,
Ukraine, 03022, tel. 259-70-26, e-mail: spopov@mail.univ.kiev.ua

Fossil remains of alluvial taphocoenoses are always heterochronous to a certain extent, but in many cases the difference in the geological age of remains is negligible. Other sites containing remains of significantly different age are more difficult for biostratigraphi-cal interpretation. Their heterochroneity is reflected by fauna taxonomic composition (presence of remains of older species) or, more accurately, by increasing of specific variability range (Tesakov, 2002). Chronologi-cal mixing is a result of a terrace forming (washing out and transporting of previously existed deposits and fauna, contained in them), so the character of this heterochroneity indicates the time of alluvium accumulation – the age of the youngest remains is closest to the age of the containing deposits.

The opposite case – finding relatively young remains within an old alluvium is very rare and harder to interpret. These taphocoenoses, as a rule, bear the marks of disturbance (slope wash and groove traces, mole-burrows and so on). Mixed taphocoenoses with introducing of younger remains, but without any visible traces of mentioned processes, are even rarer. Quantitative and qualitative composition of the site under investigation (the Kotovka vertebrate site, the Middle Bug area, Ukraine, fig. 1.) allowed the study of the genesis of such taphocoenoses.

MAMMALIAN RECORDS FROM FLUVIAL CONTEXTS: CONTRIBUTIONS TO THE IGCP 449 BIOSTRATIGRAPHY SUBTHEME

Danielle Schreve

Biostratigraphy is a traditional and well-tried method for establishing relative chronologies for fluviatile sequences. Applicable only where fossiliferous sediments have been preserved, the method has proved useful in many parts of the World. The best fossil groups are those that can be identified readily to species level and those that have undergone significant evolutionary change within the late Cenozoic. Others may provide valuable palaeoenvironmental data that can be fed into climato-stratigraphic reconstructions.

The IGCP 449 Biostratigraphy Subgroup was formed at the inaugural conference of the project, which took place in Prague, Czech Republic, in April 2001. A number of palaeontologists representing various disciplines were in attendance and an informal meeting was chaired by Dr Danielle Schreve (DCS) of Royal Holloway, University of London, UK (vertebrate palaeontology). Other participants included:

- Prof. David Keen (DHK), Birmingham University, UK (malacology)
- Dr Rich Meyrick (RM), formerly of Forschungsstation für Quartärpaläontologie, Weimar, Germany (malacology)
- Dr Martin Ubilla (MU), Instituto de Geología y Paleontología, Uruguay (vertebrate palaeontology)
- Dr Richard Fariña (RF), Instituto de Geología y Paleontología, Uruguay (vertebrate palaeontology)

Other workers involved in mammalian biostratigraphical analysis of assemblages from fluvial deposits, with whom consultations have been made:

- Prof. Raffaele Sardella (University of Rome "La Sapienza") has worked extensively on Italian mammalian assemblages from the Tiber and other Italian rivers
- Prof. Anastasia Markova (Institute of Geography, Russian Academy of Sciences, Moscow) has studied mammalian assemblages from the Prut, Dnieper and Danube systems amongst others.

Because of their rapid evolution during the Late cenozoic, mammals are especially useful for biostratigraphy. Recent work suggests that mammalian fossils offer the most powerful tool for correlation of fluvial sequences with the global marine record of glacials and interglacials The bones and teeth of large mammals are commonly found in fluviatile deposits, probably because animal carcasses often find their way into rivers. Vertebrate remains from river deposits sometimes include hominid fossils, such as at Swanscombe, UK, in the Thames sequence (Conway et al., 1996), and Steinheim, Germany, within sediments of the River Murr (Adam et al., 1995). At another German fluvial site, Mauer, in the Neckar system, a hominid mandible from fluviatile sands represents the type specimen of Homo heidelbergenisis. Mammals are especially valuable for biostratigraphy, as they have undergone considerable evolution and numerous extinctions during the Neogene and Quaternary (Horacek, 1990). Small mammals and other small vertebrates are readily obtained from systematically collected samples by sieving (Rabeder, 1974, 1981; Fejfar & Heinrich, 1983).

This poster includes a gazetteer of mammalian research contributing to IGCP 449.

A PRELIMINARY ASSESSMENT OF THE LATE QUATERNARY FLUVIAL EVOLUTION OF THE LOWER TAGUS VALLEY NEAR MUGE (PORTUGAL)

Tim van der Schriek[1] & David G. Passmore[1]

[1] *Department of Geography, University of Newcastle upon Tyne, Newcastle upon Tyne, NE1 7RU.*
e-mail corresponding author: tim.van-der-schriek@ncl.ac.uk

This paper discusses the Quaternary fluvial deposits of the Lower Tagus River around Muge in central Portugal. Palaeotagus sediments form a flight of terraces which reflect uplift-driven deposition-incision cycles. To date, the chronology and stratigraphy of these deposits is poorly studied; here we present a comprehensive overview supported by stratigraphic and geomorphological field-data. Recent investigations have focussed on the late Quaternary valley floor evolution in the lower Muge valley, an east-bank tributary of the lower Tagus River. The presently canalised and cultivated lowland alluvial floodplain of the lower Muge tributary extends 10km upstream from the Tagus confluence and is locally infilled with at least 11m of Holocene homogeneous fine-grained sediments and peat which bury the Late Glacial-early Holocene incision profile.

Published data suggest that the last major fluvial incision phase of Atlantic Iberian estuarine valleys took place after c. 13,800 BP. This paper provisionally links this incision phase, during a period of rapid sea level rise, to climate change at the Pleistocene-Holocene transition. However, the confluence zone of the lower Muge tributary probably experienced base level induced incision governed by entrenchment of the Tagus River. Early Holocene sea level rise led to saltwater penetration of the lower Muge valley up to c. 5km inland from the Tagus confluence. The period of tidal influence in the lower Muge valley floor (c. 6200-3800 cal BC) is associated with rapid infill and balancing rates of sea level rise and sediment input. Fluvial aggradation slowed down after c. 3800 cal BC, while the final standstill of Tagus base level led to stabilisation of the valley floor between c. 3200 to 230 cal BC. Renewed sedimentation started after 230 cal BC near the Tagus confluence and only after c. 1800 cal AD in the central-upstream reaches of the lower Muge valley floor. These phases of renewed sedimentation have been tentatively linked to human impact on the catchment vegetation of the lower Tagus and Muge Rivers, respectively. It is concluded that Holocene deposition in the lower Muge valley floor is strongly related to inherited topography, base level fluctuations, and sediment input by tidal and fluvial processes.

EROSION MODELLING OF STRATIGRAPHIC SEQUENCES

Aleksey Sidorchuk
Landcare Research, New Zealand

Fluvial systems are characterised by the processes of erosion, sediment transport and deposition. Cainozoic history of fluvial system behaviour is imprinted both in erosion and depositional features, such as river terraces and alluvial stratigraphic sequences. Numerical modelling of erosion landscape evolution is useful for adequate interpretation of morphological features and alluvial deposits, as well as for the better understanding of all difficulties and uncertainties of such interpretation.

Basic for erosion modelling on the net of flowlines is so called equation of deformation

$$(1-\varepsilon)\frac{\partial Z}{\partial t}+\frac{\partial Q_s}{\partial x}=F(x,t) \qquad (1)$$

Here Z is flow bed altitude; Q_s is sediment transport rate; t is time; x is longitudinal coordinate; ε is eroded matter porosity and F is spatio-temporal function of tectonic deformation. Numerical solution of (1) depends on type of functions for Q_s and F, initial Digital Terrain Models of erosion landscape, river water flow change in time/space and sea level change in time.

Two main examples are discussed: a small catchment of Brook Creek (New South Wales, Australia) evolution during 40 years under land use changes and long profile of the Yana River (East Siberia, Russia) transformation during the last two million years in the conditions of tectonic uplift of Kular ridge.

For the Brook Creek catchment modelling initial Digital Elevation Model was performed from year 1941 air-photos, the nearest hydrological station long-term water flow records were used and sediment transport rate variability along the flow was described as sum of erosion and deposition terms (Sidorchuk, 1999):

$$\frac{1}{W}\frac{\partial Q_s}{\partial x}=k_e qS-k_d V_f C \qquad (2)$$

Here W is flow width; q is specific flow discharge (m^2/s); S is flow surface slope; V_f is particle fall velocity in a turbulent flow; C is mean sediment concentration in flow; k_e is erosion coefficient and k_d is deposition coefficient. Several scenarios of land use type (vegetation cover quality) were appointed and deposition at the catchment mouth was simulated. These depositional sequences (rate of deposition through time) were significantly different for the same climate (water flow change), but different land use type. Inverse problem solution – the reconstruction of water flow change through time from the depositional sequence, was therefore possible only with the knowledge about land use type.

The initial and boundary conditions for the Yana River long profile modelling were much more indefinite: the contemporary long profile was used as initial; water flow change was reconstructed from fossil flora data (Sidorchuk, Panin, 1996); best fit Kular ridge uplift rate was calculated from the model (Matveev *et al.*, 1994) and sea level change through the Cainozoic was taken from Klige with co-authors (1998). Sediment transport rate (kg/s) for gravel was calculated with Shamov's (1954) formula

$$Q_s=0.95W\sqrt{D}\left(\frac{U}{U_{cr}}\right)^3\left(U-U_{cr}\right)\left(\frac{D}{d}\right)^{1/4} \qquad (3)$$

and for sand with Rossinkiy-Kuzmin (1950) formula:

$$Q_s=0.024\frac{U^4W}{V_f d} \qquad (4)$$

Here D is sediment grain size; U is flow velocity; U_{cr} is velocity of erosion initiation and d is flow depth. A system of terraces was simulated in this example. The model sensibility to initial and boundary conditions uncertainty was analysed.

GEOMORPHIC DIVERSITY, STRATIGRAPHIC DEVELOPMENT AND FLUVIAL RESPONSE TO MONSOONAL FLUCTUATIONS: EXAMPLES FROM THE GANGETIC BASIN, HIMALAYAN FORELAND, INDIA

Rajiv Sinha

Engineering Geosciences Group, Indian Institute of Technology Kanpur, Kanpur 208016, India (rsinha@iitk.ac.in)

The Gangetic basin in the Himalayan foreland is a part of the world's largest area of Quaternary alluvial sedimentation and supports a population of over 200 million people. The Gangetic plain deposits not only serve as a modern analogue for the ancient fluvial sequences of the Himalayan foreland basin but they also provide one of the most significant continental records for understanding the interplay of climate, tectonics and eustatic changes in generating thick sedimentary fills in a monsoon-dominated foreland system. Given the large dimensions of the Gangetic basin and the lack of an integrated approach, the available data are fragmentary, and several important questions regarding the sedimentary architecture and the process-form relationships of the parent rivers remain unanswered. We record significant variation in sedimentary architecture between the western and eastern parts of the Gangetic basin. This variation reflects geomorphic diversity (linked especially to precipitation gradients) and tectonic history in the frontal orogenic areas which, in turn, impact sediment supply into the basin. Most of the rivers in the eastern part show an aggradational regime and the alluvial sequences being generated below consist of thick sand bodies intercalated with muddy deposits. On the contrary, many of the alluvial sequences in the western Ganga basin are interrupted by discontinuities that reflect floodplain aggradation and degradation in response to forcing by the southwest Indian Monsoon. The major Himalayan and cratonic rivers in the western Gangetic plains area occupy narrow, incised valleys and do not inundate the adjoining broad interfluves. However, these areas were under active alluviation because thick floodplain muds underlie the interfluve. Our age data suggests that interfluve areas near the major rivers aggraded periodically between about 27 ka and 90 ka B.P. (Marine Oxygen Isotope Stages 3-5). They subsequently degraded or accumulated sediment only locally, probably reflecting decreased monsoonal precipitation around the Last Glacial Maximum (Marine Isotope Stage 2) when major river valleys moved to an underfit condition. Increased precipitation during the 15 to 5 ka period of monsoon recovery probably increased discharge and promoted incision and widespread badland formation. In addition to controlling the long-term accumulation rate, tectonics may have had some local influence, and the effects of eustatic changes were almost certainly limited to the deltaic region of the lower Gangetic plains, extending to a maximum of 300-400 km landward.

A PRELIMINARY INTERPRETATION OF PLEISTOCENE FLUVIAL EVOLUTION IN LITHUANIA

Petras Sinkunas & Vaida Seiriene

Institute of Geology and Geography, Sevcenkos 13, LT-03223, Vilnius, Lithuania;
sinkunas@geo.lt, seiriene@geo.lt

Glacigenic deposits compose a major part of the Quaternary sequence in Lithuania. The major part of the deposits between tills originate from melting during the adjustments from glacial climates to the Butenai (Holsteinian) and Merkine (Eeemian) Interglacials. After the till beds were correlated, inter-till sediments related to meltwater stream, proglacial basin and nonglacial sedimentation were interpreted. Patterns of glacially and interglacially controlled sedimentation and, particularly, fluvial sedimentation are distinguished using the logs from about 3000 boreholes and almost fifty outcrops studied sedimentologically and palaeobotanically. Palaebotanical (pollen, macrofossil and diatom) data were used. These inter-till deposits occur throughout Lithuania except in its northern part, which has been repeatedly eroded by glaciers.

Two main types of criteria were used to recognise interglacial fluvial sedimentation. The first consists of visual characteristics, peculiarities of grain-size frequency distribution and composition of sediments. The second involves peculiarities of occurrence, patterns of bed topography and lithostratigraphy, derived from borehole core data and proved under palaeogeomorphological interpretations.

Fluvial lithofacies usually consist of tabular or trough cross-bedded sands. In borehole logs a high maturity of composition was considered as a distinguishing feature of non-glacial water-lain sedimentation. A low content of minerals that are not resistant to weathering and a high quantity of quartz is also considered characteristic of interglacials. Such mineralogy causes the light yellow or even white colour of these deposits. It is clearly reflected in differences of geochemical composition of sediments repeatedly redeposited and weathered in an interglacial environment. The results of statistical principal component analysis display a good positive correlation between CaO, MgO, Al_2O_3, K_2O and Na_2O, which are characteristic of deposits formed in glacial environment and notably decrease in the interglacial sediments of Lithuania.

The organic-rich interglacial sediments of fluvial-lacustrine systems provide palaeogeographic evidence on the evolution of hydrodynamic conditions during sedimentation. Fluctuation of mean annual, January and July temperatures and annual precipitation during interglacials is inferred using palaeobotanical data from these sediments. A probabilistic method for evaluating pollen composition and gradation of trees according to their distribution, and the climatic indicator species method, were used to estimate the climatic variability.

A cold dry climate led to erosion and widespread terrigenous sedimentation, which caused a poor content of organic matter in sediments during the initial stage of the Butenai (Holsteinian) Interglacial. A warm but quite dry climate throughout this interglacial did not stimulate organogenic sedimentation at such high rates as occurred during the later Mekine (Eemian) Interglacial. The climatic optimum was warmer and damper during the Mekine (Eemian) Interglacial: the mean annual temperature fluctuated from +11 to +13 °C, the mean January temperature from +1 to -1 °C and the mean July temperature from +22 to +23 °C. At this time the land surface was sheltered by vegetation, preventing erosion, and major organogenic sedimentation took place.

Palaeo-basins of interglacial sedimentation are linked to surface topography and reflect the main features of the hydrographic network, which in Lithuania tends to be inherited (from each interglacial to the next) throughout the Quaternary.

LONG-TERM DYNAMICS OF SOIL, VEGETATION AND LANDSCAPE, A CASE STUDY IN KWAZULU/NATAL, SOUTH AFRICA

Arnaud Temme

Laboratory of Soil Science and Geology, Department of Environmental Sciences, Wageningen University and Research Centre, Netherlands

This research attempts to use a 100ka sedimentary record present in colluvia in the fieldwork area to study long term dynamics of soil, vegetation and landscape. Also, using paleo-environmental data from this record and paleoclimatic data from other work (cf. Partridge, 1997), we want to run and calibrate landscape simulations that focus on the interaction of soil, vegetation and landscape.

For this purpose, dynamic landscape evolution model LAPSUS (LAndscape ProcesS modeling at mUlti dimensionS and scales; Schoorl and Veldkamp, 2001) will be extended with soil-vegetation-landscape functions and feedbacks.

The fieldwork area is in the foothills of the Drakensberg mountains, in KwaZulu/Natal, South Africa at an altitude of about 1200 m. Local bedrock consists of alternating layers of sand- and mudstone of the Permian, Triassic and Jurassic Karoo Supergroup, capped in places with Jurassic Drakensberg basalts. Quaternary sediments in the valley are colluvia derived from the Karoo Supergroup, called the Masotcheni formation.

Masotcheni formation colluvia are located in concave piedmont positions in the research area that are protected from fluvial erosion by their altitude or by resistant doleritic intrusions of Jurassic age. The landscape system that formed the Masotcheni formation, has been disconnected from the downstream fluvial system for most of its age, given the apparent relatively continuous accumulation of sediments in it. Currently, gully erosion is widespread though. Stratigraphy of the Masotcheni formation, visible in gully-walls, is complex because different phases of erosion and sedimentation occurred during the Quaternary and bedrock morphology is irregular.

Discontinuous outcrops of the Masotcheni formation are visible in the walls of the gullies in the area for hundreds of meters. Unfortunately, they are frequently obscured by vegetation and muddy crusts or altered by bioturbation and desiccation.

Still, it is possible to distinguish sometimes up to 8 paleosols in the Masotcheni formation that seem to occur in more or less similar order throughout the area. We plan to spatially inventarize occurence, depth and thickness of the different paleosols and the sediments in between them to get better insight in paleolandscapes. In combination with a DEM, these data can be used to calibrate the landscape evolution model.

Organic matter from the paleosols present in the sedimentary record, either as pieces of charcoal or as Soil Organic Matter, will be used to estimate paleo-vegatation structures with the $\delta^{13}C$ method and for radiocarbon dating. Suitable fluvial sandy sediments in the record will be dated with Optical Stimulated Luminescence, to get an additional age-control on the Masotcheni formation. Micromorphological analysis of thin sections of the paleosols is expected to yield additional insights in the environment these soils developed in.

A combination of the data from these five sources; fieldwork, $\delta^{13}c$ analysis, radiocarbon dating, OSL dating and micromorphology; is expected to yield a complete picture of the environments and landscapes that the Masotcheni formation was formed in. Consequently, these data will be used as inputs and calibration data for dynamic landscape evolution model LAPSUS.

References

Schoorl, J., Veldkamp, A., 2001: *Linking land use and landscape process modelling: a case study for the Alora region (south Spain),* Agriculture Ecosystems & Environment 85, pp 281-292.

Partridge, T.C., 1997: Cainozoic environmental change in Southern Africa, with special emphasis on the last 200.000 years. *Progress in Physical Geograhpy 21, pp 3-22.*

FLUVIAL HISTORY IN THE CZECH REPUBLIC

Jaroslav Tyráček & Pavel Havlíček

Czech Geological Survey, Klárov 3, 118 21 Praha -1

An interesting environmental setting existed during glacials in the Czech Republic. Despite the narrow periglacial zone between the Scandinavian ice sheet in the north and a large Alpine ice cap in the south, the inner parts of the state remained ice free and no major erosional factors intervened during interglacials. So the river valleys should theoretically preserve a complete undisturbed record of the entire period since the start of terracing.The terrace sequences along major rivers in Bohemian and Moravia have been documented in many studies. Practically all of them state regular development of individual staircases, which made their mutual correlation feasible. Nevertheless, some differences exist between the long stable crystalline masses of the Bohemian Massif and geologically younger and more mobile Moravia / Silesia. It is, therefore, advantageous to tackle the fluvial history in both regions separately.

In the Bohemian Massif the fluvial history starts with high terraces, their gravel covering high plateaux and water divides. Repeated alternation of down-cutting and aggradation phases formed 11 to 15 membered step-like terrace systems in which the younger terraces are generally lower than the older. The only problem open to debate is dating the beginning of terracing in which two utterly different views exist. According to the first one the original high relief ensured down-cutting whenever the environment permitted. And because the alternation of aggradation and erosion phases is controlled by climate changes, the beginning of terracing responds to the start of cyclic alternation of glacials and interglacials i.e. to the onset of the Quaternary era. The second point of view stressing the increased uplift shifts the beginning to the younger part of the Quaternary, more precisely toward the Lower / Middle Pleistocene boundary.

The fluvial achieve shows different development in Moravia, which mostly comprises the West Carpathians and the Vienna Basin – Carpathian foredeep system. Becausa of differences in development, three regions are separately considered.

North Moravia was affected by two continental glaciations, so practically all older fluvial sediments have been destroyed in the inner part of the Ostrava Basin. Three terraces developed during the Middle Pleistocene there. The "main terrace", formed between the Elsterian and Saalian glaciation, represents an index horizon vital for inter-regional correlations. The post-Saalian fluvial record comprises two low terraces (Warthe and Weichsel). Some relics of Lower Pleistocene terraces are preserved at the elevated rims some 35 to 60 m above the valley floors. They are pre-Elsterian in age and contain no nordic petrologies. At the foot of the Beskydy Mountains a system of mostly younger Saalian and post-Saalian alluvial fans is developed. Relics of older fans cover elevated hillocks rising from the surrounding gently sloping pediment.

Central Moravia comprises the Hornomoravský úval (Upper Moravian Basin) and its surrounding rim. The basin itself is a transverse tectonic depression filled by Neogene marine and lacustrine clay, plus sands and gravels. The Late Cenozoic fluvial and fluviolacustrine sediments are deposited mainly in a shallow NW-SE trending graben and overdeepened channels, which they reach up to 100 m thick. The Lower Pleistocene terraces are preserved in the form of small relics at elevations 25-26 m (base 20 m), 30-35 m and 50-

55 m above the valley floors. Lower terraces 17-18/13 m, 10-12 m, 4-5 m and valley bottom gravel correspond to the time span Upper Elsterian – Weichselian.

The region of South Moravia comprises the Dolnomoravský úval (Lower Moravian Basin), Vyškovskou bránu (Vyškov Gate) a Dyjskosvratecký úval (Dyje-Svratka Basin). In general the South Moravian fluvial archive contains seven Late Cenozoic terraces best developed in the Dyje (Thaya) valley at the relative altitudes 65, 50, 35-40, 30, 22, 9-13 and 5-6 m above the river and the valley bottom (floodplain) terrace.

There is a different situation in the Brno Basin, where the Lower Pleistocene is represented by two large alluvial fans. The older one (Smolin gravel; relative altitude 40-50m) is composed of two superimposed gravel bodies of diverse petrology. The lower complex gravel fan is built up by five accumulations separated by four interglacial fossil soils. The fan, with its surface some 40 m above the river, passes downstream into the clearly distinguishable Tuřany terrace and southward into the Syrovice-Iváň terrace. The thickness of the gravel body averages 20 m, although in places it reaches up to 40 m. The ferreto type of soil at its surface dates the terrace to the pre-Elsterian. Formation of this great gravel body was controlled most probably by local tectonic movements of the Drahany phase. Lower terraces, at the elevations of 25, 8-15 and the floodplain terrace, are dated to late Elsterian – Last glacial. The 8-15 m terrace correlates with the “main terrace” in the Ostrava Basin.

A "SNAPSHOT" ON THE EVOLUTION OF THE PARANÁ RIVER SYSTEM. THE SALTO FORMATION (PLEISTOCENE, URUGUAY)

Veroslavsky, G. & Ubilla, M.

Departamento de Evolución de Cuencas, Facultad de Ciencias. Iguá 4225, 11400, Montevideo, Uruguay.

The evolution of the Paraná River System is a major topic in the geology, palaeontology and geomorphology of South America. It covers a wide geographic area rounding 1,870,000 km^2 and is included in the Plata Basin, with climatic, economic, social and ecologic significance. Indeed, its origin had a significant impact on the landscape evolution in mid-latitudes of South America acting as a natural barrier to many terrestrial organisms and as a means of dispersal of others. Glacial/interglacial cycles accounted for its evolution, which was particularly related to marine fluctuations.

It is our purpose to provide a sedimentological, palaeontological and geochronological characterization of the Salto Formation, which provides a glimpse on the development of the Paraná River System. This unit outcrops discontinuously in western Uruguay between 30º to 33º S and 58º to 57º30´ W and is represented by braided river deposits, which include two depositional fluvial cycles. The Salto Formation is more than 30 m thick, and it is mainly composed of lenticular coarse sandstones bodies intercalated with sandy conglomerates, pebbles conglomerates and, secondarily, fine sandstones and mudstones. The fluvial channels were single and multi-threaded, locally occupied by bars that migrated by downstream translation and lateral expansion of the floodplain-channels and were associated with the major channels. Unidirectional palaeocurrents, measured in cross-bedded sandstone of fluvial facies, and three-dimensional facies analysis established a SW - W palaeodrainage for this region. Locally, the sandstones were genetically associated with lenticular gypsum clay bodies (Bellaco unit), which arguably indicates a warm-arid climatic event. Several elements are regarded by most researchers as indicative of neotectonic activity during and after the sedimentation of the Salto Formation.

Even though the Salto Formation is a poorly fossiliferous unit, silicified wood of small to medium trees assigned to Leguminosae and Caesalpinoideae have been described, which convey neither biostratigraphic nor chronological connotations. Taphonomic features of fossil wood suggest that these are not reworked remains.

The age of the Salto Formation has been a matter of discussion. This unit was considered as Late Miocene(?), Pliocene and Pleistocene in age. Two samples of sand picked from the lower part of the unit were dated by the thermoluminescence method with the following results: 986 ± 100 Ky BP (LVD-948, Salto city, type area) and 830 ± 95 Ky BP (LVD-949, Boycuá creek). The ages are congruent with each other and both outcrops can be considered more or less isochronous; both provide a rough date for the First Cycle of depositation in the late-Early Pleistocene to early-Middle Pleistocene, confidently supporting a Pleistocene age for this unit, as was suggested by some previous authors. An important global warming event occurred around 850 ka (~OIS 25) and relationships with this event might be considered.

As by-product of this research is the provision of a correlation table between Uruguayan and Argentinean stratigraphic units, which involves the 'Mesopotamian' region included between the current Paraná and Uruguay rivers.

QUATERNARY FLUVIAL TERRACE RECORD OF THE TANA RIVER, KENYA

A. Veldkamp[1], E. Buis[1], D.O. Olago[2], E.H. Boshoven[1], M. Marée[1], P.T. Gicheru [3] & J. Wijbrans[4]

[1]*Laboratory of Soil Science and Geology, Wageningen University, P.O. Box 37, 6700 AA Wageningen, The Netherlands*
[2]*Department of Geology, University of Nairobi, Chiromo Campus, Riverside Drive, P. O. Box 30197 Nairobi, Kenya*
[3]*Kenya Soil survey, NAL, PO Box 14733, Nairobi, Kenya*
[4]*Vrije Universiteit Amsterdam, Earth Science Department. De Boelelaan 1085, 1081 HV Amsterdam*

The Tana river, currently the largest fluvial system in Kenya has known major reorganisations in both its course as well as its incision rates, due to regional tectonic uplift changes related to rift valley formation. Between 2.82 – 2.65 ($^{40}Ar/^{39}Ar$) Ma, a major up-doming occurred related to either rift valley formation or the activity of Mount Kenya. This up-doming has been reconstructed from lava flows preserving former river gradients. Around 2.65 Ma ($^{40}Ar/^{39}Ar$) a major reorganisation of the drainage pattern took place, the Tana river shifted its course down slope of the tilted eastern rift shoulder to a 300 m lower altitude. It has been at this position ever since and has carved out a major valley. The changing climatic conditions combined with a continuing uplift yielded a terrace staircase of strath terraces with a minimum of 10 distinct levels. The average reconstructed incision rate is 0.058 m/ka. By correlating mineralogical fingerprinted volcano-clastic deposits preserved in Tana terraces with U/Th dated Quaternary tephras in lakes a more detailed reconstruction of the incision rates could be made for the last 220 k yrs. The reconstructed incision rate for the three younger terraces is 0.082 m/ka considerably faster than the overall incision rate. The reconstruction also demonstrates that only major glacial/interglacial transitions caused terrace formation. Sediments of the last three terraces were deposited at the end of a glacial, contemporaneous with volcanic mudflows, and rapidly incised during the subsequent interglacial. By using the valley morphology and some qualitative terrace modelling a reconstruction of the changing incision rates was made. The simplest model suggests that the incision rate was initially 0.03 m/ka and accellerated to 0.11 m/ka around 0.98 Ma. It is apparent that the Late Cainozoic development of the Eastern rift (Gregory) branch of the East African rift valley system has strongly determined the fluvial dynamics of Tana River. It is also suggested from the still incomplete field evidence that potentially a complete terrace staircase from the Late Pliocene onward is present in the Tana valley to be explored.

THE LATE CENOZOIC EVOLUTION OF RIVER SYSTEMS IN SOUTHWEST BULGARIA IN RELATION TO SURFACE UPLIFT AND CRUSTAL EXTENSION

Rob Westaway

Faculty of Mathematics and Computing, The Open University,
Eldon House, Gosforth, Newcastle-upon-Tyne NE3 3PW, UK.
E-mail: r.w.c.westaway@ncl.ac.uk

Southwest Bulgaria forms the northern margin of the Aegean extensional province. Since the Early Pliocene (~4 Ma), this region has accommodated southward or SSE extension at several millimetres per year, superimposed onto ~400 m of post-Early Pliocene regional uplift that is revealed by river terrace staircases. This sense of deformation superseded earlier extension, oriented ENE-WSW, which is estimated to have begun in the early Late Miocene (~10-9 Ma) and lasted until ~4 Ma, the regional topography being dominated by NNW-SSE-striking grabens and normal fault escarpments that are relics from this time. Normal faults that are now active cut across these older structures, although in some localities normal faults that were oriented obliquely to the earlier extension have remained active, also oblique to the modern extension sense. It is suggested that this present phase of extension relates to the modern sense of deformation throughout the Aegean region and to the modern geometry of the North Anatolian Fault Zone (NAFZ), which is independently inferred to have existed since ~4 Ma. The earlier ENE-WSW extension is inferred to have involved two phases, the first pre-dating the NAFZ and the second synkinematic with its initial phase of slip during ~7-4 Ma, when its geometry and the overall sense of deformation in the Aegean region were different from at present.

RHEOLOGICAL MODELLING OF LATE CENOZOIC FLUVIAL SEQUENCES: KEY RESULTS FROM IGCP 449

Rob Westaway

Faculty of Mathematics and Computing, The Open University,
Eldon House, Gosforth, Newcastle-upon-Tyne NE3 3PW, UK.
E-mail: r.w.c.westaway@ncl.ac.uk

The start of IGCP 449 coincided with the initial availability of software packages that calculate from first principles the isostatic uplift response to surface processes, taking account of the flow that is induced by these processes in the mobile lower crust. These techniques lend themselves to the modelling of regional-scale crustal deformation on time-scales of hundreds of thousands to millions of years. The spatial scales and time-scales involved make these methods well-suited to explaining long-timescale fluvial sequences, providing a valuable by-product to observational studies and a rationale for gathering new observational data in regions that have not previously been investigated in detail. The ability, through use of such physics-based models, to explain in terms of crustal properties the different characteristics of fluvial terrace staircases that have developed in different regions, and to thus make meaningful estimates of these properties, is arguably the most significant achievement of IGCP 449 worldwide.

Two techniques have been developed. The first calculates the isostatic response to cyclic loading of the Earth's surface by ice-sheets or glacial-to-interglacial sea-level variations. The second calculates the isostatic response to changes in erosion rates. In both techniques, the time-scale of the response to any change in the forcing mechanism depends primarily on the thickness of the mobile lower-crustal layer, thus providing a method of estimating this parameter. The responses predicted by both techniques for a given set of crustal properties can be very similar, so that in practice the two methods can be used interchangeably. In regions of abnormally high (~110 mW m^{-2}) heat flow, such as western Turkey and the Massif Central region of central France, crust that is ~30 km thick will have a lower-crustal layer maybe ~17 km thick. This causes relatively sluggish variations in uplift rates in response to any forcing. As the heat flow decreases, the predicted uplift response becomes more abrupt, such that in regions of very cold crust (say, Early Proterozoic cratons) one observes a very different form of response, characterised by rapid variations in uplift rates. This is observed, for instance, in eastern Europe in the Early Proterozoic Ukrainian shield (e.g., in the rivers Dnieper and Don) and in South America in the upper reaches of the Paraná / Paraguay river system in the border region between Brazil and eastern Bolivia at the southern margin of the Guaporé shield, where the lower-crustal layer may be only ~4-6 km thick. Regions of Archaean crust and lithosphere are so cold that they lack any mobile lower-crustal layer and so do not exhibit these forms of behaviour. Examples are provided in the Archaean crustal provinces of Western Australia (e.g., the Yilgarn craton), South Africa (the Kaapvaal craton) and central India. Regions where oceanic lithophere has been buried beneath thick sediment to create a subaerial land surface likewise lack any mobile lower-crustal layer and so do not exhibit equivalent behaviour. Examples are provided in Russia on the lower Volga, north of the Caspian Sea, and the United States on the lower Mississippi, north of the Gulf of Mexico ocean basin.

Use of these physics-based techniques should in time supersede the empirical approaches that are currently widely-used by others to model landscape evolution. Some of the results that have emerged from the use of these alternative methods are readily explicable using physics-based approaches. However, the latter require information regarding the conditions at and before the start of each phase of regional uplift, and are thus difficult to use to investigate regions with high erosion rates (say, Taiwan, southern New Zealand, and Cascadia, the U.S. Pacific Northwest) to which empirical techniques have been widely applied.

Well over 100 fluvial sequences worldwide (currently the list of countries covered includes the United Kingdom, Spain, France, Italy, Belgium, the Netherlands, Germany, the Czech Republic, Poland, Ukraine, Russia, Georgia, Moldova, Romania, Hungary, Bulgaria, Greece, Turkey, Syria, Iraq, South Africa, China, Australia, Argentina, Brazil, Bolivia, Peru, Colombia, Mexico and the United States), have now been modelled using these techniques. This has provided a wealth of experience in their use and has contributed significantly to resolving lateral variations in crustal properties and in amounts of regional uplift since, say, the Middle Pliocene or Early Pleistocene. Examples will be presented here from Turkey, Italy and northern South America.

CROCODILES, RIVERS AND GEOMORPHOLOGY; IMPLICATIONS FOR THE REGIONAL NEOTECTONICS OF MOROBE PROVINCE, PAPUA NEW GUINEA

R.H. Findlay

Geological Survey of PNG, Dept. Mining, Private Bag, Port Moresby;
E-mail bob_findlay@mineral.gov.pg

The neotectonics and consequent sedimentological record of collisional orogens are the surface reflections of fundamental crustal processes. The seismically active region of Papua New Guinea forms part of the collisional orogen between the Australian and Pacific plates and is deforming by reverse and strike-slip faulting involving rapid uplift. Although uplift of the central ranges of the PNG cordillera has been dated by fission-track analysis as commencing at about 7-8my ago, to the east the dividing ranges (Chapman and Kratke Mountains) of the Wau-Menyamya region of Morobe Province contain features showing younger rapid uplift.

The Wau-Menyamya region is characterised by antecedent meandering rivers incised into between several hundred to 3500 metres of Cretaceous and younger bedrock and at least 50 metres into Quaternary or younger alluvial deposits. Three of these rivers, the Tauri, Kapau and Biaru Rivers, cut the main divide which, SE of the Biaru gorge, rises to 3500 metres asl; the Tauri and Kapau rivers cut the divide further west where it rises to about 2300 metres.

Two important, young, fluvio-lacustrine deposits occur in the Wau-Menyamya region. The better known, the tilted and folded middle to late Pliocene Otibanda Formation of the Wau-Bulolo region, is thought commonly to be an intermontane lacustrine deposit. The less well-known Babwaf Conglomerate of the Aseki-Watut River region occurs some 30km west of the Otibanda Formation. At Aseki, the Babwaf Conglomerate is contains extremely coarse, well-rounded clasts (to 3metre diameter) of Middle Miocene granodiorite whose nearest probable source is some 15km east and from which it is now separated by heavily incised mountains rising to 2300m. The Babwaf Conglomerate rests with inferred unconformity on a Pliocene coralline limestone series which, at Aseki, rises to about 2200masl and which appears to underlie a tilted peneplane sloping south for some30-40km to the near sea-level Lakekamu Basin before dipping south under the Gulf of Papua. The Babwaf Conglomerate extends north for 50km from Aseki into the Lower Watut Valley, where it is tightly folded.

Although the Otinbanda Formation was thought to have formed locally in intermontane lakes, it contains a mammalian and reptilian fauna that includes Pliocene and Quaternary crocodiles. Crocodiles are not known for scaling mountains or heavily incised gorges and their attendant high waterfalls to find intermontane lakes a minimum of 100km from the sea. Therefore the Otibanda Formation would have been deposited not in an intermontane basin but on a low-lying alluvial plane connected to the Gulf of Papua to the south via the Lakekamu Basin. This clearly confirms regional rapid post-Pliocene uplift and incision.

I argue that the Babwaf Conglomerate and Otibanda Formatoin were once part of the same middle to late Pliocene alluvial plain sequence and that this was extensive throughout Morobe Province until the end of the Pliocene. Thus the uplift in the Chapman-Kratke ranges of southern Morobe coincides with the post-Pliocene uplift of the spectacular 4000m high Finisterre and Sarawaget Mountains in northern Morobe. That is, post-Pliocene uplift in Morobe Province is far more widespread than previously supposed and this indicates oversimplification of current ideas of the tectonic development of PNG.

EVIDENCE OF HUMAN ACTIVITY FROM PLEISTOCENE FLUVIAL DEPOSITS: FINDINGS DURING THE COURSE OF IGCP 449

Mark White[1], Sheila Mishra[2], David Bridgland[3] & Rob Westaway[4]

1 - Department of Archaeology, Durham University, South Road, Durham DH1 3LE, UK
E-mail: m.j.white@dur.ac.uk
2 - Department of Archaeology, Deccan College, Pune 411 006, India.
E-mail: chingunde@yahoo.com
3 - Department of Geography, Durham University, South Road, Durham DH1 3LE, UK
E-mail: d.r.bridgland@dur.ac.uk
4 - Faculty of Mathematics and Computing, The Open University,
Eldon House, Gosforth, Newcastle-upon-Tyne NE3 3PW, UK.
E-mail: r.w.c.westaway@ncl.ac.uk

River terraces are an important source of Lower and Middle Palaeolithic artefacts in Europe, large collections having been made during the years of manual gravel extraction. Now that many terrace sequences can be reliably dated and correlated with the oceanic record, potentially useful patterns can be recognized in the distribution of artefacts. The earliest appearance of artefacts in terrace staircases, marking the arrival of the first tool-making hominids in the region in question, is the first of several archaeological markers within fluvial sequences. The Lower to Middle Palaeolithic transition, with the appearance of Levallois, is another. Others may be more regional in significance: the occurrences of the Clactonian industry, twisted ovate hand-axes and bout coupé hand-axes, for example. Further work is required to discover whether these have widespread temporal significance.

IGCP Project No. 449 (Global Correlation of Late Cenozoic fluvial deposits) has instigated the compilation of fluvial records from all over the World. In Europe, where some of the best-documented river terrace sequences are found, a record of early human occupation can be reconstructed from rich artefact assemblages - much more readily than from rare occurrences of hominid fossils. Matching of climatically-forced river terrace generation to Quaternary Milankovitch climatic fluctuation, using independent lines of evidence, allows the fluvial archive of human occupation to be well constrained temporally.

IGCP 449 has included an active Palaeolithic working group (led by Sheila Mishra, Deccan College, India, and Mark White, Durham, UK). European highlights on which it has reported include the discovery of a fossiliferous tufa at the Acheulian type locality, St Acheul (River Somme), northern France (Pierre Antoine & Nicole Limondin-Louzouet). Correlation between British and Central European sequences has also been undertaken, with the QRA excursion to Thuringia providing an opportunity for some of these to be inspected. The British Government's Aggregates Levy Sustainability Fund, initiated during the life of IGCP 449, has seen a plethora of new studies of Palaeolithic fluvial archives in southern Britain, since these coincide with the exploitation of aggregate sources that the levy is designed to mitigate.

THE NORTHERN PERI-AEGEAN REGION IN THE NEOGENE AND QUATERNARY: ONSET AND EVOLUTION OF THE FLUVIO-LACUSTRINE SYSTEMS

Ivan Zagorchev

Geological Institute, Bulgarian Academy of Sciences

The present drainage pattern in the central and eastern parts of the Balkan Peninsula was formed as a result of complex interplay of regional tectonic and climatic controls, and of global eustatic and climatic factors. The Late Oligocene system of river-connected lakes drained towards the Central Paratethys was closed through transpression in earliest Neogene time, and a peneplain formed during the following relative tectonic quiescence in Early and Middle Miocene times. The new pattern of fluviolacustrine system has set on and developed in conditions of irregular uplift of the linear morphostructure of the Stara-planina (Balkan) Range and of the Rhodope region, and the subsidence of the Aegean and Black Sea basins. The Danube drained the area situated to the North of the Stara-planina Range, and the Morava and Iskur palaeorivers inherited Late Oligocene relations in draining to the North and East (via the Danube towards the Black Sea) some of the territories situated to the South of the Balkan. However, most of the latter territories have been drained by the rivers Vardar/Axios, Strouma/Strymon, Mesta/Nestos and Maritsa/Merich/Evros that formed along major fault belts.

The first sedimentation cycle recognized throughout the Strouma/Strymon fluviolacustrine system occurred in Badenian and Sarmatian times within a river plain and local lakes. The lakes formed mostly in the Sarmatian, and often produced lignite coal seams (Kyustendil, Serres) and locally (Simitli) diatomites or diatom-bearing marls. The Vardar/Axios fluviolacustrine system and parts (Rhodope, Razlog graben) of the Mesta/Nestos system have been also set on.

All three fluviolacustrine systems developed considerably during the second sedimentation cycle in Maeotian and early Pontian times. Well-sorted thick alluvial deposits were related to meandering channels within the plain. A marine ingression flooded most of the Serres graben in Maeotian and early Pontian time. The northern threshold of the ingression in the whole peri-Aegean region has been the major Middle-Mesta fault at the southern slope of the Belasitsa/Kerkini Mountain and its continuations West and East. This fault has been a long-living branch of the North-Anatolian Fault Zone (NAFZ), with considerable normal faulting and right-lateral strike-slip displacements throughout Neogene and Quaternary times. Interaction of proluvial and alluvial sedimentation of the Palaeo-Strouma with the lacustrine sedimentation occurred within the Kyustendil graben. All along the Blagoevgrad, Simitli and Sandanski grabens, river channels within the plain and some small lakes were influenced by seasonal abundant flood of the border fans. The widening of the system in Maeotian time was certainly not only a result of its maturation but also of the gradual extension due to normal faulting in the graben boards. Gorges have been gradually incised through transversal horsts resulting from activation of cross or oblique faults. After initial alluvial and proluvial sedimentation related to the onset of Palaeo-Mesta in the Razlog and Gotse Delchev areas, lakes have been formed and evolved in Maeotian to Middle Pontian times with prolonged deposition of diatomites in the Gotse Delchev graben. These lakes have been probably related in Pontian times through the Drama basin and Palaeo-Angitis to the Serres basin and the Aegean Sea. The Pirin horst continued to be a low barrier between the two fluviolacustrine systems as witnessed by the presence of well-rounded marble fragments in the Badenian? – Sarmatian Katountsi Formation and the Maeotian Sandanski Formation (Sandanski graben), and in the conglomerate (Maeotian or Early Pontian) beneath the diatom calcareous clays near Amphipolis in the Serres graben. The evolution of the Ilindentsi and Katountsi proluvial fans with a steady influx of marble pebbles derived from the Pirin horst may be followed virtually at the same emplacements from Badenian? – Sarmatian through Maeotian and Pontian to Pliocene and Pleistocene times.

The Pontian evolution of the fluviolacustrine systems exhibits a dramatic change in mid-Pontian time. It is marked by the massive influx of very coarse terrigenous material from the horsts into the adjacent grabens, with formation of bajadas along the border faults. These events continued during the Pliocene. The climate changed gradually from tropical through subtropical and semi-arid to arid, and finally, to moderate. The main connections between the different widened areas of the fluviolacustrine systems almost reached their present position. Intense horst uplift in late Pontian and Pliocene times led to deposition of thick proluvial-alluvial fans.

Most important neotectonic movements occurred in latest Pliocene times. They resulted in considerable block rotations and tilting of the grabens against the highest-amplitude faults. Later (Pleistocene) sediments cover with unconformable depositional contact both the tilted pre-Quaternary sections and the graben-bounding normal faults.

Continuing horst uplift was accompanied by climatic changes in Pleistocene times. The highest mountain horsts (Rila, Pirin, Belasitsa/Beles, Olympos) were covered by glaciers during three glacials (Mindel, Riss and Wurm). Glaciation in the high mountains induced the formation of glacial and fluvioglacial deposits in the river valleys, and produced typical features of the relief. Mesta/Nestos emancipated from the Strouma/Strymon fluviolacustrine system with formation of a new gorge through the young horst of Lekanis Mountain, and formed the present impressive delta partially at the expense of the Prinos-Kavala basin.

Note. The present abstract is largely based upon the following publications by the author:

Zagorchev, I. S. 1992. Neotectonic development of the Struma (Kraistid) Lineament, southwest Bulgaria and northern Greece. - *Geological Magazine,* 129, 2; 197-222.

Zagorchev, I., N. Ognyanova-Roumenova. 1995. First finds of diatom clay and silt in the Neogene filling of the Serres graben, Struma rift, Northern Greece. - *Proceedings 15th Congress of the Carpatho-Balkan Geological Association, Spec. Publ. Geol. Soc. Greece, 4/*1; 304-309.

Zagorchev, I. 2002. Neogene fluviolacustrine systems in the northern Peri-Aegean Region. – *Geologica Carpathica*, Special issue (CD), 53 (same on paper, Zagorchev, I. 2002. Neogene fluviolacustrine systems in the northern Peri-Aegean Region. – *Geologica Balcanica*, 32, 2-4; 139-144).

Zagorchev, I., Ognjanova, N., Stoykova, K., Dimadis, L. 2002. Pontian lacustrine regimes and marine ingressions in the Strymon area, Northern Greece. - *Geologica Carpathica*, Special issue (CD), 53.

Zagorchev, I. 2004. Neogene and Quaternary tectonics and the fluvio-lacustrine evolution of the northern peri-Aegean region. – Proceedings 5th ISEMG, Thessaloniki, v. 2; 908-909.

The appropriate references and acknowledgements are made in the cited publications.

Global Correlation of Late Cenozoic Fluvial Deposits

http://qra.org.uk/FLAG/IGCP449.htm

Hotel Posadas de España, Málaga, 14th December 2004

Meeting organizer: Dr Jeroen Schoorl,Laboratory of Soil Science and Geolog, Wageningen University & Research Centre Duivendaal 10, 6701 AR Wageningen,PO Box 37, 6700 AA Wageningen, The Netherlands

Scientific Business Meeting 8

Agenda

- Summary of Outcomes from Previous meeting(s) & project activity
    - Business Meeting 6, Belem, Brazil, June 2003
    - Business Meeting 7 Reno, USA, July 2003
    - Project publications – status and prospects
- Data base & web site (update of status and discussion of protocols and prospective data providers)
- Final project outcomes
    - End-of-Project Publication (*Quaternary Science Reviews*)
- Final project report (requirements and deadlines)
    - Targets for final project content
    - National reports
    - Thematic reports
- Follow-up project – update and discussion
    - Aims and objectives
    - Project structure and work programme
    - Differences from original project; key themes
    - Key data and meetings targets
- Any Other Business

Leaders: *Dr David Bridgland (Durham, UK : d.r.bridgland@durham.ac.uk)*
Prof Sampat Tandon (New Delhi, India : sktand@giasdl01.vsnl.net.in)
Dr Liping Zhou (Beijing, China : lpzhou@urban.pku.edu.cn)
International Secretary *Dr Darrel Maddy (Newcastle, UK : darrel.maddy@ncl.ac.uk)*