



**GLOBAL CORRELATION OF LATE CENOZOIC
FLUVIAL DEPOSITS**

FINAL REPORT

1. INTRODUCTION

The participants in IGCP Project No. 449 (Global Correlation of Late Cenozoic fluvial deposits) have spent the past five years (2000-5) 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, and so it proved. Nevertheless, the project has facilitated the dissemination of important European data previously difficult to access in English. To this European resource 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), now made accessible in English-language publications for the first time thanks to IGCP 449 (Appendices A, C, D & F). 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, the last of which acted as a catalyst for wider activity in South America that will largely bear fruit following the end of the project. 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 a meeting that would have instigated project activity were thwarted. It is anticipated that a meeting during Year 2 of the follow-up project (IGCP 518) will make good this and other shortcomings and continue the task of data collection initiated by Project 449, as well as the further compilation of the internet database (see below). Plans exist for an IGCP 518 Chinese meeting in summer 2006, to be led by Prof. Zhongyuan Chen (East China Normal University, Shanghai) with, as its theme, the Late Cenozoic evolution of the River Yangtze.

1.1 Background

Within their geomorphological and sedimentary records, rivers provide valuable archives of global change. In particular, fluvial sediments represent databanks of palaeoclimatic and palaeoenvironmental information, as well as repositories for fossils and archaeological material, providing important

evidence about biotic evolution and early human occupation, respectively, and for biostratigraphical and relative dating. IGCP 449 sub-themes devoted to these interests have reported separately in annual reports and will do so as appendices to this final report. These lines of evidence contribute to the general palaeo-environmental interpretation of fluvial sequences, which also benefits from sedimentological and other palaeoclimatic evidence (e.g. periglacial structure; soil-formation evidence). In addition, the physical disposition of fluvial sequences, be it as fragmented terrace remnants or as stacked basin-fills, provides valuable information about geomorphological and crustal evolution. Although that was already known prior to the start of IGCP 449, the discovery of different preservational patterns of fluvial records in different types of crust - ancient crust (Archaean or older) as opposed to post-Archaean crust - has been an important unforeseen result of the project and one of its main highlights.

Fluvial archives benefit from a global distribution, being represented on all continents and across all climatic zones, with the exception of the frozen polar regions and the driest deserts. While it was clearly impractical to include studies of every river, an essential aim of the project was to compile representative information from a wide geographical range. This has been achieved, as will be seen from the content of this report, its various appendices and the range of publications arising from the project (Appendices A - G).

Staircases of large-scale aggradational river terraces, a notable feature of many valleys in the temperate latitudes (particularly in areas beyond the reach of the erosive activities of Pleistocene ice sheets), form a core data resource for the Quaternary record. Older Late Cenozoic sequences are more likely to be stacked basin fills, a fact that points to a significant change in fluvial sedimentation style globally, something that project data has helped to explain. The reconstruction of longitudinal profiles represents the main tool for local to regional correlation of what are often very fragmentary former floodplain remnants. Correlation can be additionally undertaken using sediment composition (e.g. clast lithologies, mineralogy, erratic input), biostratigraphy and geochronology, methodological themes that are addressed in the output of the project.

IGCP 449 has thus involved a wide and growing range of disciplines, including geomorphology, sedimentology, palaeontology, archaeology and mathematical modelling. The project benefitted from a close relationship with the pre-existing Fluvial Archive Group (FLAG), a research group that was established in 1996 under the auspices of the British Quaternary Research Association. This relationship included representation of IGCP 449 within biennial FLAG conferences during 2000, 2002 and 2004, and in the resultant conference proceedings publications (Appendices A & C). This has provided links with FLAG's other activities, including GLOCOPH (An INQUA subcommission, full title 'Global Continental Palaeohydrology Project'), IGU and IGBP (PAGES).

IGCP 449 was timely in the light of advances in methodology for the study of fluvial systems and their sedimentary sequences and in the understanding of the Cenozoic palaeoenvironmental record in general, particularly in relation to the globally valid oxygen isotope record from oceanic sediments (cf. Shackleton & Opdyke, 1973; Bassinot *et al.*, 1994). Since river sequences can be used to link the oceanic record into the interiors of continents, fluvial archives provide potential frameworks for continental studies - a major thrust of IGCP 449. Frameworks thus established can provide a structure onto which high-resolution studies can be built, as well as contexts for a variety of related disciplines (e.g. faunal evolution, human occupation and migration, late Cenozoic environmental change). Project 449 has made significant advances towards the goal of correlating Late Cenozoic terrestrial and oceanic records, by using the globally valid marine record as a template for correlation and comparison between fluvial sequences in different parts of the World.

To a large extent the content of this report is paralleled by material awaiting publication in the special issue of *Quaternary Science Reviews* arising from the final plenary project meeting in December 2004, in Malaga, Spain. This will include regional/national syntheses, thematic overviews from project sub-themes (working groups) and reports from individual key studies. Prospective authors were asked to produce their papers by the Spring of 2005 with a view to publication late that year or in 2006. At present the list of abstracts submitted, based on papers and posters for the Malaga meeting (Appendix H), is oversubscribed and there may be over-spill into other compilations, yet to be arranged. Experience has shown that the planned publication date

might prove optimistic, but the content will provide much of value for inclusion in the IGCP 449/518 Internet database (see below). At the time of writing eleven papers have been received and are in review, with a number of others still expected (see Appendix F).

2. METHODOLOGY

The recent development of enhanced dating techniques applicable to fluvial sequences was one factor that made Project 449 extremely timely, as these have been of considerable assistance in the correlation process. Important advances in this respect (and the 'value added' as a result of IGCP 449) have been as follows:

- Improved understanding of biostratigraphy, especially using animal fossils, the primary basis for relative dating (biostratigraphy from fluvial deposits has been developed by the sub-theme of that name - see below; Appendices lii & liii);
- Application of enhanced absolute dating techniques, notably luminescence techniques, as well as calibrated relative methods such as amino acid geochronology (numerous contributions to IGCP 449 have made use of these methods - see below);
- Recognition of critical stratigraphical markers provided by magnetic reversals, glaciations, marine transgressions, volcanic eruptions, etc., which can often be linked with geochronological studies (e.g. dating of interbedded lavas using potassium - argon or argon - argon methods);
- Regionally, within parts of the 'Old World', anthropogenic artefact assemblages provide a means of relative dating (again, this has been the topic of a project sub-theme - see Appendix li);
- At least regionally, the progressive valley incision recorded by terrace formation can provide a broad guide to age (significant advances were made during the course of IGCP 449, directly as a result of the accumulating data archive - see Westaway *et al.*, 2003a; see next point).
- The improved interpretation now possible for this type of record has led to enhanced understanding of landscape evolution, with (another project sub-theme has looked at records of crustal activity

that can be derived from fluvial sequences, which is closely related to incision and terrace formation as a response to uplift - Appendix liv).

Together with more traditional field-based methods, the above advances have allowed the formulation of a multidisciplinary methodological framework for the investigation of fluvial sequences, involving teams of specialists with expertise in geomorphology, stratigraphy, sedimentology, palaeontology, archaeology and geochronology. The cumulative results can be seen in the IGCP 449 internet database:

www.geography.ac.uk/projects/igcp449-518

(see below, p. 15)

[Note that progress with the project database has been on hold since autumn 2004 while the University of Durham site as a whole, and the Geography content in particular, was redesigned and its provision reorganized. Once the basic new site has been fully established (this is behind schedule) the IGCP database will be restored and enhanced using new protocols (see below and Appendix J). The new URL (above) was established on 15th June 2005, allowing the new site to be constructed, finally, over the following weeks. The old site has now been deactivated.

2.1 Lithostratigraphical principles

Fundamental to the utilization of fluvial archives is the establishment of a secure lithostratigraphical framework within which the additional palaeoenvironmental and palaeoclimatic data can be placed. Formal lithostratigraphy (cf Hedberg, 1976) has seldom been undertaken in the case of river terraces except in the UK and North America, workers elsewhere preferring informal geomorphology-based nomenclature. It is clearly desirable to make use of nomenclature that is already well established; this has been and will continue to be the normal policy.

2.2 Biostratigraphy subtheme

This is a traditional and well-tried method for establishing relative chronologies for fluvial 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. An indication of geographical range is provided by Table 1. The most important groups are as follows:

Vertebrates: These include land animals as well as fish and other aquatic vertebrates. 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 (Preece & Parfitt, 2000; Stuart & Lister, 2001; Schreve, 2001a, b; Schreve & Bridgland, 2002b; Auguste *et al.*, 2003; Matoshko *et al.*, 2004; Ubilla, 2004; see Appendix lii).

Molluscs: 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; Penckman, 2004). Molluscs are also extremely important climato-stratigraphical tools, since they provide reliable evidence for palaeoclimate and palaeoenvironmental conditions. See Appendix liii.

3. SUMMARY OF PROJECT ACHIEVEMENTS AND OUTPUT

3.1 Internet sites

Main project website:

<http://igcp449.co.uk/>

This is a replacement site, moved (retaining a link) from

<http://www.qra.org.uk/FLAG/IGCP449.htm>

The IGCP 449 Internet database, a resource of summary data on fluvial systems, resides on the University of Durham site. It was launched late in 2002 but development was held up when it was decided that the Durham site

would be redesigned in 2004 (see above). This process has been incremental, replacing the previous site with a flexible database-driven system that is more easily updated. This has meant, however, that the IGCP 449 database can no longer reside on project co-leader David Bridgland's personal web space. The new Durham site is now fully operational and it is planned to relaunch the database via a portal and link it to other sites.

Initial coverage has centred on N.W. European rivers, although this has been extended to include coverage of Turkey, Ukraine and southern Russia, with more in the pipeline. The database consists of summary diagrams of data from fluvial sequences (maps, longitudinal and transverse profiles, palaeodrainage reconstructions and tables) accompanied by minimal text. Material is only uploaded onto the site once it has been published or accepted for publication (with permission of the author/copyright holder). The intention is to put summary material from publications arising from the project onto the database. Full bibliographical details will be provided (with pdf copies of publications where available). With the relaunch, a change will be made from the provision of summary diagrams as pdfs to fully interactive web pages capable of displaying images to a range of sizes and resolutions. This will allow tagging with captions, keywords, etc. See Appendix J for example content.

3.2. Summary of project achievements, 2000-2003 (also covered in annual reports)

The project started in 2000 with 104 identified participants from 33 countries. The first year was spent getting organization in place and promoting participation. The first international meeting, funded by the project allocation for 2000, was postponed until April 2001, but the project was represented and promoted at the biannual meeting of the Fluvial Archives Group (FLAG) in March 2000 at Mainz, Germany, and at the 31st IGC in Rio de Janeiro (see 2000 Annual Report of IGCP 449).

The project was formally launched in April 2001 at its 1st International Meeting (its postponed 2000 meeting) in Prague, hosted by the Czech Geological Survey (see Annual Report for 2001). Attended by 44 participants, representing 18 countries, this meeting was a great success and

provided useful momentum for the early stages of the project. It generated a collection of papers for the journal *Proceedings of the Geologists' Association*, eventually published in 2004 (Appendix D).

In the same year, the 2nd IGCP 449 International Meeting was convened, in Kanpur, northern India, during December 2001. Involving a field visit to the Yamuna River (tributary of the Ganges), this meeting revealed a vibrant and well-informed Indian fluvial community. It led to publication of a collection of papers in the important Indian journal *Current Science* (New Delhi), which became the first major project publication when it appeared in April 2003.

The year 2002 was extremely busy, with three meetings sponsored by the project. The first was organized jointly with FLAG and GLOCOPH and took place in eastern Australia, under the leadership of Gerald Nanson (University of Wollongong - June 29th to July 16th). This ambitious meeting revolved around field excursions to three of Australia's diverse fluvial provinces, together with a one-day indoor session of papers and a business meeting. The main field excursion was a full two weeks in duration and was operated in tandem with project work by students at the University of Wollongong. Themes included the interpretation and dating of fluvial sediments, as well as inter-related aeolian and lacustrine deposits. The following areas were included:

- the east-coastal drainage (east of the Dividing Range)
- the Murray - Darling catchment (northern part)
- the internally draining Lake Eyre Basin (Cooper's and Strezlecki Creeks)
- the 'Riverine Plain' of the Murray and its tributaries

The field meeting was open to members of the Fluvial Archives Group (FLAG) and INQUA's GLOCOPH project as well as participants in IGCP 449. Non-student IGCP participation totalled 9 individuals, 2 from Brazil, 2 from Lithuania, 2 from the UK and 3 from Australia. Project funds were used to support the Brazilian and Lithuanian participation. As far as IGCP 449 interests are concerned, particular attention was paid to Quaternary deposits laid down by the rivers themselves and by wind reworking fluvial sediments. The dating of these deposits was also highlighted, much use having been made in these areas of luminescence dating. There was also a lecture session (on July 15th at the University of Wollongong, New South Wales),

attended by 28 persons, there being a number of participants who did not take part in the long excursion. The meeting ended with a one-day IGCP 449 excursion to the Upper Shoalhaven Valley to observe the terrace system there, which provides a record from Early Cenozoic through to Holocene (Nott *et al.*, 2002 - see publications). This was attended by 8 persons.

Full details of the combined meeting are available in the 2002 Annual Report, Appendices G & H (as posted on the IGCP449 web-site).

Later in the same year was the FLAG 2002 meeting, at Clermont Ferrand, France, 9th-14th September (Leader: Dr Jean-Francois Pastre, CNRS, Meudon). Day 3 of this meeting was a lecture and poster session devoted to IGCP 449. Presentations during earlier sessions, representing other focuses of FLAG activity, were also of relevance to the IGCP project. The field excursion (days 3-6) was of mainstream interest to IGCP 449, involving the examination of the complex inter-relationship between volcanic activity and fluvial evolution in the Auvergne during the late Tertiary and Quaternary. A full report appears in the 2002 Annual Report, Appendix I. Papers arising from the FLAG 2002 meeting were published in a special issue of the French journal *Quaternaire* during 2004 (Appendix C). Sixteen of the papers are contributions to IGCP 449 and the project logo appears on the cover of the issue.

In December 2002 the 3rd International Meeting took place, in Agadir, Morocco (Leader: Dr A. Aït Hssaine, University Ibnou Zohr, Agadir). Attended by >30 participants, representing 8 countries, this meeting involved a lecture programme and four days of field visits, as well as a project business meeting (IGCP 449 2003 Annual Report, Appendix B). The field meeting started with a visit to the internationally renowned marine terraces of the Agadir coastal area, important for comparison with the fluvial record, and moved progressively inland towards and beyond the Atlas Mountains (one night was spent at Marrakech), looking at fluvial sites. A special issue or collection of papers arising from the Agadir meeting, being compiled for publication in the journal *Géographie Physique et Quaternaire*, has yet to appear. It will comprise papers in French and English (Appendix E).

In 2003 the project sponsored two meetings, the first being in Brazil (9th - 18th June), convened as part of a symposium held at Belem entitled

'Neogene Paleogeography, Paleohydrology and Paleoecology of Southwestern Amazonia'. This constituted the 4th Annual International Meeting of IGCP 449, which included a lecture session at the symposium and a field conference entitled 'Sedimentology of Late Cenozoic fluvial deposits' that visited the upper/middle Amazon basin (2003 Annual Report, Appendix D). A business meeting was convened in two sessions, one in Belem and the other on the field excursion, in Rio Branco (2003 Annual Report, Appendix E). A special issue of the Journal of South American Earth Sciences is to be produced, based around the Belem conference, to be edited by Dr Carina Hoorn (Amsterdam) and others. It will include contributions to IGCP 449. Secondly there was an important IGCP 449 component at the 16th INQUA Congress in Reno, Nevada, USA. The project shared in a FLAG poster session entitled 'Fluvial Archives of Environmental Change' (2003 Annual Report, Appendix F). There was also an IGCP 449 workshop and business meeting conducted within the INQUA congress (24th July 2003) but the planned INQUA excursion to the Susquehanna River was unfortunately cancelled.

3.3. Summary of project achievements, 2004

3.3.1. *International meetings:*

In its final year, 2004, the project was represented at the 32nd IGC in Florence, at the FLAG 2004 meeting, held in Siena, Italy, and its activity culminated in its final annual meeting, December 12-18th, based at Malaga, Spain.

32nd IGC, Florence, Italy (August 20-28, 2003)

The FLAG Siena meeting was originally intended to follow immediately after the 32nd IGC in Florence, so that participants, particularly those funded by the IGCP project, could attend both events during a single visit to Italy. It proved impossible to arrange this, as one of the Siena convenors was involved in an IGC post-conference excursion. IGCP 449 was represented at Florence by a summary poster, presented by Mauro Coltorti. Other IGCP 449 involvement in the Florence IGC included individual contributions to particular sessions, such as the general session on 'Continental Sequences and climatic changes' (convenors Mauro Coltorti and Charles Turner). In addition, the Bulgarian IGCP 449 group contributed two important items at the IGC: *field trip B26*

"Neotectonic transect Moesia - Apulia" and *during-congress workshop DWO 017* "Tertiary tectonics of SE Europe: extensional collapse and rifting, or detachment tectonics?".

FLAG 2004, Siena, Italy (7-11 September, 2004), organized by Mauro Coltorti & Pierluigi Pierruccini

It was decided to reserve all the 2004 project funding for the final meeting, in Malaga, to ensure the success of that meeting and its intended summary publication (see below). Despite that, the Siena meeting was attended by 21 IGCP 449 contributors, within a total attendance of 39 fluvial specialists, the others representing other FLAG themes. It included the first IGCP 449 contribution from Japan (T. Ueki) amongst a mostly European programme. The theme of the meeting was '*Fluvial architecture and dynamics in rising mountain chains and related basins: tectonics, climatic influence and human impact*'. After two days of lectures and posters there was a three day excursion to the Apennines, looking at Pliocene and Quaternary evidence. The meeting will lead to a thematic issue of *Quaternary International*, to be compiled by the meeting organizers. This will include several IGCP 449/518 contributions.

Final IGCP 449 International Project Meeting, Malaga, Southern Spain, December 8th - 12th, led by Jeroen Schoorl, Wageningen University, Netherlands

The final IGCP 449 meeting in Spain (Appendix H), which took place only two weeks before the end of the project was organized by Jeroen Schoorl (logistics and field excursion) and David Bridgland (conference and business meetings: see Appendix H). The meeting was attended by 28 scientists, from 16 different countries (Belgium, Brazil, Czech Republic (3), France (3), Greece, Hungary (3), India, Lithuania, Morocco, Netherlands (4), Papua New Guinea, Russia, Turkey, UK (4), Ukraine, USA). In addition there were several other countries represented by 'absentee posters' (supplied by e-mail – see Appendix Ha). A series of project summary publications is to appear in a special issue of the leading international journal '*Quaternary Science Reviews*' (Appendix F). Business Meeting 8 took place at the Malaga venue, discussing final data collection, the revised internet site and plans for the follow up project (see Appendices Hb and Hc).

3.3.1. Project regional meetings:

EuroMam 2004, S & E England, 10th-14th May 2004, organized by Danielle Schreve

This meeting of the European Quaternary Mammal Research Association included a visit to the celebrated Lower Thames sequence, with its key mammalian faunas. IGCP 449 Biostratigraphy sub-theme co-leader Danielle Schreve was meeting organizer and editor of the field guide for the meeting, published by the Quaternary Research Association (Schreve, 2004) and identified as a contribution to IGCP 449. Several European project participants attended, mainly those involved with activities of the biostratigraphy sub-theme.

The planned regional meeting in Perm, Russia, was postponed until August 2005, and will now form the inaugural meeting of new IGCP Project 514 'Fluvial Palaeosystems: Evolution and Mineral Deposits'. It will be promoted as part of 449's follow-up project IGCP 518.

3.4 List of countries involved in the project (* denotes activity in 2004)

Argentina*	Australia*	Austria*
Bangladesh	Belarus*	Belgium*
Bolivia	Brazil*	Bulgaria*
Canada*	Chile	China*
Czech Republic*	Denmark	Egypt*
Ethiopia*	Finland	France*
Germany*	Hungary*	India*
Indonesia	Iran	Italy*
Japan*	Jordan	Latvia
Lithuania*	Moldova	Morocco*
Namibia	Netherlands*	New Zealand*
Papua N. Guinea*	Peru*	Poland*
Republic of Korea	Romania	Russia*
Serbia & Montenegro	Slovakia	South Africa*
Spain*	Switzerland	Syria*
Turkey*	Ukraine*	United Kingdom*
Uruguay*	USA*	Venezuela*

4. General Scientific achievements

Reports from the various regional and thematic groups within IGCP 449 reveal vibrant project activity in a number of countries and thematic areas. Activity has, since the early stages of the project, been building on the initiation data collection from the Phase 1 (core) area of NW Europe and its early extension into phase 2 areas such as central and eastern Europe. Active contributors were identified in these areas, as well as in the Middle East, India, North Africa, the Far East, North and South America and Australasia, thus giving genuinely global coverage.

Final Project Reports are anticipated (in early 2005) from National Correspondents and group coordinators as follows (these will be appended to the final version of this report):

National Reports:

- (i) IGCP 449 Activity in Argentina (Appendix Ki)
- (ii) IGCP 449 Activity in Australia (Appendix Kii)
- (iii) IGCP 449 Activity in Belarus (Appendix Kiii)
- (iv) IGCP 449 Activity in Belgium (Appendix Kiv)
- (v) IGCP 449 Activity in Brazil (Appendix Kv)
- (vi) IGCP 449 Activity in Bulgaria (Appendix Kvi)
- (vii) IGCP 449 Activity in Canada (Appendix Kvii)
- (viii) IGCP 449 Activity in China (Appendix Kviii)
- (ix) IGCP 449 Activity in the Czech Republic (Appendix Kix)
- (x) IGCP 449 Activity in France (Appendix Kx)
- (xi) IGCP 449 Activity in Germany (Appendix Kxi)
- (xii) IGCP 449 Activity in Hungary (Appendix Kxii)
- (xiii) IGCP 449 Activity in India (Appendix Kxiii)
- (xiv) IGCP 449 Activity in Lithuania (Appendix Kxiv)
- (xv) IGCP 449 Activity in Morocco (Appendix Kxv)
- (xvi) IGCP 449 Activity in the Netherlands (Appendix Kxvi)
- (xvii) IGCP 449 Activity in Papua New Guinea (Appendix Kxvii)
- (xviii) IGCP 449 Activity in Poland (Appendix Kxviii)
- (xix) IGCP 449 Activity in Russia (Appendix Kxix)
- (xx) IGCP 449 Activity in Spain (Appendix Kxx)
- (xxi) IGCP 449 Activity in Syria (Appendix Kxxi)
- (xxii) IGCP 449 Activity in the Turkey (Appendix Kxxii)

- (xxiii) IGCP 449 Activity in the UK (Appendix Kxxiii)
- (xxiv) IGCP 449 Activity in Ukraine (Appendix Kxxiv)
- (xxv) IGCP 449 Activity in Uruguay (Appendix Kxxv)
- (xxv1) IGCP 449 Activity in the USA (Appendix Kxxvi)

4.1 ACHIEVEMENTS OF IGCP 449 - BY REGION

NW Europe

Numerous extensive fluvial records were well known from this region, part of the core area of IGCP 449, even before the project began. These mainly take the form of terrace staircases, but there are also important buried and stacked sequences (e.g. the Lower Rhine, the North Sea basin). Much work was carried out during the lifetime of IGCP 449 and has been published in journal articles, including those in the project-sponsored special issues and edited volumes (*Quaternary International*, 2001 [The response of river systems to climate change]; *Netherlands Journal of Geosciences*, 2003 (Appendix A); *Proceedings of the Geologists' Association*, 2004 (Appendix D); *Quaternaire* 2004 (Appendix C). Information from this area forms the core of the IGCP 449 internet database, with summary sequences available from, e.g., the Rivers Thames, Solent, Trent, Somme, Seine, Allier/Loire and Maas.

Highlights:

The discovery within the fluvial sequence at the Lower Palaeolithic type locality at St Acheul, River Somme (N. France), of travertine containing the characteristic molluscan assemblage of the *Lyrodiscus* biome (Antoine & Limondin-Louzouet, 2004).

Eastern Europe and the former Soviet Union

Numerous records were well established from this region prior to IGCP 449, although the knowledge was only patchily available in English language publications. Amongst the most significant previous work was that by Kukla (1975, 1977, 1978), who established the central European record as paramount in the drive to correlate terrestrial and oceanic sequences, based essentially on stacked loess/palaeosols overlying river terrace gravels. This region thus forms the remainder of the core area of IGCP 449.

Records of significance were known from the Czech Republic, Poland, Russia, the various countries on the Danube and from other Black Sea rivers, having been published previously in German, Russian and/or other languages. Under IGCP 449 several summary publications have appeared in English, notably those by Matoshko *et al.*, 2002, 2004; Matoshko, 2004; Meyrick & Schreve, 2002; Marks & Pavlovskaya, 2003; Alekseev & Drouchits, 2004; Marks, 2004; Patyk Kara & Postolenko, 2004 and Tyráček *et al.*, 2004. Others are anticipated for the special issue of *Quaternary Science Reviews* (Appendix F). Information from this area has been entered on the IGCP 449 internet database, with summary sequences available from the Wipper and Ilm (eastern Germany), Vltava (Czech Republic), Vistula (Poland), Dniester (Moldova/Ukraine), Dnieper (Ukraine), Volga (Russia), Don (Russia), Kolyma (Russia) and Lena (Russia). Andrei Motoshko (Ukrainian National Academy of Sciences, Kiev) is a co-leader of the proposed follow-up project (518).

Highlights:

The Inaugural IGCP 449 meeting, held in Prague, included a field visit to the terraces of the River Vltava, shortly before its infamous flooding of the Czech capital (August 2002). Led by veteran fluvial specialist Jaroslav Tyráček, this was followed up by a summary paper lead-authored by him (Tyráček *et al.*, 2004) in a special collection of papers in the journal *Proceedings of the Geologists' Association* (Volume 114, Nos 2 & 4). This same collection of papers included valuable reviews of the River Vistula in Poland (Marks, 2004) and of the southward-flowing rivers of European Russia (Matoshko *et al.*, 2004).

Southern Europe

Data from southern Europe are less systematic than in the core NW and C European areas. The area lies outside the destructive influence of the Pleistocene ice sheets and so should readily preserve long-timescale fluvial sequences. Project participation has provided records from the Iberian Peninsula, where fluvial deposits are repositories for faunal and archaeological remains (Santonja & Villa, 1990; Agusti *et al.*, 2001; Table 1), and Italy, which hosted the project-supported FLAG 2004 meeting (Siena) as well as the 32nd IGC (Florence). The final plenary meeting of IGCP 449 in December 2004 documented key sequences there. Data also exist from Greece, where an offshore subsiding area in the Gulf of Corinth contains a stack of fluvial sediments (Westaway, 2002c). Material from this area will be

added to the internet database as publications appear. Looking eastwards, the level of Turkish participation has been excellent, providing useful links with the Middle East and Asia (cf. Westaway *et al.*, 2003b, 2004a, b; Demir *et al.*, 2004).

Highlights

The field excursions of FLAG 2004 and the IGCP 449 Malaga meeting examined fluvial sediments and geomorphological evidence in southern European settings.

N. Africa

This was the location of a plenary IGCP 449 meeting in Agadir, Morocco, during December 2002, which led to a supply of data from North Africa, although only Egypt (the Nile) was represented from Africa outside Morocco. A collection of papers arising from the Agadir meeting is being compiled for publication in the journal *Géographie Physique et Quaternaire*, comprising articles in French and English. A paper on fluvial sequences in Morocco appears in the IGCP 449 special issue of *Proceedings of the Geologists' Association* (Bhiry & Occhietti, 2004). Dutch-led research in Kenya was reported at the Malaga meeting and will be represented in the special issue of *Quaternary Science Reviews*. Other North African and circum-Saharan countries remain data vacuums. Material will be added to the internet database as publications appear.

Highlights:

The December 2002 field excursion from Agadir (also based at Marrakech) viewed fluvial archives from semi-arid settings from the Atlantic coast to the Atlas Mountains. The record of Pre-Pleistocene to Early Pleistocene surfaces '*glacis*' needs to be integrated into the fluvial story, but is difficult to date. The work by Rafat Zaki on the famous River Nile sequence is notable and may lead to a plenary meeting there as part of IGCP 518.

North America

Two key meetings involving IGCP 449 took place in North America:

"The 7th International Conference on Fluvial Sedimentology, 6-10 August, 2001, University of Nebraska. This included sessions sponsored by FLAG

(Fluvial Archive Group) in which there were IGCP 449 contributions. These sessions were '*Fluvial system response to climate change through time*' (organizer: Kees Kasse, Amsterdam) and '*Alluvial and tectonic system interactions*' (organizer: Martin Stokes, Plymouth). The conference was organized by Mike Blum, University of Nebraska, himself an IGCP 449 participant.

Project participation in the 16th INQUA Congress in Reno, Nevada, was confined to indoor Session No. 3 (Fluvial Archives of Environmental Change), the planned field excursion to the River Susquehanna being cancelled as a result of a lack of bookings before project-funded participants could make reservations. Project participation in the USA and Canada resulted in publications on the Mississippi (Blum & Straffin, 2001), St Lawrence (Clet-Pellerin & Occhietti, 2000) and Yukon Rivers, the last of which, perhaps surprisingly, given its location in the extreme north of the continent, has a terrace sequence extending back into the Tertiary (Froese *et al.*, 2000; Duk-Rodkin & Barendregt, 2001; Froese, 2002).

Highlights:

The 7th International Conference on Fluvial Sedimentology, in August, 2001, University of Nebraska, was a considerable success. The 16th INQUA Congress was a further opportunity to liaise with the global Quaternary community, with IGCP 449 input into the FLAG poster session.

Asia: Middle East (Turkey, Levant, Mesopotamia)

Building on pioneering work in Iraq by Czech project participant Jaroslav Tyráček (1987), significant new data has been accumulated from the Middle East during the lifetime of IGCP449. One such contribution was published in the IGCP 449 special issue of *Current Science* (New Delhi) in 2003, from the Orontes in Syria (Bridgland *et al.*, 2003). Other data come from a variety of Turkish rivers in the Levantine part of that country (Demir *et al.*, 2004) and new work on the Euphrates and Tigris in both Turkey and Syria. A paper arising from the last-mentioned will be included in the special issue of *Quaternary Science Reviews* that will arise from the final project meeting (Demir *et al.*). In Syria the work has been largely inspired by archaeological (Palaeolithic) interests in the fluvial sequence (see Appendix II).

In western Turkey significant progress has been made on the study of the River Gediz, which has been repeatedly affected during the Quaternary by basaltic volcanism (the Kula volcanic complex). The eruptions can be dated by K-Ar / Ar-Ar dating of lava, constraining the ages of fluvial sediments buried by these (Westaway *et al.*, 2003, 2004; Maddy *et al.*, 2005).

Highlights:

The discovery of a staircase of Gediz river terraces, buried by lava dated 1014 ± 16 ka, that appears to have formed in synchrony with 41 ka Milankovitch climatic fluctuation probably represents the first such record globally (Maddy *et al.*, 2005). Documentation of Turkish long-timescale fluvial archives in a comprehensive review paper was achieved by Demir *et al.* (2004). This sets a baseline for continued activity by the Turkish group in IGCP 518; that project will hold its inaugural meeting in Sanliurfa, SE Turkey (meeting organizer T. Demir - <http://www.harran.edu.tr/igcp/index.htm>).

Asia: Central & Far East

The most productive project work in Asia was carried out in India, where a vibrant community became engaged through the joint project leadership of Sampat Tandon. India was the location of the 2nd plenary project meeting during December 2001, which led to publication of an IGCP 449 collection of papers (Edited by Rajiv Sinha & Sampat Tandon) in *Current Science* (New Delhi). This was devoted to fluvial studies mostly, but not exclusively, in India, the best of which have been selected for adding to the project web site (Table 1). Much activity has taken place in India following the meeting, including a major drilling programme in the alluvial Ganges plain, aimed at building a sound database of the Late Quaternary sequences (Sinha & Tandon again, in collaboration with Martin Gibling of Dalhousie University, Canada)). More than 700 metres of cores have been collected and are being analysed for sedimentology, magnetic susceptibility and OSL chronology. Rajiv Sinha is a co-leader of follow-up project IGCP 518.

Although China was also represented amongst the IGCP 449 leadership, efforts to organize a meeting there were repeatedly frustrated, the final straw being the 2003 SARS epidemic. China has some of the most extensive fluvial sequences in the World, often with thick loessic overburden, with interbedded fossil soils. Its principal river systems, the Yellow (Huanghe) and Yangtze, flow from the Tibetan plateau to the East China Sea. During 2004

the prospects for a future meeting in China, a high priority for any follow-up project, have received a boost with the visit of Prof. Zhongyuan Chen to the University of Durham and his agreement to participate in the follow-up project. Prof. Chen is interested in the evolution of Chinese drainage systems, in particular the Quaternary history of the Yangtze, the upper part of which once flowed into the Red River system.

Highlights:

The vibrant plenary meeting in Kanpur, with its excursion to the exposures beside the Yamuna tributary, led to one of the first of several project-inspired journal compilations/special issues. This included no fewer than 11 articles on the Indian record and its analysis (including dating), as well as papers of societal benefit, notably a review of the problem of arsenic contamination of drinking water in the Ganges area.

Outside China relatively little is known of records from the Far East, although Kim (2001) and Takeyuki Ueki (Ueki 2001; Ueki & Yamamoto, 2003) have recently reported on fluvial records from Korea and Japan, respectively. The participation by Takeyuki Ueki in the FLAG 2004 meeting in Siena included a review by him of recent work in Japan. It is hoped that this will appear in the issue of *Quaternary International* being compiled following that meeting.

Australasia

In 2002 a project meeting took place in Australia, based in the University of Wollongong and including a 10 day field programme in the Lake Eyre inland basin and adjacent east coast/south coast catchments. Although Australia has been predominantly (and increasingly) arid during the late Quaternary, there are important fluvial archives in the Murray - Darling Basin, the filling of which began in the Early Cenozoic (Jones, 2002). East coast rivers such as the Shoalhaven also have excellent records (Nott *et al.*, 2002) and important fluvial sequences, interbedded with aeolian and lacustrine sediments, are also known from the Lake Eyre region and its main feeders such as Cooper's Creek (Nanson *et al.*, 1999). A review of SE coastal rivers was also undertaken under IGCP 449 (Nanson *et al.*, 2003).

A further significant project contribution has come from Papua New Guinea, where rivers in the Finisterre and Sarawaget mountains show evidence of rapid. Bob Findlay (Geological Survey of Papua New Guinea) presented on

this topic at the final project meeting in Malaga, where he will present further data from that country (leading to a prospective contribution to the special issue of *Quaternary Science Reviews*). New Zealand was represented within the project for the first time Malaga, by a paper reporting (and comparing) fluvial and marine terraces, dating back into the Pleistocene, from the northern Waitkere Ranges, North Island (Appendix H).

Highlights:

The Australian meeting in 2002 contrasted the records from the inland Lake Eyre Basin with that from the coastal and SE catchments. Notable and unusual features are the interaction between aeolian, lacustrine and fluvial processes in this semi-arid region. Also remarkable is the consistent success of thermoluminescence dating of sand deposits in eastern Australia by Wollongong's David Price (Nott *et al.*, 2002, 2003) - something to do with the quality of Australian quartz grains and/or Australian sunshine (as a TL signal zeroing agent). This success story contrasts with the near total dominance of the OSL variant as a means for dating sand grains elsewhere.

Sub-Saharan Africa

The level of activity in this varied region during the five years of the project was disappointing. Attempts to initiate new work on the Vaal-Orange sequence were unsuccessful, despite much interest in its archaeological contents (IGCP 449 Annual Reports: 2001, Appendix Ei; 2002, Appendix Ci; 2003, Appendix li). Most research taking place during the lifetime of IGCP 449 was instigated by foreign workers, such as a Dutch project in Kenya (IGCP 449 2002 Annual Report, Appendix Civ).

Highlights:

Papers/posters on the Tana River in Kenya and on landscape evolution in Kwazulu/Natal, South Africa were included in the programme for the Final Project Meeting in Malaga, December 2004.

South America

There was immediate interest in IGCP 449 from workers on mammalian faunas from fluvial sequences in Argentina and Uruguay, with representation at the inaugural meeting in Prague and a paper in the resultant special issue of *Proceedings of the Geologists' Association* (Ubilla, 2004). Plans for a meeting in Argentina in 2003 foundered because of the economic

uncertainties at that time, but could be resurrected for IGCP 518. Meanwhile there was a significant contribution from Brazil, which hosted the 2003 plenary meeting in Belem, with an excursion into Amazonia. The Amazon is the World's largest river system but has been relatively little studied due to difficulties of access and lack of exposure resulting from the dense vegetation cover. An additional problem that became apparent at the 2003 meeting was that there are major disputes between workers concerning both ages and depositional environments of Late Cenozoic sediments (Westaway, in press (a)). A special publication on the evolution of Amazonia is being prepared and will include IGCP 449 contributions, which will then be added to the internet database.

Co-organizer of the Brazilian IGCP 449 meeting, Edgardo Latrubesse participated in the final project meeting in Malaga and will be lead-author of a review of South American records for the special issue of *Quaternary Science Reviews*. He is a co-leader of follow-up project IGCP 518. He and Rajiv Sinha have edited a special issue of *Geomorphology* devoted to tropical rivers, which is identified as a contribution to IGCP 449 (publication imminent and already available on line - see Appendix G and Elsevier website)

Highlights:

The Amazon meeting in 2003, as well as being an unforgettable experience for those who attended it, promises to bring details of the fascinating history of this huge system into the compendium of project data.

4.3 OUTPUT AND DISSEMINATION OF RESULTS

List of most important project publications (by year):

2000:

Antoine, P., Fagnart, J.P., Limondin-Lozouet, N. & Munaut, A.V. 2000. Le Tardiglaciaire du Bassin de la Somme. *Quaternaire* (1)-2, 85-98.

Antoine, P., Fagnart, J.P., Limondin-Lozouet, N. & Munaut, A.V. 2000. Le Tardiglaciaire du Bassin de la Somme. *Quaternaire* 11, 85-98.

Antoine, P., Lautridou, J.P. & Laurent, M. 2000. Long-term fluvial archives in NW France: response of the Seine and Somme rivers to tectonic movements, climate variations and sea-level changes. *Geomorphology* 33, 183-207.

Antoine, P., Rousseau, D.D., Lautridou, J.P. & Hatte, C. 2000. Last Interglacial-Glacial climatic cycle in loess-palaeosol successions of north-western France. *Boreas* 28, 551-563.

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Blum, M.D. & Tornqvist, T.E. 2000. Fluvial response to climate and sea-level change: a review and look forward. *Sedimentology* 47 (supplement), 1-48.

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Dodonov, A.E., Tchepalyga, A.L., Mihailescu, C.D., Zhou, L.P., Markova, A.K., Trubikhim, U.M., Sunakova, A.N. & Konikov, E.G. 2000 Last-interglacial records from Central Asia to the Black Sea shoreline: stratigraphy and correlation. *Netherlands Journal of Geosciences*, 79, 303-311.

Dvareckas V. 2000. The structure and evolution of river valleys and out-wash channels. In: Stone age in South Lithuania (according to geological, palaeogeographical and archaeological data), ISBN 9986-615-28-3, Vilnius, p. 101-107.

Dvareckas, V., Florek, W. & Gaigalas, A. 2000. Development of Lithuanian river valleys and Baltic sea in Late Glacial and Holocene. *IV konferencja Geologia i geomorfologia Pabrzeża i Południowego Bałtyku*. Słupsk-Ustka, 12-13 października 2000.

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5 BENEFIT TO SOCIETY

5.1 Educational, training or capability building activities

Workshops were included in the Inaugural IGCP 449 International Meeting in Prague (on databases) and the 2001 International Meeting in Kanpur, India (on dating methods).

A combined project workshop and business meeting took place at the 16th INQUA Congress, with workshop discussions of data vacuum areas and how they might be filled and of priorities for a possible follow-on project.

5.2 Participation of scientists from developing countries.

The 2001, 2002 and 2003 meetings were convened in developing countries (India, Morocco and Brazil). Expertise on the study of fluvial sequences and on related areas of research that fed into the project, such as geochronological methodology, was disseminated, by means of the project, to areas where it is at present less well developed. This was carried out by means of participation in working groups and by holding workshops on key methodological topics at project meetings, such as in Prague (2001), where there was a workshop on database protocols, and Kanpur (2001), where there was a workshop on geochronological methods.

5.3 Other societal benefit

In addition to furthering academic research and promoting the exchange of ideas and scientific methods (see above), a number of aspects of the project will be of potential value to society. These range from provision of enhanced information on river activity, of value to water authorities and river management bodies, to benefits to companies engaged in wealth-creating enterprises such as mineral extraction from fluvial sediments. Some of these will be identified below.

Environmental change

The Late Cenozoic records researched and collected during the course of the IGCP 449 contribute to a database of environmental change during the Late

Cenozoic and, especially, the Quaternary. This has been a period of fluctuating climate, which has resulted in considerable environmental instability. There is increasing evidence that human activities are causing atmospheric changes that may lead to future climatic change over a very brief timescale, in geological terms; concern about this has significantly increased during the life of the project. A possible connection with increased incidence of flooding by rivers (see the section below) is just one of the issues. Data on past changes can help scientists to make accurate predictions about the future.

River management and water supply

The project database of fluvial sedimentary records represents an archive of river activity and its relation to forcing factors such as climate, vegetation and tectonic activity. Some of the higher-resolution studies, in particular, provide detailed information on the extent and rapidity of changes in the river environment and of fluvial activity. These will be of value to those responsible for managing the World's rivers, or for providing advice for those living in close proximity to rivers, many of whom will depend on the river for their livelihood. Closely related to living in harmony with rivers is their use for water supply, for drinking, for industry and for crop irrigation. Those managing water extraction from rivers again require the best possible knowledge and understanding of river activity, knowledge that the proposed project will enhance. In general, it is clear that a better understanding of what rivers have done in the past will lead to more informed prediction of what they might do in the future.

This aspect of societal benefit was brought home to participants in IGCP 449 by the much publicized flooding of Prague by the River Vltava during the summer (August 2002) following the Inaugural Project Meeting there. Several studies carried out in India during the tenure of the IGCP 449 project have demonstrated the utility of geomorphological approaches for furthering understanding of avulsion-related processes and flood hazards of the Indian river basins using a case study of the Bagmati river, north Bihar. Very effective use was made of a large number of tools, particularly remote sensing, including several image processing techniques. The resulting publications have provided new insights on avulsion processes and development of anabranching stretches in river systems of humid settings (Jain & Sinha, 2003b, 2004). The publications arising out of this work constitute a definite addition to knowledge in the field of flood studies that is of

critical importance in the Indian context (Jain & Sinha, 2003c, d). Another important issue in India and neighbouring countries is arsenic poisoning of water supplies, which was also addressed in the publication from the Indian meeting (Appendix B). As well as considering longer timescales, the June 2003 IGCP 449 field trip to the Amazon addressed environmental management issues related to river systems (e.g., flooding, landsliding caused by bank collapse; cf. Latrubesse *et al.*, 2003). It is intended that the follow-up project will include similar ventures in other river systems.

The commercial value of river sediments

The mineral extraction industry exploits river deposits in many parts of the World. This exploitation ranges from low value bulk extraction of sand and gravel by the aggregate industry to the procuring of high value secondary (placer) minerals from fluvial sediments. The latter has given rise to data contributing to IGCP 449 from Siberian rivers (Patyk-Kara & Postolenko, 2004) and is a key factor in the working of South African fluvial deposits for diamonds (Helgren, 1979; De Wit *et al.*, 1997). In the cratonic part of Brazil, extraction of alluvial diamonds has provided extensive information on the complex history of incision and aggradation by the upper reaches of the Paraná (Bibus, 1983), whereas extraction of alluvial gold exposes the deposits of the Madeira, the largest Amazon tributary (Westaway, in press). Data on the distribution of fluvial deposits, their classification by type, age and origin and a better understanding of their emplacement, will all be of value to those exploiting such deposits commercially.

Other valuable sediments from fluvial sequences:

Sediments of non-fluviatile origin that occur in association with alluvial deposits are sometimes of commercial value. These include, amongst others, valley-bottom peats, loessic material overlying fluvial gravels (of use for brick-making and as a supply of 'loam') and travertine (a source of lime and building stone).

In some cases the alluvial sediments themselves have special qualities and are more valuable than mere sand or aggregate for building. High silica sands are required for glass-making and other industries, whereas other sands may be suitable for use in filter systems. Again, data on distribution and quality of fluvial sediments will assist in these commercial interests.

6. WIDER SCIENTIFIC CONTEXT

6.1 Activities involving other IGCP projects or the IUGS

Prior to IGCP 449, no previous project had attempted global correlation of the sedimentary records provided by the World's rivers. Several regionally and/or thematically based IGCP projects had paid considerable attention to such deposits, however, notably **IGCP 73/1/24** (*Quaternary Glaciations of the Northern Hemisphere*), **IGCP 378** (*Circumalpine Quaternary correlations*) and **IGCP 396** (*Continental Shelves in the Quaternary*). IGCP 449 activities have overlapped to a certain extent with those of **IGCP 437** (*Coastal Environmental Change during Sea-level Highstands*), including representation of 449 at UK 437 meetings in London (2000), Durham (2001) and Southampton (2003), as well as vice versa at the 449 meeting in Wollongong, Australia, July 2002. The 2002 Annual International Meeting of IGCP 449 in Morocco, which included consideration of Quaternary raised beaches and shorelines on the Moroccan coast at Agadir, was open to participation by contributors to IGCP 437. Cooperation and interaction is anticipated between the proposed follow-up project (IGCP 518) and new project **IGCP 495** (*Quaternary Land-Ocean Interactions: Driving Mechanisms and Coastal Responses*), which is co-led by Anthony Long, a colleague of David Bridgland in Durham. Another new IGCP project, entitled '*Fluvial Palaeo-Systems: Evolution and Mineral Deposits*' and mainly concentrating on mineral deposits related to palaeodrainage systems, is led by IGCP 449 contributor Natalia Patyk-Kara. She will provide a link into follow-up project IGCP 518, ensuring cooperation between the two projects.

USA project participant Joel Pederson contributed to INQUA Session 31 '*Deserts over the last 100,000 years*', sponsored by **IGCP 413**, on the topic of: '*The Grand Canyon, Arizona (U.S.) Record of full-landscape response to Middle-Late Pleistocene climate change*'.

6.2. Successor Project (IGCP 518)

An application for a follow-on project was submitted. It was approved for one year in the first instance, unfunded. The chosen topic, '**Fluvial sequences as evidence for landscape and climatic evolution in the Late Cenozoic**', is

globally inclusive, in that it is viable both in areas where much work has already been achieved and in areas perceived as gaps in the IGCP 449 coverage. This project will allow the continued compilation of the internet database and other unfinished activities from the original project, while developing exciting new research areas.

List of Appendices - the following are attached:

Appendix A – 2002 FLAG/IGCP 449 special issue of *Geologie en Mijnbouw/Netherlands Journal of Geosciences*

Appendix B – 2003 Special Issue of *Current Science* (New Delhi)

Appendix C – 2004 Special Issue of *Quaternaire*

Appendix D – 2004 Special Issue of *Proceedings of the Geologists' Association*

Appendix E – Proposed collection of papers for *Géographie Physique et Quaternaire*

Appendix F – Proposed special issue of *Quaternary science Reviews* (project culmination)

Appendix G – Proposed special issue of *Geomorphology*

Appendix Ha – List of papers and posters at the final project meeting in Malaga, December 2004

Appendix Hb – Agenda, Business Meeting 8, Malaga, 16/12/04

Appendix Hc – Minutes, Business Meeting 8, Malaga, 16/12/04

Appendix I - thematic reports:

- (i) Report of the Subgroup on Archaeology from fluvial sequences (Mark White & Sheila Mishra)
- (ii) Report of the Biostratigraphy Sub-Group of IGCP 449: mammals
- (iii) Report of the Biostratigraphy Sub-Group of IGCP 449: molluscs
- (iv) Report of the group for Crustal Deformation & Uplift Modelling (R. Westaway & A. Matoshko)

Appendix J - Example material from internet database

Appendix K - National reports

- (Ki) IGCP 449 Activity in Argentina
- (Kii) IGCP 449 Activity in Australia
- (Kiii) IGCP 449 Activity in Belarus
- (Kiv) IGCP 449 Activity in Belgium
- (Kv) IGCP 449 Activity in Brazil
- (Kvi) IGCP 449 Activity in Bulgaria
- (Kvii) IGCP 449 Activity in Canada
- (Kviii) IGCP 449 Activity in China
- (Kix) IGCP 449 Activity in the Czech Republic
- (Kx) IGCP 449 Activity in France
- (Kxi) IGCP 449 Activity in Germany
- (Kxii) IGCP 449 Activity in Hungary
- (Kxiii) IGCP 449 Activity in India
- (Kxiv) IGCP 449 Activity in Lithuania
- (Kxv) IGCP 449 Activity in Morocco
- (Kxvi) IGCP 449 Activity in the Netherlands
- (Kxvii) IGCP 449 Activity in Papua New Guinea
- (Kxviii) IGCP 449 Activity in Poland
- (Kxix) IGCP 449 Activity in Russia
- (Kxx) IGCP 449 Activity in Spain
- (Kxxi) IGCP 449 Activity in Syria
- (Kxxii) IGCP 449 Activity in Turkey

- (Kxxiii) IGCP 449 Activity in the UK
- (Kxxiv) IGCP 449 Activity in Ukraine
- (Kxxv) IGCP 449 Activity in Uruguay
- (Kxxvi) IGCP 449 Activity in the USA

IGCP 449 special issue *Quaternary Science Reviews*

Global Correlation of Late Cenozoic fluvial deposits

Regional syntheses:

UK - *The British fluvial archive: East Midlands drainage evolution in the context of the British and NW European record* – A. Howard, P. Allen, M. Bates, B. Briant, D. Bridgland, P. Gibbard, D. Knight, S. Lewis, D. Maddy, J. McNabb, J. Rose & R. Westaway

France - *Pleistocene fluvial terraces from northern France (Seine, Yonne, Somme): synthesis and new results* - P. Antoine, J-F Pastre, N. Limondin-Louzouet

Italy – *Title awaited but paper promised* - M. Coltorti, P. Pieruccini

Iberia - *The present-day Spanish fluvial network: a chronological framework* - J.I.S. Navarro & F. Schulte

Eastern & Central Europe - *Fluvial record in the Czech Republic* - J. Tyracek & P. Havlicek

- *Long-term fluvial archives in Hungary: response of the Danube and Tisza rivers to tectonic movements and climatic changes during the Quaternary* – G. Gabris & A. Nador

- *Late Cenozoic fluvial development of the coastal plains and shelf of the Azov Sea and Black Sea basin* - A. Matoshko et al.

India - *Title awaited but paper promised* - Rajiv Sinha, S.K. Tandon et al.

North Africa - *Early and Middle Pleistocene sediments of the Nile In northern Upper Egypt* - Rafat Zaki

Australasia - *Title awaited but paper promised* - G. Nanson (et al.)

South America - *Title awaited but paper promised* - E. Latrubesse, J. Stevaux (et al.)

- *The role of coupling between surface processes and lower-crustal flow in the Late Cenozoic evolution of the Andes / Amazon system* - Westaway, R.

Middle East & Turkey - *Terrace staircases of the River Euphrates in southeast Turkey, northern Syria and western Iraq: evidence for regional surface uplift* - Demir, T., Seyrek, I. Yesilnacar, M. Kartal, B. Celik, R. Westaway, I. Kopar & D.R. Bridgland.

Thematic syntheses:

Progress in faunal biostratigraphy of Late Cenozoic fluvial sequences 2000-4: report of the IGCP 449 biostratigraphy subgroup - D. Schreve, D. Keen et al.

Archaeology - Evidence of early human activity from fluvial deposits: widespread in the 'Old World' - S. Mishra, M.J. White, P. Beaumont, P.

Antoine, D.R. Bridgland, A.J. Howard, N. Limondin-Lozouet, J. McNabb, D.C. Schreve, F.F. Wenban-Smith, R.W.C. Westaway

Use of fluvial sequences to constrain the rheology of the continental crust – R. Westaway

Overall synthesis (patterns, correlations) [Title to be decided] – D.R. Bridgland.

Key studies

Last Glacial – interglacial cycle in the evolution of river valleys in Poland – L. Starkel

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

A Quaternary uplift record for the northern Waitakere Ranges, Te Henga-Muriwai, New Zealand - L. Claessens & A. Veldkamp

Late Quaternary fluvial evolution in the lower Tagus valley (central Portugal): the interaction of base level, climate and anthropogenic change – T. van der Schriek, D. Passmore, J. Rolao & A. Stevenson

Late Cenozoic fluvial dynamics of the Tana river, Kenya, an uplift dominated record - A. Veldkamp, E. Buis, J.R. Wijbrans, D.O. Olago, E.H. Boshoven, M. Marée, R.M. van den Berg van Saparoea

Rapid uplift and a tale of 5 rivers; fluvial impacts from the Finisterre and Sarawaget mountains, Papua New Guinea - R.H. Findlay

Innovation in dating: new methods for amino acid analyses – K. Penkman & M. Collins

A 'snapshot' of the evolution of the Paraná river system. The Salto Formation (Pleistocene, Uruguay) - G. Veroslavsky & M. Ubilla

No sea-way through Southwestern Amazonia during the Late Miocene: Evidence from Brazil – E.M. Latrubesse and M. Cozzuol

**FLAG/IGCP 449 special issue of Geologie en Mijnbouw/Netherlands
Journal of Geosciences.**

Editors: David Bridgland, Durham, and Frank Sirocko, Mainz

Published Volume 81, No.3/4, December 2002

- D. Bridgland & F. Sirocko - Preface: Special Issue arising from the meeting in Mainz, Germany, of the Fluvial Archive Group – 263-264.
- D. Bridgland & D. Maddy - Global correlation of long quaternary fluvial sequences: a review of baseline knowledge and possible methods and criteria for establishing a database – 265-281.
- R. Westaway - Geomorphological consequences of weak lower continental crust, and its significance for studies of uplift, landscape evolution, and the interpretation of river terrace sequences – 283-303.
- R. Westaway - Long term river sequences: Evidence for global increases in surface uplift rates in the Late Pliocene and early Middle Pleistocene caused by flow in the lower continental crust induced by surface processes – 305-328.
- D. Maddy – An evaluation of climate, crustal movement and base level controls on the Middle-Late Pleistocene development of the River Severn, UK – 329-338.
- A. Matoshko, P. Gozhik & A. Ivchenko - The fluvial archive of the Middle and Lower Dnieper (a review) – 339-355.
- D. Schreve & D. Bridgland - Correlation of English and German Middle Pleistocene fluvial sequences based on mammalian biostratigraphy – 357-373.
- T. Veldkamp, M. van den Berg, van Dijke, van den Berg & van Saparoea - Reconstructing Late Quaternary morphogenetic process controls in an upper reach fluvial system: the Aller Valley (North Germany) – 375-388.
- K. Cohen, F. Stouthammer & H. Berendsen - Fluvial deposits as a record of neotectonic activity in the Rhine-Meuse delta, the Netherlands – 389-405.
- A. Gaigalas & V. Dvareckas - The evolution of river valleys in Lithuania from deglaciation to recent changes: data from the sediment infill of oxbow lakes – 407-416.
- E.C. Straffin & M.D. Blum – Holocene fluvial response to climate change and human activities; Bergundy, France – 417-430.
- F. Sirocko, T. Szeder, K. Seelos, R. Lehne, M. Diehl, B. Rein, W.M. Schneider. & M. Dimke - Young tectonic and halokinetic movements in the North-German-Basin: its effect on formation of modern rivers and surface morphology – 431-441.

Special IGCP 449 Issue of *Current Science* (New Delhi)

Guest Editor: Dr Rajiv Sinha, University of Kanpur

Published – April 2003 (Vol. 84, No. 8)

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2. Facies, fossils and correlation of the late Miocene fluvial sequences of the Himalayan foreland basin (S.B. Bhatia) – 1002-1005.
3. Mio-Pliocene sedimentation history the north-western parts of the Himalayan foreland basin, India (Rohtash Kumar, S.K. Ghosh & S. Sangode) – 1006-1013.
4. Magnetostratigraphic Correlation of the Late Cenozoic fluvial sequences from NW Himalaya, India (S.J. Sangode & R. Kumar) – 1014-1024.
5. River systems in the Gangetic plains and their comparison with the Siwaliks: a review (V. Jain & R. Sinha) – 1025-1033.
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7. A sediment budget for the Ganga-Brahmaputra catchment (R.J. Wasson) – 1041-1047.
8. Quaternary alluvial stratigraphy and paleoclimatic reconstruction at the Thar margin (M. Jain and S.K. Tandon) – 1048-1055.
9. Late Quaternary fluvial sequences of the southern mainland Kachchh, Western India: Lithostratigraphy and neotectonic implications (D.M. Maurya, S. Bhandari, M.G. Thakkar & L.S. Chamyal) – 1056-1064.
10. Quaternary fluvial sequences of the south Saurashtra, Gujarat, western India (Nilesh Bhatt & U.A. Bhonde) – 1065-1071.
11. Sedimentary records of palaeofloods in the bedrock gorges of the Tapi and Narmada Rivers, central India (Vishwas S. Kale, Sheila Mishra & Victor R. Baker) – 1072-1079.
12. A long Quaternary terrace sequence in the Orontes River valley, Syria: a record of uplift and human occupation (David Bridgland, Graham Philip, Rob Westaway & Mark White) – 1080-1089.
13. Pliocene and Quaternary surface uplift of western Turkey revealed by long-term river terrace sequences (Rob Westaway, Malcolm Pringle, Sema Yurtmen, Tuncer Demir, David Bridgland, George Rowbotham & Darrel Maddy) – 1090-1101.
14. The arsenic cycle in fluvial sediments: mineralogical considerations (B.C. Raymahashay & A.S. Khare) – 1102-1104.
15. The effect of changes in the Earth's moment of inertia during glaciation on geomagnetic polarity excursions and reversals: implications for Quaternary chronology (R.W.C. Westaway) – 1105-1115.

FLAG Special issue of Quaternaire (2004, 1-2)

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Pierre Antoine, David Bridgland, Darrel Maddy & Jean-François Pastre

- 3-4 Fluvial Archives Group (FLAG) Meeting, Clermont-Ferrand, September 2002, Préface - Pastre, J.-F., Antoine, P., Bridgland, D. & Maddy, D.
- 5-15 Evidence for early Devensian (Weichselian) fluvial sedimentation: the upper Pleistocene deposits at Deeping St James, Lincolnshire, England - Briant, R.M., Coope G.R., Preece R.C. & Gibbard P.L.
- 17-28 The Thames Valley sediment conveyor : fluvial system development over the last two Interglacial-Glacial Cycles - S. Lewis, D. Maddy & S.S. Glenday
- 29-40 Quaternary lithostratigraphy and mammalian biostratigraphy of the Lower Thames terrace system, South-East England - Bridgland D.R. & Schreve D.
- 41-52 Identification of MIS 11 Interglacial fluvial deposit in the Somme valley (France): new results from Saint-Acheul - Antoine, P. & Limondin-Lozouet N.
- 53-64 Middle and Upper Pleistocene Evolution of the River Yonne Valley (France). First results - C. Chaussée, P. Voinchet, J.J. Bahain, N. Connet & V. Lhomme.
- 65-76 Pleistocene alluviation in the Meurthe and the Moselle valleys (Eastern Paris Basin) : Lithofacies and incision rhythms, first results - Cordier, S., Harmand, D., Losson, B. & Beiner, M.
- 77-86 Pleistocene fluvial systems of the Creuse river (Middle Loire basin - Centre region (France) - Despriée, J., Gageonnet, R., Voinchet, P., Bahain, J.-J., Falguères, C., Duvialard, J. & Varache, F.
- 87-101 The Perrier plateau ; a Plio-Pleistocene long fluvial record in the River Allier basin, Massif central, France - Pastre, J.F.
- 103-115 Pliocene and Quaternary surface uplift revealed by sediments of the Loire-Allier river system, France - Westaway, R.
- 117-128 Evolution of the fluvial system of the Prypiat, Desna and Dnieper during the late Middle-Late Pleistocene - Matoshko, A.V.
- 129-134 Reconfiguration of small river channels under conditions of crustal instability (NE of Asia) - Patyk-Kara, N.G. & Spasskaya, I.
- 135-141 ESR dating of quartz extracted from quaternary sediments. Application to fluvial terraces system of Northern France - Voinchet, P., Bahain, J.-J., Falguères, C., Laurent, M., Dolo, J.-M., Despriée, J., Gageonnet, R. & Chaussée, C.
- 143-157 Optically stimulated luminescence dating: How significant is incomplete light exposure in fluvial environments - Jain, M., Murray, A.S. & Bøtter-Jensen, L.
- 159-165 The suitability of dated travertines as a record of fluvial incision. A case study for the Allier - Veldkamp, A., Kroonenberg, S.B, Heijnis, H. & Van den Berg van Saparoea, R.M.
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- 187-193 Weichselian and Holocene fluvial evolution of the Vezère river Valley (Dordogne, France) - J. Mol, W. Roebroeks, H. Kamermans, T. van Kolfschoten & A. Turq.
- 195-206 Holocene terraces in the Middle Euphrates valley between Halfeti and Karkemish (Gaziantep, Turkey) - Kuzucuoglu, C., Fontugne, M. & Mouralis, D.
- 207-218 Holocene deposits in the lower section of the oued Noun (South Morocco): Preliminary results - Mathieu, J. + 11 others
- 219-231 Hydrogeomorphic effects of beaver dams on floodplain morphology: avulsion processes and sediment fluxes in upland valley floors (Spessart, Germany) - John, S. & Klein, A.
- 233-242 Micromammals fauna of the Dnieper modern channel alluvium: Taphonomic and biostratigraphic implications - Popova, L.

Special Issue of *Proceedings of the Geologists' Association*

Inaugural meeting of IGCP 449

Global Correlation of Late Cenozoic Fluvial Deposits

Guest editors: D.R. Bridgland, S.K. Tandon & R.W.C. Westaway

Published as two sets of papers in Vol. 115, parts 2 & 4

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- 125-140 Biostratigraphical correlation between the late Quaternary sequence of the Thames and key fluvial localities in central Germany - D.R. Bridgland, D.C. Schreve, D.H. Keen, R. Meyrick & R. Westaway
- 141-173 Key Late Cenozoic fluvial archives of eastern Europe: The Dniester, Dnieper, Don and Volga – A.V. Matoshko, P.F. Gozhik & G. Danukalova
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- 313-324 Fluvial sedimentation in a semiarid region: the fan and interfan system of the middle Souss Valley, Morocco - N. Bhiry & S. Occhietti
- 339-346 Quaternary fluvial sediments in the Russian Arctic and Subarctic: Late Cenozoic development of the Lena river system, northeastern Siberia - M.N. Alekseev & V.A. Drouchits
- 325-338 Structure and Cenozoic evolution of the Kolyma river valley, eastern Siberia, from its upper reaches to the continental shelf - N.G. Patyk-Kara & G.A. Postolenko
- 347-357 Mammalian biostratigraphy of Pleistocene fluvial deposits in northern Uruguay, South America - M. Ubilla

Géographie Physique et Quaternaire **IGCP 449 Special issue**

(Arising from December 2002 Annual Meeting in Morocco)

This publication has been delayed and will now be revised as a potential supplement to the final project compendium for *Quaternary Science Reviews*. Some of the papers listed here will be diverted that compendium.

Andre Weisrock & Serge Occhietti – SYNTHESIS PAPER (in French)

Ali Ait Hssaine, Andre Weisrock & Serge Occhietti – QUATERNARY OF MOROCCO (in French)

T. Demir, R.W.C. Westaway, D.R. Bridgland & A. Seyrek – TERRACE STAIRCASES OF THE RIVER EUPHRATES IN SOUTH-EAST TURKEY AND NORTHERN SYRIA.

R.M. Zaki – EARLY AND MIDDLE QUATERNARY SEDIMENTS OF THE NILE IN NORTHERN UPPER EGYPT.

R.W.C. Westaway, A. Matoshko & D.R. Bridgland – EFFECT OF CRUSTAL RHEOLOGY ON UPLIFT RATES IN THE NORTHERN BLACK SEA REGION FROM RIVER TERRACE EVIDENCE.

Martin Stokes, Anne Mather & Astrid Blum – THE APPLICATION OF STREAM-LENGTH GRADIENT INDICES FOR ELUCIDATING ACTIVE TECTONICS IN SE SPAIN

Sheila Mishra – NEOGENE GRAVELS IN PENINSULAR INDIA, THEIR WEATHERING AND RELATION TO HUMAN OCCUPATION.

R.H. Findlay - A TALE OF THREE RIVERS; FLUVIAL IMPACT IN A ZONE OF RAPID UPLIFT, FINISTERRE AND SARAWAGET MOUNTAINS, PAPUA NEW GUINEA.

Special Issue on Tropical Rivers

Geomorphology, Elsevier Science

Contents

Fluvial geomorphology and processes

1. Tropical Rivers
E.M. Latrubesse, J.C. Stevaux, R. Sinha
2. Geomorphic characterization and diversity of the fluvial systems of the Gangetic plains
R. Sinha, V. Jain, G. Prasad Babu, S. Ghosh
3. Fluvial process and morphology of the Brahmaputra river system in Assam, India
J. N. Sarma
4. Morphologic changes in the Paraná River channel (Argentina) in the light of the climate variability during the twentieth century.
M. Amsler, C.G. Ramonell, and H. Toniolo

Paleohydrology/bedrock channels

5. Reconstructing the c.100-year Flood in Northern Thailand
R. Kidson, K.S. Richards, P.A. Carling
6. The Sinuous Bedrock Channel of the Tapi River, Central India: Its form and processes
V.S. Kale
7. Physiogeographic features of the Oubangui catchment and environmental trends reflected in discharge and floods at Bangui 1911-1999, Central African Republic
Jürgen Runge, C. Nguimalet

Active tectonics/River response

8. Neotectonics and channel evolution of the Lower Ivinhema River: a right-bank tributary of the upper Paraná River, Brazil
E. Fortes, J.C. Stevaux, S. Volkmer
9. Response of active tectonics on the alluvial Bagmati river, Himalayan foreland basin, eastern India
V. Jain, R. Sinha
10. River avulsions on the Taquari megafan, Pantanal Wetland, Brazil.
Mario L. Assaine

Quaternary evolution

11. The late Quaternary evolution of the Negro River, Amazon, Brazil: implications for island and floodplain formation in large anabranching tropical systems
E.M. Latrubesse, Elena Franzinelli
12. Rivers turned to rock: Late Quaternary alluvial induration influencing the behaviour and morphology of an anabranching river in the Australian monsoon tropics
G.C. Nanson, Brian G. Jones, David M. Price, T. J. Pietsch

IGCP 449 Activity in Belarus

Irina Pavlovskaya

Meetings or field excursions relevant to the project

Field Symposium on Quaternary Geology and Geodynamics was held in western Belarus, May 20-25 2002, Grodno area (organizers: the Peribaltic Group of INQUA Commission on Glaciations, Friends of Baltic Quaternary; local organizers: Institute of Geological Sciences, Belarusian National Committee of INQUA). The symposium gathered 52 scientists from 8 countries.

17 oral presentations and 33 posters were presented at the scientific session. The 4 days' field excursion was an interdisciplinary trip focused on the Middle and Late Pleistocene glacial/interglacial sequence, glacial and fluvial depositional environments, evolution of the Neman river valley, as well as the maximum extent of the last Pleistocene glaciation within the Neman Lowland and the Grodno Highland. During field trip participants visited 11 key sections with Holsteinian, Eemian, Saalian and Weichselian fluvial and lake sediments. The published Excursion Guide considered geological structure, results of radiocarbon dating, biostratigraphical and sedimentary records registered in Middle/Late Pleistocene deposits including fluvial series of the Neman river in western Belarus.

The poster "Correlation of Holsteinian fluvial series in Poland and Belarus" was presented by L. Marks & I. Pavlovskaya during the general poster session at the XVI INQUA Congress, July 2003, Reno, Nevada, USA.

Research relevant to the project

Study of the Middle and Late Pleistocene fluvial sediments and reconstruction of river interglacial network, as well as correlation of fluvial series, were undertaken 2002-4. The main results of the study are:

1. Late Pleistocene sedimentary records have been studied within the Neman drainage basin (sites Ponemun, Dubna, Bogatyrevichi, Gozha and others). This study has revealed history of evolution of the Neman river – one of the largest rivers in central Europe. According to lithofacies successions in the key sections in the Neman area, traces of fluvial activity in the present Neman valley corresponded to the Late Weichselian time. The oldest fluvial sediments have been registered at Dubna, the most southern site of the area. These sediments were formed during the maximum extent of the last ice sheet, as well as initial phases of filling of the Skidel ice-dammed lake. Further to the north, within longitudinal part of the present Neman valley, river sediments are even younger. As recorded at Gozha, the large lake existed before and during the maximum advance of the last ice sheet. Forming of the river beds and a development of the stream was connected with phases of the

Skidel lake drainage and level drops in the Middle-Lower Neman ice-dammed lake system during the retreat of the ice sheet margin. According to paleocurrent measurements, general direction of flow in the Late Weichselian was changed from the S to NNW which was similar to the present Neman watercourse. The Neman present course within the area was formed during the end of the last glaciation and the Late Glacial (Pavlovskaya – *in press*).

2. Sedimentary archives and stratigraphical position of the Holsteinian sections within the Upper Dnieper area have been analysed. Interglacial alluvial beds in Prypiat, Berezina and Dnieper valleys occur at 110-130 m, however the lake sediments occur at 160-140 m. Altitudinal differences between them are in different river basins 20-40 m. Based on data about intrinsic thresholds, the attempt of assessment of the drainage zone has been done. Using the palaeobotanical data on pollen successions in different sites, it has been estimated that the lakes located near Dnieper were drained first of all. The width of the drainage zone was smallest there due to significant altitudinal differences between a base threshold and lake kettles (e.g. the deposits of the Dobraya lake situated 26 km away the Dniepr valley possess complete pollen succession characterizing the whole Holsteinian Interglacial). Berezina and Prypiat drainage zones were much wider and the rate of their enlargement was less significant, especially the Prypiat one due to the threshold position (Pavlovskaya *et al.* – *in press*).

3. Fluvial Holocene sediments in Drut and Neropla valleys (Dnieper basin, eastern Belarus) have been studied (Kalicki *et al.* 2003). The studied profiles represent sedimentary environments of flood plain (abandoned channel fills, backswamps), alluvial fan of small erosional hollow. Preliminary results allow to assume that sedimentation pattern changed in one of the Drut's abandoned channels at 3230±105 BP (IGSB-920), when peat was covered with clastic overbank deposits.

Publications

Published:

Pavlovskaya, I., Yelovicheva, Ya., Murashko, L., Khursevich, G. & Szadkowska M. 2002. Muravian (Eemian) sediments at Poniemun as a key to definition of the last glaciation limit and evolution of the Neman valley. In: Field Symposium on Quaternary Geology and Geodynamics in Belarus. Excursion Guide. Minsk, Geoprint. 39-45.

Pavlovskaya, I., Davydik, K., Luchina, G. & Kolkovsky, V. 2002. Evolution of the Neman valley recorded in Late Poozerian (Late Weichselian) sediments at Gozha. In: Field Symposium on Quaternary Geology and Geodynamics in Belarus. Excursion Guide. Minsk, Geoprint. 58-62. L. Marks, I. Pavlovskaya 2003. The Holsteinian Interglacial river network of mid-eastern Poland and western Belarus. *Boreas*: Oslo. Vol. 32. P. 337-346.

L. Marks, I. Pavlovskaya 2003. Correlation of Holsteinian fluvial series in Poland and Belarus. In: Shaping the Earth: a Quaternary Perspective. XVI INQUA Congress. Programs with Abstracts. Reno. P. 68.

Kalicki T., Savchik S., Kalkovskiy V., Makhnach N., Kalicki S. 2003. Human impact reflected in the sediments of Drut river valley. 9th Annual meeting of European Association of Archaeologists. Final Programme and Abstracts. P. 19.

In press:

I. Pavlovskaya. Late Pleistocene evolution of hydrographical network recorded at geosites in the Middle Neman area (western Belarus) (Papers of Polish Geological Institute – *accepted for publication*).

I. Pavlovskaya, T Yakubovskaya, I. Savchenko. Middle and Late Pleistocene fluvial series in eastern Belarus (Lithosphere - *accepted for publication*).



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., Stemerink, 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 Kercksmár & 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 - 18.30 **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**

Global Correlation of Late Cenozoic Fluvial Deposits

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

Hotel Posadas de España, Málaga, 16th December 2004



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

Project co-leader: Dr David Bridgland, Department of Geography, University of Durham, South Road, Durham DH1 3LE

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@iasdl01.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)*



IGCP 449 Business meeting 8

Minutes

Rob Westaway

Hotel Posadas de España, Campanillas, Malaga, Spain, 4:30 pm, 14 December 2004.

1. Outcomes of previous business meetings

June 2003, Belem and Rio Branco, Brazil. The main outcome of these meetings was to suggest the name of the proposed follow-up IGCP, intended to start in 2005, which is to be 'Fluvial sequences as evidence for landscape and climatic evolution in the Late Cenozoic'. Dr David Bridgland added that he understood that this new project had been provisionally assigned the number IGCP 518, though it had not yet been approved.

July 2003, Reno, USA. This was another well-attended meeting.

2. Project publications

Dr Bridgland explained that any publication acknowledging IGCP 449 could count as project output, not just papers in the project's special publications.

To date, two project special issues of journals had been published:

The **International Meeting for 2000**, held in Prague, Czech Republic, in April 2001, had led to a special issue of **Proceedings of the Geologists' Association**. This had been published in two parts, in June and December 2004. The **International Meeting for 2001**, held in Kanpur, India, in December 2001, had led to a special issue of **Current Science**, published in April 2003.

Other project publications remained unfinished.

For the **International Meeting for 2002**, held in Agadir, Morocco, in December 2002, a special issue of **Géologie Physique et Quaternaire** had been proposed. However, this had been held up due to insufficient manuscripts having been received.

The **International Meeting for 2003**, held in Belem, Brazil, in June 2003, had been hosted as part of the 3rd Latin American Conference on Sedimentology. Independent of IGCP 449, the organisers of another conference session on the Late Cenozoic Evolution of Amazonia had arranged a special issue of **Journal of South American Earth Sciences**. It had therefore been decided to combine publication of the IGCP 449 session with this volume. However, this arrangement had led to many problems: manuscripts (even those that had been invited) were subjected to arbitrary reviewing, leading to many being rejected; one guest editor resigned in protest at what was happening; and some people withdrew their manuscripts since they required cross-referencing to other manuscripts that had

been rejected. It was anticipated that what was left of this special issue would be published during 2005.

The **International Meeting for 2004**, currently under way in Malaga, Spain, would lead to a special issue of **Quaternary Science Reviews**.

Dr Bridgland explained that publication in this prestigious journal would be the most significant output of the project. Given the stature of the journal, and the limitation on space, manuscripts will have to be rigorously reviewed, and some conference presentations would have to be merged into integrated syntheses. The unfinished special issue of GPQ may be used as 'overspill' for the QSR issue; late submissions, manuscripts that encounter refereeing problems, and multiple manuscripts from individual authors may be redirected into that.

Dr Bridgland reported that the deadline for submissions to the QSR special issue would be 28 February 2005. To facilitate reviewing, manuscripts would be edited for English by the guest editors before being sent out for review.

Professor Edgardo Latrubesse and Dr Westaway raised the question of whether to try to resurrect an IGCP 449 special issue for the Belem meeting. It was decided that it was now too late for that. However, Dr Bridgland agreed that manuscripts by IGCP 449 participants that had been rejected from the JSAES special issue could be considered for the other IGCP 449 special issues, in QSR and GPQ.

3. IGCP 449 Internet data resource

Dr Bridgland explained that originally this had been proposed as a fluvial archive database. However, at the Kanpur business meeting it had been decided that developing a true database was not feasible and so the resource would be prepared as a searchable website. A pilot website was promptly developed, which was hosted as part of the Durham University website and which enabled the full set of requirements of the resource to be established. However, this aspect of the project had since been frozen due to delays resulting from the reorganisation of the whole Durham University website. Once this reorganisation was completed, the project website would be established in such a way that it would be directly accessible, so that it would remain unaffected following further such reorganisations.

Dr Rajiv Sinha reminded the meeting that at Kanpur it was agreed that he would take charge of developing a true prototype fluvial archive database for rivers in northern India. Work on this was progressing.

The project led by Dr Philip Gibbard to produce an internet resource of maps of rivers was also discussed.

4. IGCP 449 Final Outcomes

The IGCP organisation required a final report on IGCP 449 by June 2005. A draft was needed to enable a decision to be made about the follow-up project; this had been submitted in December 2004. The quality of the final report for IGCP 449 may influence funding levels for the first two years of the follow-up IGCP 518. High funding was considered important in view of the high cost of the planned meeting in China, scheduled for 2006. Dr Bridgland asked all participants to complete their submissions to the final report by 31 March 2005.

5. Follow-up project

Outline

Dr Bridgland explained that the name, 'Fluvial sequences as evidence for landscape and climatic evolution in the Late Cenozoic', was intended to enable additional topics to be added (specifically, in relation to landscape evolution) while also keeping the existing themes covered by IGCP 449. It was also hoped that stronger links could be established with other IGCPs, such as on Quaternary sea-level. Meeting participants (particularly those from developing countries) were encouraged to send letters of support confirming their participation in the new project. Dr Bridgland asked for these to be sent to him by 1 February 2005.

Another difference relative to IGCP 449 would be that IGCP 518 would have greater emphasis on educational objectives, which would probably be addressed by holding training workshops at its international meetings. There was also greater emphasis on outreach activities, in line with general IGCP policy.

Dr Bridgland announced that the leaders of IGCP 518 would be Professor Latrubesse, Professor Andrei Matoshko, Dr Sinha, and himself. The International Secretary would be Dr Darrel Maddy and the webmaster for the project website would be Dr Westaway.

Schedule

A tentative schedule for IGCP 518, assuming prompt approval in early 2005, would be as follows:

2005. International meeting to be held in September or October 2005. Option 1 would be to hold it in Egypt, hosted by Professor Rafat Zaki, looking at the Nile. Option 2 would be to hold it in SE Turkey, hosted by Dr Tuncer Demir, looking at the Euphrates and Tigris, possibly also including a field excursion into Syria. At this stage option 2 seemed the more likely, because of the limited time available for planning. If so, the option to hold a meeting in Egypt could possibly be held over to the end of the project in 2009.

2006. International meeting to be held in Spring 2006 in Shanghai, China, hosted by Professor Chen Zhongyuan. This meeting would possibly be co-hosted with a conference for IGCP 475 on Quaternary sea-level variations. A field excursion to the Yangtze would also be included.

It is anticipated that there would be an IGCP 449 presence at the **FLAG 2006** meeting to be held in western Turkey, probably in September 2006.

2007. The international meeting for 2007 has been tentatively scheduled to be co-hosted with the **INQUA** conference in Cairns, Australia. It may thus include a field excursion to look at the fluvial sequences associated with dramatic surface uplift in Papua New Guinea.

2008. Ideally, the international meeting for 2008 would be co-hosted with the **IGC** meeting in this year. However, that is scheduled to take place in Norway, a country that lacks long-timescale fluvial sequences. So although there may be an IGCP 518 presence at the IGC, the main international meeting would probably take place elsewhere. No locality had yet been finalised; options considered so far include Ukraine (to look at the Dniester), Bulgaria (to look at the Struma and Mesta), and Kenya (to look at the Tana).

It is anticipated that there would be an IGCP 449 presence at the **FLAG 2008** meeting to be held in Spain.

2009. Assuming that it does not go ahead in 2005, the final international meeting for IGCP 518 may be hosted in Egypt, looking at the Nile.

6. Any other Business

None.

The meeting closed at 5:45 pm.

Evidence of human activity from Pleistocene fluvial deposits: findings during the course of IGCP 449

Mark White¹ & Sheila Mishra²

*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

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.

GAZETTEER OF PALAEOLOGICAL RESEARCH FROM FLUVIAL SITES

FRANCE:

River Somme

Saint-Acheul, River Somme (Northern France)

(Pierre Antoine & Nicole Limondin-Louzouet)

Malacological analyses of sediments from the type-locality of the Acheulian have yielded data consistent with other malacological records from tufa deposits of northern France and England allocated to MIS 11, with the presence of the genus *Lyrodiscus* and associated southern species (Antoine & Limondin-Louzouet, 2004).

A new cleaned profile at Saint-Acheul provided an opportunity to undertake malacological analysis and ESR dating on a tufa deposit at the top of the fluvial sequence. The basal fluvial deposits are attributed to the Garenne Formation (Formation V) of the Somme terrace system, which has been previously allocated to MIS 12 and 11. This chronostratigraphic interpretation is now consolidated by an ESR age determination on quartz (403 ± 73 kyrs BP), consistent with a MIS 11 allocation. The molluscan species belong to the particular "*Lyrodiscus* biome" recognized in several tufa deposits from north-west Europe, all allocated to MIS 11. Finally, these results reinforce the interpretation of the Somme terraces system as a model of river response to Milankovitch cycles during the Pleistocene.

France: R. Yonne

Soucy

A gravel quarry at **Soucy** has yielded Palaeolithic material within Middle Pleistocene alluvial deposits. These deposits are assigned to MIS 10 and 9, according to aminochronology and ESR dating. They have yielded abundant and original terrestrial and aquatic malacofaunas indicative of interglacial conditions (Chaussé *et al.*, 2001; Limondin-Lozouet, 2001).

GERMANY:

Quaternary Research Association short field meeting in Central Germany, Weimar, 12-17/5/02

Rich Meyrick and Danielle Schreve were joint leaders of this meeting, during which were visited several key fluvial sequences with Palaeolithic components in this celebrated area. Highlights were the staircase of terraces and MIS 11 archaeological site at **Bilzingsleben**, on the River Wipper, presented by

Dietrich Mania, and the Late Middle-Late Pleistocene travertines at Weimar-Ehringsdorf, on a terrace of the River Ilm (Meyrick & Schreve, 2002 - the guide book for the meeting, which is tagged as a contribution to IGCP 449). The travertine of the Bilzingsleben II level includes the celebrated archaeological 'living floor', part of which is preserved in a building. There is also a dedicated museum in the village nearby. Both were presented to participants in the 2002 meeting by Dietrich Mania, who has devoted much of his career to studying this locality.

The quarry sections at the **Weimar - Ehringsdorf** geological conservation site were visited. These reveal travertines that are interbedded with fluvial sediments of the River Ilm, archaeological horizons, including hearths, occurring at several levels within the travertine. Hominid fossils are also known from here. There was a lively discussion during the 2002 visit about whether the travertines date entirely from MIS 7 or whether the upper ones are Eemian.

India:

Shiela Mishra's team has continued to work in two basins: the Karha basin in Pune district of Maharashtra and the Narmada basin in Barwani, Dhar and West Nimar Districts of Madhya Pradesh. Evidence here was important in formulating the topic of the new follow-up IGCP project (see Westaway, Bridgland & Mishra, 2003). The research team consists of a number of people from Deccan College and formerly at Deccan College, including Sushma Deo, Sonali Naik, S. N. Rajaguru, Savita Ghate, Probodh Shirwalkar, Riza Abbas, Gurudas Shete, Neetu Agarwal and Utpala Adhav. Shiela recently had a sabbatical period in Ethiopia.

Fieldwork has been carried out in northern Madhya Pradesh. There are two rivers, the Parvati and the Betwa, which drain the peninsula but are tributaries to the Ganga. They are very different to the peninsular rivers Godavari, Bhima and Narmada.

Karha Basin

The Karha basin has preserved very interesting traces of Pre-Quaternary sediments. It was earlier considered that in the erosional Deccan Trap landscape, no traces of pre-Quaternary sediments existed. Three localities, Saswad, Jejuri and Morgaon have exposures of these sediments. Initially a pre-Quaternary age for these sediments had been inferred for gravels at Morgaon, based on their post-depositional weathering. The gravel at Morgaon overlies 5 m of weathered basalt that must have weathered after the gravel deposition. In addition the cobbly clast sizes is totally different from the modern gravel which is sandy to pebbly. The absence of calcrete clasts from this gravel was another important contrast as Late Pleistocene gravels exposed at Morgaon are dominated by calcrete clasts. Exposures of similar gravels have been found at Saswad and Jejuri where it was noticed that laterite pebbles occur in the gravel. Laterite does not presently occur

anywhere in the Karha basin. The nearest exposure of laterites is presently on the southern divide between the Nira and Krishna rivers, the drainages to the south of the Karha. This shows that when these gravels were deposited such exposures did exist. Laterite component of the gravel at Morgaon has also been found. This discovery of laterite is a very strong confirmation of the antiquity of the gravels.

At Morgaon, the Pre-Quaternary gravel is overlain by a fluvial sequence which includes Early Acheulian artefacts. On the basis of the artefacts we have concluded that the correlation of the tephra layer within the same complex to the 75 kyr Toba eruption is erroneous. The “Acheulian/tephra” sequence has been studied and distinct units defined and their stratigraphic relationships defined. The sequence begins with calcareous red silt. A fine sandy, well-cemented gravel occurs as lenses in this silt and also cutting into the surface of the Pre-Quaternary gravel. This red silt grades into overlying black fissure clay. The tephra is a lense within this clay, and forms a channel fill that can be traced for over 2 km, paralleling the Karha. A rubble, which resembles modern gully fills, is seen just above the tephra. This rubble contains reworked boulders of the Neogene and “red silt” gravels. A distinctive spongy calcrete coating on pebbles is seen. Two trihedral handaxes have been found in this rubble. It appears to be an immediate environmental response to the tephra fall. The rest of the sequence is dominated by clays with some sandy gravels. We excavated a small test pit into the clay sequence and found abundant in situ Acheulian artefacts. The artefacts are not geologically transported but occur on the bounding surfaces between layers. They are much larger in size to any of the naturally transported clasts.

A Late Pleistocene, laterally extensive cover of calcrete gravels is seen. These contain microliths, mollusks and Ostrich eggshells.

Narmada Basin

The Narmada river between Maheswar and Barwani (lat. 22 0'-22 10' Long 74 45' –75 45') follows a remarkably straight course and bedrock is exposed in its bed almost throughout this stretch. In our recent studies we have identified four distinct phases in the history of the Narmada river. These are:-

1. Pre-Quaternary Narmada

A cobbly pebbly gravel is seen in the Narmada channel between Ratwa and Karondia. At a number of places, most clearly at Bara Barda, it can be seen that almost 1 m of weathered bedrock (*murrum*) underlies this gravel. This weathering of the underlying bedrock is post depositional and so indicates the relative time elapsed since deposition. Our work in Upland Western Maharashtra has shown that gravels with Lower Palaeolithic artefacts are not weathered to the same extent, leading us to the inference that such gravels are Pre-Quaternary in age. The present gravel bars in the Narmada co-incide to a large extent with the exposures of these gravels. Modern Narmada gravels re-working these older gravels are enriched in quartzite due to greater weathering of non quartzite components in the older gravels.

2. Middle Pleistocene Narmada

Narmada alluvium, identified by the quartz rich sands, gravels with quartzite and silts with mica, all of which imply a non Trappean provenance is exposed by southerly tributaries from 2 to 5 km to the south of the present Narmada channel. In some cases, this older Narmada alluvium is separated from the present channel by bedrock hills. Southerly tributaries such as the Sosar and Satak flow parallel to the Narmada for some distance before the confluence, re-occupying the former Narmada channel. A number of distinct channel phases can be distinguished on the basis of different archaeological material. Thus the Durkadi nala channel lacks handaxes, while the Panwa and Ganesh nala channels have rolled quartzite handaxes and the Mandwara and Utawad channels have unabraded basalt handaxes and cleavers. Folding and tilting of some of the silt beds is seen at Utawad and Mandwara. On the basis of the archaeological material associated with these units they can be assigned to the Middle Pleistocene.

3. Late Pleistocene Narmada

During the Late Pleistocene, the Narmada River was aggrading, and overbank silts dominate over channel facies. This depositional environment was ideal for the preservation of archaeological sites and a large number of Upper Palaeolithic sites, such as Mehtakheri, Pitnagar, Dharampuri, Nalway, Nalway, Chota Barda, Mohipura Khapadkhera and Nisarpur are found recently exposed by the erosion of the Late Pleistocene alluvium. Radiocarbon dates on mollusks from these sites range from 30 –12 kyr. The Narmada channel was around 10 m higher than the present between 15-12 kyr as shown from dates at Akbarpur and Karondia.

4. Holocene Narmada.

During the Early Holocene, channel facies dominates over overbank facies. A series of massive sandy deposits are seen from Durkhadi, Ganesh nala, Akbarpur, Barda Barda, Chota Barda and Piplode. These are well exposed as they are being mined by the Indore construction industry for sand. They contain microliths but no pottery and are from 15-20 m higher than the present Narmada channel. The only absolute date is from Akbarpur where this unit overlies the gravel dating to 12 kyr.; The 12 kyr gravel has a dust impregnated surface implying some time gap between the two units.

The second Holocene unit is overbank silts which contain Chalcolithic pottery. A date of 3.8 kyr was obtained from the top of this alluvial phase. In some stretches the Narmada course was to the south of the present course, at least in the early part of the Chalcolithic.

At almost all the localities studied a second Holocene aggradation is seen post dating the Early Historic period. This aggradational phase could be placed anywhere in the Medieval period (800AD to 1400 AD). This alluvium occurs at least 3-4 m above the highest recent flood levels, which

most probably shows that 3-4 m of bed level lowering has occurred in the last 500 years.

The vast amount of literature available on Quaternary Geology and Archaeology of the Narmada River is mostly related to Neotectonics, Palaeoclimate, Vertebrate Palaeontology and Prehistoric Archaeology. While our results have implications for all these fields, it is the unique behaviour of the Narmada that is shown. Perhaps no other River in India has documented such dynamic behaviour during the Holocene period.

Jordan

Wadi Araba system

(R. Tipping, B. Finlayson, S. Mithen & D. Sanderson)

Significant Acheulian assemblages have been recovered *in situ* from terrace surfaces of the Wadi Faynan tributary of this system. Research intended to provide dating control to this sequence continues. Provisional OSL estimates suggest that the sequence extends back to before 300ka (Finlayson *et al.*, 2000; Mithen & Finlayson, 2000).

South Africa:

River Vaal/Orange

(Peter Beaumont & John McNabb)

The results of the 2002 research are still being assessed. This was based at Tswalu in the southern Kalahari with a week-long visit to handaxe sites in the Vaal (with Michael Chazan (Toronto), Liora Howitz (Jerusalem) and Naomi Porat (Geol Survey, Israel)). At **Winsorton**, a diamond digger has been backfilling a final pit with a full sequence, causing the immediate priority to be retrieval of samples from a sand layer there for optical (by Murray in Copenhagen) and palaeomagnetic dating, in order to check on an initial date of ~800 ka for terminal Acheulean with blades.

Two publications have appeared, but both on dates relating to the age of early modern humans at Border Cave. A project with a Toronto - Jerusalem team on the Hutton Sand sequence above the Younger Gravels at Canteen Koppie was to have commenced in October 2003. However, the SA Heritage Resource Agency was unable to issue the necessary excavation permit in time. As for other Vaal sites, rampant diamond mining makes the news about them even worse. The sites at Winsorton visited by the 1999 INQUA excursion was largely destroyed by the end of 2002. The last vestiges - under the tarred road - are due to disappear over the 2 - 3 months at the end of 2003/start of 2004.

Preparation of publications on the Vaal/Orange story continues. A paper on Canteen Koppie (River Vaal) appeared late in 2001 (McNabb, 2001).

Syria:

River Euphrates: Ar Raqqa area

(T. Demir , Ali Seyrek, Bahattin Celik, D.R. Bridgland, Keith Challis, R. Westaway & M.J. White)

Research took place once again on both sides of the border with Turkey. Artefacts were found at a number of Syrian localities during 2003 during what amounted to further detailed reconnaissance. This confirmed that the Euphrates terrace deposits are well preserved and readily accessible. It was also observed that both downstream and upstream from Ar Raqqa, some terrace gravels are capped by Pleistocene basaltic lavas. It is believed that these have never been dated. Age estimates from these basalts would provide minimum ages for the underlying gravels, which could also be dated using luminescence techniques. Further work here is funded in the 2004-5 awards, but fieldwork will not take place until March 2005.

River Orontes: Homs area

(G. Philip, M. Abdelkareem, M. Bshesh, Ian Candy, D.R. Bridgland, A. Shaw, R. Westaway & M.J. White)

Further research funding for the continuing work on this system was obtained in 2004-5, from the Council for British Research in the Levant. Fieldwork undertaken in July 2004 provided further ground-truthing of GIS data and a detailed survey of calcreted gravel outcrops in search of *in situ* artefacts. This met with modest (but important) success. Further fieldwork is planned for March 2004 and a presentation will be made in Damascus in April 2005.

Artefacts collected during previous seasons and the current field survey have now been analysed and catalogued in terms of condition and character, and their distribution in relation to the Orontes terraces has been plotted. An interesting pattern is beginning to emerge, which suggests that the artefacts are genuinely associated with the terraces on whose eroded surfaces they are now found.

The new funding will allow preliminary dating and geochemistry work on the calcretes (Ian Candy). A further application for funding is planned for 2005.

Turkey:

River Euphrates

(Tuncer Demir, Ali Seyrek, Bahattin Celik, Rob Westaway, David Bridgland & Sema Yurtmen)

In August and September 2003, fieldwork was carried out to investigate Quaternary fluvial evolution of Euphrates River around the Ataturk dam, the Birecik area near the Syrian border and in northern Syria. River terraces were documented and their heights were accurately measured using differential GPS equipment. Basalt samples were taken for dating from localities where Quaternary volcanism interacts with this fluvial system. This work resulted in the discovery of Lower Palaeolithic material at several Turkish of the sites, notably Birecik and Karababa. A summary was presented (Demir et al.) at the December 2004 meeting in Malaga. Further field work was undertaken in March 2005, in part as preparation for the Inaugural Meeting of IGCP 518 (September 2005).

River Tigris

(Tuncer Demir, Ali Seyrek, Bahattin Celik, Rob Westaway & David Bridgland)

Work on the Tigris deposits around **Diyarbakir** commenced in March 2005. Archaeological material from this valley is documented. It will be visited during the Inaugural Meeting of IGCP 518 (September 2005).

River Gediz

(D. Maddy, T. Demir, D. Bridgland, T. Veldkamp, M. Pringle, S. Yurtmen & R. Westaway)

Work on this NERC-funded project continued until 2004-5 and has been extended as a result of funding by the British Academy. Attention in 2003 was focused on high-level sites associated with early volcanism. Hominid migration between Africa and Europe is believed to have been underway by this time, but no artefact finds are reported from the Gediz. Papers are in press and/or recently published; the area will supply the venue for the FLAG 2006 meeting.

River Orontes, Antakya area

(Rob Westaway, David Bridgland, Tuncer Demir & Ali Seyrek)

As part of the research programme, described above under Syria, in the upper reaches of this river, its lowest reach in the Antakya area was examined during August 2003. The upper and middle Orontes transports limestone and chert for long distances away from its headwaters in the Lebanon Mountains. The proportion of chert increases downstream as it resists abrasion better than the limestone. It has been used by Lower (and Middle?) Palaeolithic hunter-gatherers as a raw material for tool making. However, the 2003 field investigation showed that virtually none of this material reaches Turkey, where the Orontes is instead transporting almost entirely material of a local origin. This appears to be because in NW Syria it flows through a major

depoecentre, the Ghab Basin, which acts as a sediment trap. It would appear that artefacts from the Antakya area come predominantly from coastal (beach?) deposits rather than the Orontes terraces. Future investigations may be able to integrate these stratigraphically. A synthesis of work to date on the whole length of the Orontes, in both Syria and Turkey, will be prepared during 2004. Applications for funding were successful and a further programme of work is continuing into 2005.

United Arab Emirates:

Wadi Bih/Wadi Dhaid

(Asma al-Faraj, Adrian Parker, Andrew Goudie, Steve Stokes, Keven White, Derek Kennett)

Work on the geoarchaeology of these systems was reported in the 2003 Annual Report. Wadi Bih, which has an impressive set of terraces, is one of a number of such systems in the area. The work includes OSL dating of fluvial sequences, including the Wadi Bih fan and the Wadi Dhaid. In addition a detailed chronology for dune accretion and lacustrine pluvial sediments over the past 100 ka has been established. The archaeology seems not to extend back to the Lower Palaeolithic.

UK:

Work on UK fluvial archaeological resources has enjoyed a 'purple period' as a result of the Leverhulme-funded project AHOB (Ancient Human Occupation of Britain), and, since 2003, numerous short-term projects taking place under the aegis of the Aggregates Levy Sustainability Fund, overseen by English Heritage, English Nature and the Countryside Agency (most of the relevant projects involve the first of these). Several such projects have contributed to IGCP 449, and in particular to this subtheme of the project. First-round projects under the ALSF scheme finished in March 2004. Several relevant 2nd phase schemes are currently at the project design stage, some intended to develop and publish findings from phase 1, others entirely novel. These will contribute to the follow-up (IGCP 518) project .

Phase 1 ALSF:

Palaeolithic Potential of Secondary Contexts

(Rob Hosfield and Jenni Chambers)

This project has sought to reassess the value of artefacts from secondary contexts, in particular fluvial sequences. It has sought to develop new frameworks for interpretation based on modelling in relation to climatic change and its influence on fluvial sedimentation.

Upper Thames Survey

(Kate Scott)

The team established for the excavations at the erstwhile Stanton Harcourt site has pursued new potential localities in the Upper Thames. Sites with an established Palaeolithic interest include Latton (near Cirencester).

Sussex/Hampshire Coastal Corridor

(Martin Bates and Francis Wenban-Smith)

This project encompasses the well-known Palaeolithic source areas of the Sussex raised beaches and the Solent River terraces. Particular emphasis is given to the eastern Solent, which has seen less attention in recent decades than the western Solent. The programme includes re-excavation of key sites and the application of dating methods (OSL, amino acid geochronology).

Survey of Mineral Extraction Sites in the Thames Estuary

(Essex and Kent County Councils)

This project, which employs a number of project participants, is using methods as diverse as GIS technology, including 3D computer modelling, and field survey to assess the surviving resource of Lower Thames deposits with potential Palaeolithic contents in this area (the 'Thames gateway') that has been designated for considerable housing development in the near future. Many of the former sites are already built over, but hoped-for reinvestigation of some of these may re-establish some of the lost localities of 19th and early 20th Century research, providing important contexts for existing collections. A key aim is the enhancement of the Sites and Monuments Record in the two counties.

The Stopes Palaeolithic Project

(Francis Wenban-Smith & Tim Ace)

This project aims to fully catalogue, for the first time, the substantial collection of Lower and Middle Palaeolithic artefacts assembled by the collector Henry Stopes in the late 19th Century. This resource, housed in the National Museum of Wales, Cardiff, includes material from all over the World, although much of it is from Britain, with Thames sites dominating. For example, there are 170 sites in Kent. It is hoped that previously unknown and unresearched localities will be discovered as part of this process.

The Shotton Project

(Simon Butteo, David Keen & Alex Lang)

Named after the celebrated Birmingham geologists and Quaternary scientist, Prof. Fred Shotton (responsible for publishing >50% of known palaeoliths from the West Midlands, this project seeks to assess and raise awareness of the Quaternary archaeological record from the English Midlands. IGCP 449 participants are heavily involved.

UK Site gazetteer:

Upper Thames

David Keen is studying molluscan assemblages from multi-age deposits (including OIS 7 and Devensian) of the Upper Thames at Latton, Gloucestershire.

Middle Thames

Hillingdon, West London - River Thames

Fieldwork by a team of AHOB members in May 2002 has established three localities where excavation is feasible to establish more firmly the dating of Levallois material that has been recovered from a wide variety of places in West London. A literature survey has shown that the only reliable context for these lithic artefacts is from the surface of the Lynch Hill terrace of the River Thames. The dating of the upper part of the Lynch Hill terrace has been attributed to MIS 8. An age for the overlying brickearths would establish a *terminus ante quem* for the artefactual material.

Lower Thames

Aveley, Essex, River Thames

A paper is in the final stages of preparation on this important MIS 7 interglacial sequence. The site lies in the Mucking terrace of the Lower Thames. Significant new exposures were made available in the mid-late 1990s during the course of widening the A13 dual carriageway, thereby providing the opportunity to re-examine deposits that are the stratigraphical equivalent of the famous 1960s 'Aveley elephant' site. The latest excavations yielded significant new assemblages of mammals, birds, herpetofauna, molluscs, beetles and, for the first time at this locality, flint artefacts. These have been described by Drs Danielle Schreve, Joanne Cooper and Chris Gleed-Owen, Profs David Keen and Russell Coope and Dr Mark White respectively. New pollen spectra have been written up by Drs Jeff Blackford and Frances Green and the plant macrofossils by Dr Mike Field. The stratigraphy, sedimentology and soils have been described by Drs David Bridgland, Peter Allen and Prof. Rob Kemp. Of great importance has been the discovery of artefacts here as part of the A13 road-cutting investigations (by Graham Ward), the first from the Aveley deposits. Even more important is that they included Levallois material, cementing the association of that industry with MS 9-8-7 (Schreve *et al.*, shortly to be submitted).

Lion Pit Tramway Cutting, West Thurrock, Essex

MIS 8, 7 & 6 deposits of the River Thames have been described at this site (Bridgland, 1994), a definitive publication of which is to be submitted at the end of 2004. The frequent collapse of the sediments exposed in the cutting, and consequent damage to adjoining private gardens, has resulted in this site

being cleared of vegetation in advance of stabilisation measures. This has enabled new work to be carried out on the sections by a team from London and Durham Universities. Further work related to the conservation of this SSSI (site of special scientific interest – a statutory conservation site) is anticipated in the future.

Purfleet, Essex

(Danielle Schreve, Mark White, Peter Allen, David Bridgland & Phil Harding)

Work was carried out at Greenlands Quarry, Purfleet, in summer-autumn 2001 under the direction of P. Allen. This work revealed a full, and previously undescribed sequence through the Pleistocene deposits at the western edge of the pit. Palaeolithic artefacts were found in all major stratigraphical units. These conformed to the cultural stratigraphy described by Wymer (1985)

A multi-authored paper was published in *Quaternary Science Reviews*. (Schreve *et al.*, 2002).

Further work arising from the building of the Channel Tunnel High-speed Rail-link, undertaken by Wessex Archaeology, has reached the publication stage (2004-5).

Swanscombe

(F.F. Wenban-Smith)

A report on rescue work undertaken during 1998-9 redevelopment of a site to the south-east of the famous Barnfield Pit locality at Swanscombe was published in the *Proceedings of the Prehistoric Society* (Wenban-Smith & Bridgland, 2001). This paper documents the continuation of the Swanscombe sequence to above 39m O.D.

The building of the Channel Tunnel High-speed Rail-link has led to the discovery of a new site even further to the SE, possibly in a North Downs tributary. This has yielded mammals and artefacts, the latter potentially including Clactonian material.

East Anglia

Upper Dovercourt, Essex

(Mark White, Danielle Schreve & David Bridgland)

A 1st season of excavation was undertaken at this site in August 2001 (for site details see 2000 Annual Report). Two trenches were cut into remnants of Pleistocene gravel at the edge of a relict pit (now part of a school playing field), yielding a number of Palaeolithic artefacts. Although mentioned in early reports of the site, no faunal remains were encountered, although the sections were not bottomed. Numerous artefacts were recovered, many of them handaxe-thinning flakes.

Foxhall Road, Ipswich, Suffolk

(M. White)

A report on the Hoxnian site at Foxhall Road, Ipswich has been prepared for publication using rediscovered archival materials from the 1903-5 excavations combined with a new study of the existing artefact collections (White, in press). The new study suggests that the site was initially a small lake or pond formed in a glacially overdeepened channel (one of a series of such features linked by a small and very slow flowing stream), but that later in its history it became incorporated into a major drainage system. The artefact study has confirmed that raw materials played a major role in technological variation at the site. More importantly, a unique in situ cluster of handaxes - arguably deposited around a small camp fire – clearly shows that each knapper had their own individual style of manufacture and did not adhere to a collective group template.

Happisburgh, Norfolk

(J. Rose, S. Parfitt,

The marine erosion of the cliff at Happisburgh has exposed extensive organic deposits (related to Pleistocene river systems) that are uncovered on the foreshore at the lowest tides. Investigations by Prof. J. Rose from the University of London and Simon Parfitt of the Natural History Museum, in association with local collectors, are ongoing. *In situ* flint artefacts, including an ovate handaxe, and a small number of large mammal bones of deer and bison, were recovered by a local archaeologist. Since then, two phases of fieldwork have been undertaken, the first being machine and borehole investigations to study the geological context of the organic deposits. The second phase has been the periodic collection of large bulk samples for small mammal analysis to help date the sediments.

The evidence suggests the artefacts were deposited in a backwater of a large river during the late temperate stage of an early Middle Pleistocene interglacial. The age of the interglacial is contentious, although the freshwater sediments clearly underlie the Happisburgh till, which was laid down by the earliest lowland glaciation of southern Britain.

High Lodge, Mildenhall, Suffolk

(AHOB members)

Members of the AHOB project undertook a week's excavation here in April 2002, aimed at re-examining the clayey-silt units from the site, primarily to sample for datable fauna. Previously the clayey-silts had been interpreted as fluvial and pre-Anglian in date, but there are still questions over the typology of the associated lithic assemblage, and of the dating of the stratigraphically later glacial till. The work involved the removal of backfill with a JCB from a 4m x 4m trench, originally excavated in 1966. One main section was cleaned to a depth of 3.7m and 1300kg of samples were taken through the grey, organic clayey-silt.

Hoxne, Suffolk - River Waveney system

(AHOB members)

A two week excavation at Hoxne by AHOB members (Nick Ashton, Dr Simon Lewis and Simon Parfitt) in July 2002 was the third season of a British Museum project designed to re-examine the dating of the Lower Palaeolithic industries from the site, and to set these industries in a firmer environmental context. In 2002, a trench was re-opened to examine the stratigraphic relationship between the Upper and Lower Industries at Hoxne. Beds not previously recorded from Hoxne were discovered: a series of sand-clay filled channels that cut progressively downslope from south to north. These are a new series of units that have not been recognized elsewhere at the site. Several flakes and chips were found at the base of these channel fillings, the most significant being a handaxe-manufacturing flake found at the north end of the trench in a gritty clay. This gritty clay was similar to a gritty clay identified in the 2000 excavation here, in which the Hoxne Lower Industry was represented. If this correlation is correct, it leads to potential reinterpretation of the stratigraphical relations of the Lower and Upper Hoxne Industries such that both could have been produced within broadly the same time-frame. In support of this analysis, recent pollen work (Gosling, 2001a; see also Ashton and Lewis, 2001 and Gosling, 2001b) showed that the sediments containing the Lower Industry had a similar palynological signal to Bed 5 (Mullenders, in Singer *et al.*, 1993). These are tentative conclusions, and need to be re-examined through a better understanding of the exact context of the Lower Industry.

Lynford, Norfolk (River Wissey)

(Danielle Schreve, Mark White and Bill Boismier)

The rich Late Pleistocene fossil and archaeological from this site has proved to be one of the highlights of the AHOB project. The excavations in 2002 exposed a sequence of infilled channels with rich organic preservation, including pollen, plant macrofossils, molluscs, insects and vertebrates. More than 30 Middle Palaeolithic handaxes were recovered, in association with the remains of 8 individuals of woolly mammoth and specimens of woolly rhinoceros, reindeer and brown bear. Preliminary research on the artefacts during 2003 revealed several incidences of refitting. The assemblage will be used for microwear analysis before a complete assessment of the degree of refitting is undertaken, but the primary context of the archaeology is already well established. The likely interpretation is the butchery of mixed animals in a cut-off channel of the River Wissey. This is a rare example of a primary context Middle Devensian archaeological site. The mammalian fauna belongs to the Pin Hole Mammal Assemblage Zone and the Palaeolithic assemblage to the Mousterian of Acheulian Tradition.

Maidenhall, Suffolk

(Mark White, Danielle Schreve, Peter Allen & David Bridgland)

A 4m sequence of MIS 7 deposits of the River Stour were exposed during emergency construction work in June 2002. Although situated only 30 yards from Wymer's 1975 excavation, which produced an *in situ* elephant skeleton and several associated Levalloisian artefacts, no faunal or artifactual remains were recovered. Geological analyses to allow the earlier collections of bones and artefacts to be placed in a more secure context have been awaiting the post-excavation phase..

Marks Tey, Essex

(Danielle Schreve, David Bridgland and Mark White)

Following on from the 2002 investigation (see 2002 Annual Report), a further excavation was undertaken under the auspices AHOB in April 2003. This focussed on the periphery of the lacustrine basin at Marks Tey, which is believed to be formed in a glacially overdeepened section of the pre-diversion Thames valley. A series of trial pits excavated in a field adjacent to the brick pit confirmed that the Quaternary deposits at Marks Tey feather out gradually over a much wider area than previously thought, and that fluvial gravels are included in this marginal area. A small number of *in situ* worked flakes, together with a cervid phalanx, were recovered from these gravels. Other flakes, including later prehistoric material, were recovered during field walking. Analysis of samples collected is continuing and further field investigations are anticipated.

Pakefield, Suffolk

(S. Parfitt, N. Ashton, S. Lewis)

There have been intensive investigations at this site by a group of British archaeologists and palaeontologists. A number of undiagnostic flakes have been found *in situ* by local collectors, in unrolled condition in fluvial deposits of the Cromer Forest-bed beneath glacial sediments at Pakefield/Kessingland. The deposits, known since the 1890s, are now being made accessible by marine erosion. The artefacts are in association with a rich mammalian fauna, which has been suggested to represent a previously unrecognised interglacial within the early part of the Cromerian Complex (Stuart and Lister 2001). Of biostratigraphic significance are remains of the water vole *Miomys*, which confirm that the Pakefield interglacial predates the Cromerian archaeological sites of Boxgrove and Westbury-sub-Mendip. Recent work at the site has focused on environmental sampling and recording the geological sequence. Analysis of beetles, plant remains, vertebrates, molluscs and ostracods suggest deposition within the floodplain and channel of a large river near the mouth of the estuary. Summer temperatures were probably warmer than the present day and a mosaic of deciduous woodland, scrub and open grassland supported a rich mammalian fauna.

Warren Hill, Mildenhall, Suffolk

(J. Rose & John Wymer)

An excavation here took place in March 2002 under the auspices of AHOB. The work, which followed tree-felling by the Forestry Commission, exposed sands and gravels thought to pre-date the Anglian glaciation. Six sections cut by JCB showed a lower brown sand without artefacts suggestive of shallow marine or tidal deposition, overlain by an upper sand and gravel with silts at the base, which appears to be a river deposit. The elevation, sedimentology and lithology all suggest that this upper deposit is representative of the pre-Anglian Bytham river. Importantly mudballs of red brown silty clay, similar to the High Lodge Clayey Silts, were also recovered from this unit. Archaeological material was found in situ in this unit, including a handaxe.

Southern England

Boxgrove, West Sussex

(Mark Roberts)

Although a marine rather than a fluvial site, Boxgrove is of huge importance to the British Lower Palaeolithic. It has served as a training ground, with over 3000 students having participated in the erstwhile excavations there. It is therefore a major fillip to be able to report that ALSF funds have been used to purchase a significant part of the site, which is being restored in anticipation of establishing a research and visitors' centre. It is believed that sufficient archaeological reserve exists to provide at least 20 seasons of future excavation.

Broom, Devon (River Axe)

(Rob Hosfield and Jenni Chambers)

Research at this site, as part of an ALSF programme (see above), has recovered no new artefacts but has allowed significant enhancement of knowledge of the geological context. This includes OSL dates, preliminary interpretation of which suggests an age envelope of OIS 8/7/6. The existing artefact collections are being reinvestigated as part of this programme.

Mottisfont, Hampshire (River Test)

(Francis Wenban-Smith & Martin Bates)

Work here under as part of the Sussex/Hampshire Coastal Corridor ALSF project has involved test pitting aimed at providing a better context for existing collections from the Test, notably from Dunbridge and Kimbridge, as well as prospecting for new archaeological resources. Minimal artefact discoveries have been made.

Priory Bay, Isle of Wight

(Francis Wenban-Smith & Martin Bates)

A new investigation of this site, undertaken in 2002 suggested that fluvial deposits are included there. The site coincides with the richest Lower Palaeolithic assemblage from the Isle of Wight, although that was mostly obtained from the modern beach and foreshore, the artefacts having been incorporated in cliff-fall material. Dating indicates that the oldest part of the sequence dates back to OIS 12.

River Solent

(F.F. Wenban-Smith)

An edited volume arising from a conference on the Palaeolithic of the River Solent (Southampton, January 2000) was published in 2001 (editors FF.Wenban-Smith & R. Hosfield). It includes contributions on the fluvial geology as well as the archaeology.

Sturry, Kent (River Stour)

(Mark White, Danielle Schreve & David Bridgland)

Work at Sturry to investigate a putative palaeosol that separates lower from upper gravel levels at the site and may provide evidence of interglacial conditions, as well as assist with dating, is still anticipated. This is a requirement before publication of work carried out here and at nearby Fordwich in 1997/8. Funding for this long-awaited work has been obtained from the Quaternary Research Association.

Midlands

Huncote, Leicestershire

(Shotton Project members)

This Bytham River locality, a working quarry exploiting gravels from beneath Anglian till, has been targeted by the Shotton Project for survey and observation, given the importance of discoveries in pre-Anglian contexts.

Latton (near Cirencester), Upper Thames

(Kate Scott, Simon Lewis & Darrel Maddy)

This working gravel pit has yielded artefacts and fauna in an unexpected context, since it was anticipated that the sediments being exploited would be of Last Glacial age. It now seems that remnants of OIS 7 interglacial deposits survive beneath the later gravels; the finds have generally come from basal contexts either below, or reworked into the gravel.

Welton-le-Wold, Lincolnshire (unknown river)

(Joanna Hambly)

A phase 1 ALSF project re-examined this site during 2003. The site is of particular interest in that it might include rare evidence of a Saalian-equivalent glaciation in Britain. The project included a reassessment of archaeological collections from the site, as well as a new borehole survey. Results are awaited.

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

Danielle Schreve

Brazil – Peru:

Mammalian faunas from the Solimões Group of fluvial sediments deposited by the ancestral Amazon were investigated during the June 2003 IGCP 449 field meeting in **Rio Branco**, Acre State, Brazil. Ar – Ar dating by Campbell *et al.* (2001) in an adjacent part of Peru established that deposition of this stacked sequence ended at ~3 Ma. As well as many mammalian species, the fauna includes turtles and giant crocodiles. The mammalian fauna includes many endemic South American species that disappeared following the influx of North American taxa at the end of the Pliocene.

Czech Republic:

Mammalian faunas represent an important part of the basis for dating the terrace sequence of the **River Vltava**, visited on the field excursion that formed part of the Prague Inaugural Meeting of IGCP 449. A section through the ~70 m Straškov (IIIb) terrace (Balatka & Sládek, 1962) of the Vltava, exposed in a gravel quarry at **Račíněves** (Tyráček, 2001a, b; Tyráček *et al.*, 2001), has yielded thermophilous mammals, interglacial molluscs, and archaeological material. The archaeological evidence includes cores, notches, knives, scrapers, wedges and hammerstones, made of Proterozoic lydite; some are in fresh condition, indicating a primary or near primary context. Mammal bones with cut-marks provide further evidence of human occupation, indicating hunting and butchery activities.

The Račíněves mammal fauna has strong similarities with those from north-west European sites such as Swanscombe in south-east England (Bridgland & Schreve, 2001) and Bilzingsleben I in central Germany (e.g., Mania, 1995), which are dated to OIS 11 (Holsteinian *sensu stricto*). The absence of the mollusc species *Helicigona čapeki* and *Granaria frumentum*, considered diagnostic of Cromerian Complex interglacials in the Czech Republic (cf. Záruba *et al.*, 1977), supports this correlation, suggesting that the underlying gravels aggraded late in OIS 12. Tyráček *et al.* (2001) noted that the Račíněves interglacial fluvial deposits have yielded the water vole *Arvicola terrestris cantiana* (or *A. mosbachensis*, its synonym), which points to an age no older than latest Cromerian Complex (e.g., Preece & Parfitt, 2000; Stuart & Lister, 2001), or OIS 13 (e.g., Westaway *et al.*, 2002). Tyráček *et al.* (2001,

2004) indeed noted that *A. t. cantiana* teeth from Račiněves have a characteristic Holsteinian morphology.

At Hýkovina quarry near **Ctiněves**, a ~10 m section is exposed through slope deposits, ~160-170 m above the Vltava. This section consists of loess, loam and palaeosol layers interbedded with scree material (Ložek, 1964; Horáček & Ložek, 1988, Photo 3; Tyráček, 2001b). From its molluscan and mammalian assemblages, this site has been assigned to mammal zone MN17 (e.g., Fejfar, 1989), the Late Villanyian, which is dated to ~2.4-1.9 Ma by Fejfar et al. (1997) (but see also below). It has yielded the mollusc *Gastrocopta serotina*, an MN17 index fossil, and the rodents *Mimomys pitymyoides*, *M. reidi*, *Beremendia fissidens* and *Borsodia* sp. (Ložek, 1964; Fejfar & Horáček, 1983). Younger species such as *Mimomys savini*, *Microtus (Allophaiomys) deucalion* and *Microtus (Allophaiomys) pliocaenicus* are notable absentees. This site is on a hill-slope, just above a subhorizontal bench, ~160 m above the Vltava, that is capped by scattered fluvial gravel or 'Schotterbestreuung' of indeterminate age and origin. There is no stratigraphic contact to determine whether the slope deposits overlie these gravels or not, but the biostratigraphy provides a clear minimum age for fluvial incision to this level (Tyráček et al., 2004).

At Holý Vrch, near **Únětice**, calcareous tufa overlies the Suchdol (Ib) terrace, which has a base of 88 and top of 97 m above the Vltava (Fig. 7). The sedimentary and biostratigraphic evidence indicates that a single interglacial is represented. Biostratigraphic evidence for a Cromerian Complex age is clear. The small mammal evidence from Únětice includes *Mimomys savini* and other species characteristic of the Late Biharian (Tyráček et al., 2004).

At **Zlatý Kopec**, near Přebuz, an interglacial mammalian fauna, assigned to a Cromerian Complex interglacial (cf. Fejfar, 1976), occurs in lacustrine sediments and palaeosol, in association with molluscs and chipped clasts that have been interpreted as primitive artefacts (e.g., Záruba & Roth, 1946; Ložek, 1964, 1969; Šibrava et al., 1979). This locality is at ~250 m altitude, ~75 m above the **River Labe**, which flows ~5 km to the northeast (Fejfar, 1969; Šibrava et al., 1979). The lacustrine deposits at this site, at ~244-247 m altitude, record a complete cold-temperate-cold climatic cycle. Although these are not river terrace deposits, Šibrava et al. (1979) suggested that they accumulated just beyond the southern margin of a Labe terrace that had previously aggraded to the ~244 m level. Their altitude also invites comparison with localities on the Vltava in Prague, ~10 km to the southwest. On this basis, the Zlatý Kopec site has been regarded (e.g., by Záruba et al., 1977) as younger than the Cromerian Complex interglacial site at Únětice, which caps Vltava terrace Ib.

Several karstic fossiliferous localities are documented from Chlum Hill near **Srbsko**. The most significant is **Chlum 4**, where the fossiliferous sediments (designated as sequences K, B, and C) cover terrace Ib, which has a surface ~85 m above the **River Berounka** (e.g., Záruba et al., 1977; Horáček & Ložek, 1988). Sequence K consists of loess with a cold-climate small mammal fauna, dominated by *Microtus gregaloides*. The overlying sequence

B (Fig. 11) consists of loam and tufa with a diverse temperate fauna including *Mimomys*, passing upwards into loess that is again dominated by *Microtus gregaloides*. The overlying sequence C consists of temperate-climate slope deposits containing *Arvicola*. Nearby, beneath sequence K, cave infill (sequence S), again with a diverse temperate-climate fauna containing most of the species in the temperate part of sequence B, is presumed also to post-date the aggradation of the 85 m terrace. Horáček & Ložek (1988) assigned sequence C to their biozone Q3-1 and to Kukla's (1978) climate cycle G (which probably equates with OIS 13), sequence B to biozone Q2-3 and to climate cycle H (OIS 15), and sequences S and K to climate cycle I (OIS 17), with S tentatively assigned to the earlier biozone Q2-2, even though its fauna is very similar to that of sequence B.

This site thus straddles the *Mimomys-Arvicola* transition. The temperate-climate fauna from sequence B is similar to that from **Little Oakley**, UK (Preece, 1990), probably the youngest known site in England with *Mimomys* (e.g., Preece & Parfitt, 2000; Westaway et al., 2002). The temperate fauna from sequence C is similar to that from the calcareous member at Westbury-sub-Mendip (Table 1), the only karstic site in a (British) group considered to directly post-date the *Mimomys-Arvicola* transition (e.g., Preece & Parfitt, 2000). With this extinction assigned to OIS 14 (see above), sequences B and C fall into OIS 15a-14 and 13c-13b. The faunal similarity between sequences S and B indicates that no great interval of time separates them, so that sequences S and K may have formed in OIS 15c-15b and the underlying gravel of the 85 m **Berounka** terrace (Ib) in OIS 16.

France:

Considerable work has been carried out under the auspices of IGCP 449 in France, although the principal biostratigraphical contribution has come from molluscs. A particular highlight was the discovery of fossiliferous tufa at the Palaeolithic type locality, **Saint Acheul, River Somme**. A poster was presented at the FLAG/IGCP 449 meeting held in Clermont-Ferrand in September 2002: *Pierre Antoine and Nicole Limondin-Lozouet: Identification of MIS 11 Interglacial fluvial deposit in the Somme valley (France): new results from Saint-Acheul*. Other work, again on malacological faunas, has been undertaken on sites in the River Seine. The FLAG 2002 meeting based at Clermont-Ferrand visited the late Pliocene mammaliferous sites in the **River Allier** catchment at Chilhac and Perrier.

An assemblage of small mammalian fossils from the **Cagny l'Épinette** locality, **River Somme**, conserved in the University of Leiden, the Netherlands, was studied by DCS early in the project. The assemblage comprises mostly voles and shrews, although the water vole, the teeth of which can be biostratigraphically useful, is unfortunately missing. Some 35m of fluvial, fluvio-estuarine and colluvial deposits, forming the low terrace of the **River Seine** (Terrace II: Tourville-Cléon), are preserved at **Tourville-la-Rivière**. Gravels of the Seine at the base of the sequence contain a mammalian fauna of cold-climate affinities (*Mammuthus primigenius*, *Rangifer tarandus*, *Coelodonta antiquitatis*). These are overlain by the Tancarville Member (estuarine), yielding rare molluscs, foraminifera, ostracods and a rich interglacial

mammalian assemblage. These deposits are succeeded by a silty sand containing a soil and possible evidence of an ancient butchery 'floor' with dense concentrations of bone and some Levallois flakes. This horizon is overlain by further sands and solifluction deposits with additional evidence of soil formation, before being capped by Weichselian loess. The entire sequence is attributed to the Saalian.

Germany:

In the first year of the project DCS visited the *Institut für Quartärpaläontologie* in Weimar, Germany, hosted by Drs Ralf Kahlke and Lutz Maul. There, research was undertaken into the mammalian fauna of the celebrated travertine site at **Weimar-Ehringsdorf** in the **Ilm** valley. This collaboration subsequently led to the running, 12-17/5/02, of a Quaternary Research Association field meeting in Thuringia (Rich Meyrick and Danielle Schreve were joint leaders), which visited the above site and several others. Notable mammalian sites included (1) the staircase of terraces and MIS 11 archaeological site at **Bilzingsleben**, on the **River Wipper**, presented by Dietrich Mania, and the Late Middle-Late Pleistocene travertines at Weimar-Ehringsdorf, on a terrace of the River Ilm. (2) **Untermassfeld (River Werra)**, from where a celebrated late Lower Pleistocene mammalian fauna has been obtained (Kahlke, in Meyrick & Schreve, 2002). (3) **Burgtonna (River Unstrut)** is another travertine site, although the travertine cascades here are probably independent of any fluvial terraces. The dating of this supposedly Eemian site may yet prove problematic.

The guide book to this meeting (Meyrick & Schreve, 2002), which is a contribution to IGCP 449, also includes several reviews of the biostratigraphy and research history of this important region.

In 2004 (25-30th April), also in Weimar, the 18th International Senckenberg Conference took place, coincident with the VIth International Palaeontological Colloquium in Weimar, entitled '**Late Neogene and Quaternary biodiversity and evolution: regional developments and interregional correlations**'. This was in honour of the 80th birthday of Professor Hans-Dietrich Kahlke, who worked on so many of the local mammalian localities. IGCP 449 subgroup members and contributors were involved in the organizing committee.

Danielle Schreve and David Bridgland attended the Second Workshop of the DEKLIM-EEM Project: Climate Change at the very end of a warm stage in Heidelberg in March 2003. The meeting included an excursion that included visits to the classic fossiliferous travertine sites of **Stuttgart-Bad Cannstatt** and **Untertürkheim** in the **River Neckar** valley (Van Kolfschoten, 2002). These are well exposed in disused quarries and would repay reappraisal. It seems likely that the enigmatic "intra-Saalian" interglacial episodes that remain a significant cause of controversy might be represented within this sequence. A parallel with the terrace/travertine sequence in the much smaller River Wipper (Mania, 1995) is possible.

Italy:

A European Quaternary Mammal Research Association (Euromam) meeting was held in Florence, Italy, 13th-17th June 2001. The excursion provided an opportunity to examine mammalian assemblages from classic Villafranchian and Galerian localities of central Italy. These included a number of important late Pliocene fluvial sites in the Arno valley, including **Castelnuovo dei Sabbioni**, **Montevarchi**, **Matassino** and the **Bucine** area, and Middle Pleistocene fluvial sites in the Tiber valley.

The FLAG 2004 meeting in Siena was followed (9-11 Sept) by a field excursion that included visits to Pliocene and Early Pleistocene mammalian sites in Umbria and Marche.

Syria:

A study of the upper catchment of the **River Orontes** has been underway since 2001 as part of the **Homs** Archaeological Survey (led by G. Philip, University of Durham). A series of terrace gravels of the Orontes was mapped in this area, represented in the landscape as calcreted conglomerates (Bridgland *et al.*, 2003a). Although the area has calcareous ground water, thanks to Miocene marly bedrock, no pre-Holocene vertebrate or molluscan fossils have been found thus far. Downstream in the Middle Orontes catchment, north of Hama, a site at **Latamneh** has produced a significant vertebrate fauna, however. This is at present the key pinning point for biostratigraphical dating and correlation for the Orontes terrace sequence. The assemblage includes *Mammuthus trogontherii*, *Stephanorhinus hemitoechus*, *Megaloceros verticornis* and *Equus cf. altidens* (Guérin & Faure, 1988; Guérin *et al.*, 1993). This assemblage combines mammoth and giant deer species that are unknown in Europe after the Elsterian with a rhinoceros that first appears in Europe immediately after that glacial, in the Holsteinian. The likely correlation with the oceanic oxygen isotope sequence is therefore probably with stage 13 (latest Cromerian Complex) or stage 11 (Holsteinian) - perhaps even a warmer phase within stage 12. The first implies an age of ~0.5 Ma, the second ~0.4 Ma and the third somewhere between the two.

Reconnaissance at **Latamneh** during the 2003 field season confirmed that large open quarries still exist there. This site will be included in a major review and reinvestigation of the Orontes sequence as a whole, planned for the next few years.

Turkey:

During 2002 sites in the rivers **Sakarya** and **Mudurnu** that have yielded mammalian faunas and palaeobotanical material were visited by Tuncer Demir and Rob Westaway. The aim was to locate accurately sites that had yielded biostratigraphy; no location details had been published in the literature. Having succeeded in this exercise, work is progressing on integrating their biostratigraphical details into a regional synthesis. Publication of early results is imminent (Demir *et al.*, 2004).

Westaway *et al.* (2004) addressed a significant controversy regarding the age of Miocene fluvial sedimentary unit known as the Balçıklıdere member of the Ahmetler Formation of the İnay Group in the Selendi and Uşak-Güre Basins, western Turkey. The mammalian biostratigraphy and magnetostratigraphy both support an age for the upper part of this deposit of ~7 Ma.

Ukraine:

A Subcommittee on European Quaternary Stratigraphy (SEQS) meeting took place in Kiev, Ukraine, 9th-14th September 2001. The theme of the meeting was "The Middle and Upper Pleistocene of the Middle Dnieper Area and its importance for East-West European correlation". The conference included a fieldtrip, during which mammal-bearing sediments of the River Dnieper were examined, for example at **Vyazivok** and **Gradizhsk**.

Two important summary papers have been published under the auspices of IGCP 449 – Matoshko *et al.* (2002, 2004). These include information on mammalian faunas within the exceptional fluvial records of the Rivers **Dniester**, **Dnieper**, **Volga** and **Don**.

UK:

Investigations early in the project were concentrated on the sequence preserved in the **Lower Thames**, notably at **Purfleet** and **West Thurrock** (Essex), Nightingale Estate, **Hackney**, north London. A Geologists' Association excursion "Important Pleistocene Localities in the Thames Valley" on 7th July 2000 visited the first two of the above, together with **Globe Pit**, **Little Thurrock** and the A13 Road cutting, **Aveley**, Essex (Bridgland *et al.*, 2003b). Further down the Thames, work on a long-destroyed interglacial site at **Barling**, near Southend, Essex, was completed during the early part of the project (Bridgland *et al.*, 2001).

Work has also been carried out on **Upper Thames** sites at **Latton**, Gloucestershire.

East Anglian Rivers have also received attention, notably the **Stour** at **Dovercourt**, Essex, where unfortunately no new mammalian material was recovered. Work to reopen sections in fossiliferous sediments at **Maidenhall**, Ipswich, Suffolk (**River Orwell**), eagerly anticipated in the light of development plans, is still awaited, although preliminary assessment work was undertaken in 2002. The sediments here, including the "Stoke Bone Bed", a rich source of Pleistocene vertebrate remains with associated Levallois artefacts (Layard, 1912), are known to extend for nearly a kilometre southwards, underlying a terrace at about 12-14m O.D. (Wymer, 1985). Work has also taken place on the type Hoxnian deposits at **Hoxne**, Suffolk, which include lacustrine as well as fluvial sediments, the latter belonging to the early post-Anglian **River Waveney** catchment (Schreve, 2000).

In collaboration with Steve Boreham of the Department of Geography, University of Cambridge, DCS processed new samples and re-evaluated existing mammalian collections from a number of sites relating to the **River Cam**, including **Histon Road, Grantchester, Barnwell Abbey** and **Barrington**. One of the most significant new sites to come to the fore during the life of IGCP 449 has been at **Lynford** gravel pit, Norfolk, in deposits of the **River Wissey**. Containing Middle Palaeolithic artefacts and abundant remains of mammoth, this site has benefited from a rescue investigation, led by the Norfolk Archaeological Unit under the direction of Dr William Boismier, and funded by English Heritage via the Aggregates Levy Sustainability Fund. Also in the fenland catchment, DCS has been investigating late Middle Pleistocene interglacial mammalian evidence from **Funtham's Lane (Kings Dye)** in Cambridgeshire, from sediments deposited by the River **Nene/King's Dyke**.

Significant later impetus in the UK has come from the Leverhulme-funded 'Ancient Human Occupation of Britain' (AHOB) project and various projects funded, via English Heritage or English Nature, by the Aggregates Levy Sustainability Fund (ALSF). One of these, the Shotton Project (named after a famous UK Quaternary scientist), has established a GIS database for the Midlands rivers - **Severn** and **Worcestershire/Warwickshire Avon**. A trial programme of portraying fluvial sediments and find sites of Palaeolithic archaeology and Quaternary palaeontology within a GIS system is being trialed by the Shotton Project of the University of Birmingham (Professor D.H. Keen & Mr A. Lang) with the collaboration of Worcestershire Archaeology. It is hoped to extend the mapping to other catchments in future years.

Also in the West Midlands, a major discovery was made at **Whitemoor Haye**, Alrewas, Staffordshire, in deposits of the **River Tame**. Deposits here have yielded the remains of fossil mammals attributable to the Middle Devensian (OIS 3, *c.* 60-25 ka B.P.). The most significant find is the well preserved anterior part of what appears to have been an articulated skeleton of a woolly rhinoceros (*Coelodonta antiquitatis*). The remarkably good condition of the material and the fact that the skull, lower jaw, neck vertebrae and most of the anterior postcranial skeleton had been recovered, suggests that the animal had been buried as a frozen carcass. Remains of *Mammuthus primigenius*, *Equus ferus*, *Rangifer tarandus*, *Bison priscus* and *Canis lupus* were also recovered.

Another site to have benefited from ALSF funding is **Welton-le-Wold**, Lincolnshire, where fossiliferous sediments of a long-lost river underlie a complex and important glacial sequence. The project ran until early 2004 and was led by Joanna Hambly. As part of the project the fossil material was reassessed. The results are eagerly anticipated.

Sites associated with the erstwhile **Solent River**, at **Selsey** and **West Wittering**, Sussex, and **Stone Point**, Hampshire, were re-investigated for the first time for a generation during 2003 (M.R. Bates, F.F. Wenban-Smith, R.B. Briant *et al.*). The fossiliferous sediments at these various sites are estuarine in character and mammalian remains are rather scarce.

Uruguay:

Martin Ubilla (Ubilla, 2002) participated in the First International Palaeontological Congress (Geological Society of Australia) in Sydney (Macquarie University). Martin's team studies the mammalian faunas from late Quaternary fluvial sediments in South America and has published a number of publications tagged as contributions to IGCP 449 (Bond *et al.*, 2001; Ubilla *et al.*, 2004). A publication by Martin will appear imminently in the IGCP 449 special issue of *Proceedings of the Geologists' Association* during 2004, based on Martin Ubilla's participation in the Inaugural Project Meeting in Prague (Ubilla, 2004). These publications make comparisons with Late Pleistocene vertebrate assemblages from other parts of South America as well as giving considerable attention to palaeo-environmental reconstruction. The fossiliferous sediments studied by Ubilla's team crop out along riversides in various tributaries of the Uruguay River system.

It is regretted that the political and financial situation in Argentina have forced the idea of running a 2003 meeting of IGCP 449 in Argentina/Uruguay to be abandoned.

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Molluscan evidence from fluvial sediments: contributions to the IGCP 449 database

David Keen¹, Nicole Limondin-Louzouet² & Richard Preece³

*1 - Institute of Archaeology and Antiquity, University of Birmingham
E-mail: D.H.Keen@Bham.ac.uk*

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 Zoology, University of Cambridge, Downing Street, Cambridge, CB2 3EJ, UK
E-mail: rcp1001@cus.cam.ac.uk*

with contributions by Rich Meyrick, Danielle Schreve & David Bridgland

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, 1964; 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 important contributions to data from a number of areas, notably northern France (Antoine & Limondin-Louzouet, 2004), central Germany (Meyrick & Schreve, 2002) and Ukraine (Matoshko *et al.*, 2002, 2004).

GAZETTEER OF MOLLUSCAN RESEARCH, BY SITE

Czech Republic

Attention to molluscan records in the Vltava catchment of Bohemia arose as a result of the Inaugural meeting of IGCP 449 based in Prague. The field trip to terraces of this system was followed up by a review publication in the IGCP 449 special issue of *Proceedings of the Geologists' Association* (Tyráček *et al.* (2004).

Ctiněves, Hýkovina quarry, River Vltava. This section consists of loess, loam and palaeosol layers interbedded with scree material (Ložek, 1964; Horáček & Ložek, 1988, Photo 3; Tyráček, 2001b). From its molluscan and mammalian assemblages,

this site has been assigned to mammal zone MN17 (e.g., Fejfar, 1989), the Late Villanyian, which is dated to ~2.4-1.9 Ma by Fejfar et al. (1997). It has yielded the mollusc *Gastrocopta serotina*, an MN17 index fossil, and the rodents *Mimomys pitymyoides*, *M. reidi*, *Beremendia fissidens* and *Borsodia* sp. (Ložek, 1964; Fejfar & Horáček, 1983). Although not a fluvial site, its biostratigraphy provides a clear minimum age for fluvial incision to this level (Tyráček et al., 2004).

Karlštejn, locality Altán, terrace Va (34 m) of the River Berounka. the fluvial deposits here are overlain by a thick soil complex (e.g., Záruba et al., 1977; Horáček & Ložek, 1988) consisting of a basal interglacial soil, including colluvium containing the interglacial mollusc *Ruthenica filograna*, and overlain unconformably by other interglacial deposits, also containing thermophilous molluscs. This implies that the underlying 34 m terrace pre-dates the last two interglacials, suggesting a correlation with the Dejvice 1 (Va) terrace at Prague, as would also be expected from its altitude above river level. This is thus a likely analogue of Sedlec and Letky (see below).

Letky, abandoned brick clay quarry, near Prague (River Vltava). See Záruba et al., 1977, plates III-2 and IV-1; Tyráček et al., 2004, Fig. 6). This and the nearby site of **Sedlec** have yielded interglacial molluscs from both the PK3 and PK4 soils within loessic overburden. The evidence from both sites indicates that the species most strongly indicative of warm humid climates, notably *Aegopinella ressmanni*, *Aegopis verticillus*, *Helicigona banatica*, *Soosia diodonta*, *Cepea nemoralis* and *Gastrocopta theeli*, are found in association with PK3 but not PK4 (Záruba et al., 1977). Overall, the evidence from Sedlec and Letky supports the association of PK3 with MIS 5e, the Eemian, both from stratigraphic position and the thermophilous nature of the fauna. The combination of two distinct climatic minima and three optima suggests that PK4 marks MIS 7 (7e - 7a).

Račíněves, Straškov 2 terrace, River Vltava. As described by Tyráček (2001b) and Tyráček et al. (2001), the fluvial deposits here comprise a coarse lower unit and a finer upper unit and are overlain by loess and slope deposits containing palaeosol fragments that may represent two distinct warm stages. The ~12-14 m thick lower fluvial unit, consisting of stratified sands and gravels, is thought to indicate of a cold-climate braided-channel environment. The ~0.5-2 m thick upper fluvial unit is mainly composed of sand and fine sandy gravel, disturbed by cryoturbation. It has yielded thermophilous mammals, interglacial molluscs, and archaeological material.

The rich molluscan fauna comprises 22 taxa, the most important of which are the woodland species *Drobacia banatica* and *Aegopis verticillus* which, with *Helicodonta obvoluta*, *Ena montana*, *Cochlodina laminata* and *Discus ruderatus*, indicate interglacial conditions. Tyráček et al. (2001) also reported *Lithoglyphus pyramidatus*, known from the Holsteinian of Germany. The archaeological evidence includes cores, notches, knives, scrapers, wedges and hammerstones, made of Proterozoic lydite; some of which are in fresh condition, indicating a primary or near primary context. Mammal bones with cut-marks provide further evidence of human occupation, indicating hunting and butchery activities.

Near **Tetín**, River Berounka. Here fluvial and lacustrine sediments underlie the gravels of the ~75 m terrace (of presumed 'Günz' age - probably OIS 16) that flanks the Berounka gorge through the limestone of the Bohemian Karst belt. Calcareous

colluvial loams and sands, also underlying the 75m terrace gravel, contain the molluscs *Platyla* sp., *Negalus* sp., *Argna* sp., *Palaeoglandina* sp., *Strobilops* sp., *Plioptychia* aff. *vulgata*, *Laminifera* sp., cf. *Monachoides* sp., and *Helicodonta* sp., indicating an Early Miocene age (Kukla & Ložek, 1993). At this time, the river flowed westward, the opposite to its present course (Žák *et al.*, 2001), and drained into a freshwater lake in the Most Basin (Tyráček 2001a; Tyráček *et al.*, 2004). Broadly contemporaneous travertines and lacustrine limestones of the Most Basin, interbedded with its main lignite seam, also contain rich floras and mollusc and mammal faunas, which are indicative of early Miocene biozone MN3 (early Orleanian; early Burdigalian; ~19-21 Ma), for instance at **Tuchořice** (e.g., Fejfar, 1989).

Únětice - Holý Vrch, calcareous tufa overlying the Suchdol (Ib) terrace of the River Vltava (Tyráček *et al.*, 2004). This tufa has yielded molluscs, including *Granaria frumentum* and *Helicigonia čapeki*, characteristic of interglacials within the Cromerian Complex (cf. Záruba *et al.*, 1977). The sedimentary and biostratigraphic evidence indicates that a single interglacial is represented.

Zlatý Kopec, near Přezletice, in the River Labe valley ~18 km upstream of its confluence with the Vltava. An interglacial mammalian fauna, assigned to a Cromerian Complex interglacial (cf. Fejfar, 1976), occurs here in lacustrine sediments and palaeosols, in association with molluscs and chipped clasts that have been interpreted as primitive artefacts (e.g., Záruba & Roth, 1946; Ložek, 1964, 1969; Šibrava *et al.*, 1979). This locality is at ~250 m altitude, ~75 m above the Labe, which flows ~5 km to the northeast (Fejfar, 1969; Šibrava *et al.*, 1979). The lacustrine deposits at this site, at ~244-247 m altitude, record a complete cold-temperate-cold climatic cycle. Although these are not river terrace deposits, Šibrava *et al.* (1979) suggested that they accumulated just beyond the southern margin of a Labe terrace that had previously aggraded to the ~244 m level. Their altitude also invites comparison with localities on the Vltava in Prague, ~10 km to the southwest. On this basis, the Zlatý Kopec site has been regarded (e.g., by Záruba *et al.*, 1977) as younger than the Cromerian Complex interglacial site at Únětice, which caps Vltava terrace Ib.

France

Cagny-la-Garenne & Cagny-Cimetière, River Somme (Northern France), MIS 11. Recent work has been done on the malacofaunas and a manuscript has been provided to be included in a monograph on the prehistoric settlements (Ed. A. Tuffreau).

Caours, Somme basin, Northern France (P. Antoine & N. Limondin-Lozouet). A stratigraphic survey was carried out in November 2002, by Pierre Antoine, Jean-François Pastre and Nicole Limondin-Lozouet, on this tufa locality located near Abbeville in the Scardon valley. Preliminary stratigraphical observations indicate an Eemian age for the tufa. Several levels within and below the tufa appear rich in malacofaunas.

In March 2003 a malacological succession was sampled in a trial pit 4m deep (P. Antoine & N. Limondin-Lozouet). Preliminary analyses of the Mollusca show a complete interglacial succession:

- (3) late interglacial assemblages with return of mesophilous elements.
- (2) optimum faunas characterized by a diversified community of shade-demanding species
- (1) early interglacial faunas with abundant open-ground species and a few thermophiles

La Celle-sur-Seine, River Seine, Northern France (N. Limondin-Lozouet). Well-known from literature dating back to the end of the 19th century, this site has a tufa sequence nearly 12 metres thick rich in molluscs and leaf impressions. Recently an old malacological collection was rediscovered at Jussieu University. Work undertaken on this material (N. Limondin-Lozouet) has increased the faunal list from the 40 taxa previously reported to 77 species. Preliminary results show that, despite the absence of *Lyrodiscus*, many species, reported from other sites dated to MIS 11, but now extinct or out of their modern range, are present at La Celle sur Seine (*Aegopis acieformis*, *Aegopinella bourdieri*, *Bradybaena chouquetiana*, *Perforatella bidentata*, *Platyla polita*, *Ruthenica filograna*, etc). This hypothesis will be further tested by an additional study of this material based on new field work, to be completed this year.

Field work in June and July 2003 involved a stratigraphical survey that allowed observation of some 10 metres of tufa. Samples were taken for malacology, sedimentology, palynology; ostracods and Ur/Th dating. Mammal remains were recovered from a silty level; early interpretations of these (P. Auguste) note the presence of horse, Cervidae and rhino. The same level yielded a few artefacts (N. Connet). The first Ur/Th results indicate an age older than 350 kyr (J.J. Bahain). Analyses are in progress.

Longpré-les-Corps-Saints, River Somme (Northern France), MIS 7. Previous work was done on the molluscan succession here by J.J. Puisségur but were only briefly published in a note (Bourdier *et al.* 1974, *Bulletin de l'Association française pour l'Etude du Quaternaire*=AFEQ). Further sampling has been undertaken at a better resolution from the tufa deposit.

Soucy, River Yonne (Paris Basin), probably MIS 9. A very interesting Middle Pleistocene molluscan assemblage including *Aegopis klemmi*, an extinct species recorded for the first time in France. A paper presenting the alluvial terrace sequence and including the malacological data, aminochronology and RPE dating is in press (Chaussé *et al.* - *Géographie physique et Quaternaire*). Another paper focused on the malacological succession has been submitted to *Géobios* (N. Limondin-Lozouet).

Saint-Acheul, River Somme (Northern France), MIS 11. A new cleaned profile here, the type locality of the Acheulian Palaeolithic industry, has provided an opportunity to study a tufa deposit locally preserved at the top of the fluvial sequence. Samples were taken for malacological analysis and for ESR dating. The altitudinal position of the basal alluvial sheet within the terrace system of the Middle Somme valley together with the mapping of the fluvial terraces allows attribution of the fluvial deposits of Saint-Acheul (units 2 and 3) to the Garenne Formation (Formation V of the system). Thus the fluvial sequence of Saint-Acheul is thought to correlate with the deposits at Cagny-la-Garenne which have been allocated to MIS 12 and MIS 11.

This new work, and in particular the discovery of a tufa at St Acheul containing a molluscan assemblage belonging to the "*Lyrodiscus* biome", was published in the FLAG/IGCP 449 issue of *Quaternaire* (Antoine & Limondin-Lozouet, 2004). ESR dating of quartz grains from the tufa, which caps the fluvial sequence, has given an age estimate of 403 ± 73 kys BP (MIS 5). This conforms with the context, within the Garenne Formation (Formation V of the Somme), which has been previously allocated to MIS 12 and 11.

Malacofaunas recovered from the tufa deposit are rich and diversified (60 taxa) and the presence of no less than 21 forest species point unequivocally to climatic optimum conditions. Fluvial taxa are represented by 17 aquatic species of slow-flowing water. Terrestrial habitats consist of open-grassland, as demonstrated by the strong development of *Pupilla*, *Vallonia* and *Trichia* species, and of wooded areas. Among the forest molluscs several species are out of their modern ranges (*Platyla polita*, *Ena montana*, *Ruthenica filigrana*, *Clausilia pumila*, *Macrogastera ventricosa*, *Perforatella bidentata*, *P. incarnata*). Most noteworthy of all is the occurrence of the extinct Zonitid *Lyrodiscus (Retinella) skertchlyi* (see Figure 2). These species belong to the particular "*Lyrodiscus* biome" recognized in several tufa deposits from north-west Europe, all allocated to MIS 11. Reappraisal of the French malacological lists improves their similarity with British malacofaunas of Hoxnian age. These new results strengthened the originality and biostratigraphical value of the '*Lyrodiscus* assemblage'.

Somme basin, northern France. New work (NL-L with P. Antoine) will especially focus on the definition of full interglacial conditions, based on new malacological analyses and on comparison with palynology. At the same time there are plans to look for Eemian tufa deposits in the middle and lower Somme basin.

In addition, work on the Late Cenozoic neo-tectonics and evolution of the drainage basins of the Eure, Somme, Seine, Meuse, Schelde and Oise is being conducted by a team at Lille, led by Brigitte van Vliet-Lanoe in connection with structural geologists. Molluscan data will form an important part of this project.

Germany

Rich Meyrick and Danielle Schreve were joint leaders of a Quaternary Research Association short field meeting in Central Germany, based at Weimar,(12-17/5/02), during which several key fluvial sequences in this celebrated area were visited. Highlights were the staircase of terraces and MIS 11 archaeological site at Bilzingsleben, on the River Wipper, presented by Dietrich Mania, and the Late Middle, and Late Pleistocene travertines at Weimar-Ehringsdorf, on a terrace of the River Ilm. The guide book (Meyrick & Schreve, 2002), which is a contribution to IGCP 449, also includes several reviews of the biostratigraphy and research history of this important region.

Bilzingsleben, River Wipper, Thüringia. This critical faunal and archaeological site was visited, as well as the dedicated museum in the village nearby. Both were presented by Dietrich Mania, who has devoted much of his career to studying this locality. He has agreed to allow summary diagrams of the Bilzingsleben terrace staircase to be added to the IGCP 449 internet database.

Molluscan faunas occur in the travertines of each of the terraces, probably representing every post-Elsterian warm stage. The earliest of these (Bilzingsleben I), known only from small-scale excavations, contains a molluscan assemblage that includes *Theodoxus serratilineiformis*, one of the species that appears as part of the 'Rhenish fauna' part way through the interglacial sequence attributed to MIS 11 at Swanscombe, in the Lower Thames (Figure 1). The stratigraphical range of this species on the continent is not firmly established (R.C. Preece, in Schreve & Bridgland, 2002a, 2002b), but it has been regarded as indicative of a Holsteinian age, for example at Herzele in NW France and Lo in SW Belgium (Meijer, 1988). Hominid fossils and archaeological remains have been recovered from extensive excavations at the Bilzingsleben II level (Mania *et al.*, 1980; Mai *et al.*, 1983; Mania & Weber, 1986; Fischer *et al.*, 1991), which has also produced a rich mammalian assemblage. Amongst the molluscs at this level is *Corbicula fluminalis* (Box A), although in fluvial deposits beneath the travertine. *T. serratilineiformis* is again present in the travertine, amongst species indicative of both wooded and open environments and the Mediterranean and southern elements of a typical *Helicigona banatica* fauna (Mania, 1995). The Bilzingsleben III travertine, lower in the staircase, contains what Mania (1995) has described as a '*Helix pomatia*' fauna, tentatively attributed by him to the 'Domnitz' stage. Bridgland *et al.* (2004), in a review for IGCP 449, suggested correlation with MIS 9 (see Figure 3)

Burgtonna, Thüringia. This is a partly fluviatile site in the Unstrut system (Saale tributary). New work was undertaken by Rich Meyrick in conjunction with the mammalian studies of Lutz Maul. The molluscan sequence is approximately 4m thick and spans the major mammal fossil horizons, including those sediments containing an extinct species of *Hystrix* (porcupine). The mammal evidence has shown that the sediments date from the Eemian - Weichselian transition. It is hoped that evidence from the molluscs will allow tighter dating (using a combination of terrestrial and freshwater (fluvial/limnic) species).

Untermassfeld, southern Thüringia. The second of two monographs on this site from the Werra river system is currently in press (both are edited by R.-D. Kahle). Although a few molluscs are present, the key evidence from the site comes from mammals.

Weimar-Ehringsdorf, River Ilm, Thüringia. The quarry sections at the Ehringsdorf geological conservation site were visited on the QRA excursion, as were the collections from the travertine here, which now reside in the *Forschungsstation für Quartarpalaeontologie*, in Weimar. These include exceptional finds, such as snake skeletons, bird's eggs etc. There was a lively discussion about whether the travertines date entirely from MIS 7 or whether the upper ones are Eemian. The molluscan faunas from here and elsewhere are discussed in the field guide (Meyrick & Schreve, 2002) and in the review paper by Bridgland *et al.* (2004).

Netherlands

SW Netherlands buried valley systems. Important molluscan assemblages from boreholes in the SW part of the Netherlands have recently been reinterpreted (Meijer). Based on differences in amino acid ratios, the new interpretation envisages two

additional interglacials represented by assemblages with *Corbicula fluminalis*, both post-Holsteinian/pre-Eemian. After presentation by Meijer at an INQUA Subcommission of European Stratigraphy in the Netherlands (September 1998), the work has been published as part of a review of the occurrence of *Corbicula* (Meijer & Preece, 2000, *Netherlands Journal of Geosciences*, 79, 241-255).

UK

Allhallows, Kent (DHK with Bates and Whitaker BM). River Medway. This site, discovered during construction works in 1997, is one of the few fossiliferous sites found in the Medway in the late 20th century. The sequence yielded a limited molluscan fauna of eighteen species, but the presence of *Corbicula fluminalis* (Box A) indicates temperate conditions for deposition and an age in either MIS 7 or 9. The sparse occurrence of Hydrobid gastropods also suggests a limited brackish influence to deposition. A well developed ostracod fauna included specimens of a hitherto unidentified *Ilyocypris* previously noted at a number of Middle Pleistocene sites in the Lower Thames. This taxon is now positively identified (by Dr J.E. Whittaker) as *Ilyocypris salebroso* Stepanaitys, 1960 and may be usable as a biostratigraphic marker for MIS 7 and 9 in the Thames. The site has been published by Bates *et al.* (2002) and its stratigraphical relations discussed by Bridgland (2003).

Ashton Keynes, Wiltshire (DHK with Maddy, Lewis, Coope, Parfitt and Field). Upper Thames river system. Lewis and Maddy have a paper in press on the sedimentology of this Late Glacial and Devensian site.

Aveley, Essex (DHK with Allen, Blackford, Bridgland, Field, Schreve, White and others). River Thames. Work is essentially complete and a paper is being drafted. This site might provide the best record of MIS 7 in the UK.

Barling, Essex (RCP with Bridgland, Field, Schreve, Tipping and others), River Thames. Samples from here were collected in 1983 and published as a project contribution in the *Journal of Quaternary Science* (Bridgland *et al.*, 2001). This paper discusses the dating of the lower Thames sequence at some length and highlights the important group of sites now attributed to MIS 9, of which this site is one.

Bielsbeck, Yorkshire (DHK with Blackford, Bridgland, Coope, Field, Schreve, White and others). River Foulness. This is the most northerly fluvial site in the UK that is thought to date from MIS 7. The biostratigraphically significant bivalve *Corbicula fluminalis* was recently identified in samples from here, its northernmost record as a British fossil. Preliminary publication of this site appeared in 1999 in a Quaternary Research Association field guide (Schreve, 1999).

Chislet, Kent (DHK with Bridgland, Schreve, White and others). River Stour. Further sampling and analyses might be undertaken. The site was published in preliminary fashion in 1998 (Quaternary Research Association field guide). Probably MIS 7.

Cromer Forest Bed Formation, various sites, East Anglia. RCP (with Simon Parfitt) has invested considerable effort in a thorough reappraisal of the Cromer Forest Bed, now thought to represent early Middle Pleistocene interglacial fluvial deposits.

The results have important implications for the climato-stratigraphic division of the Cromerian Complex. Preliminary results have appeared in a Quaternary Research Association field guide.

Cudmore Grove, East Mersea, Essex (RCP with Devoy, Roe and Schreve), River Thames tributary. An important site with rich vertebrate remains, a 'Hoxnian' pollen signature and a sea-level story.

Beeches Pit, West Stow, Suffolk (RCP *et al.*). At this, the type locality of the fossiliferous Icklingham Tufa (Kerney, 1976), Mollusca have been recovered from other beds, some of them fluvial. The site represents the much-disrupted drainage system that operated in the former Bytham/Ingham River valley after that river had been obliterated by the Anglian glaciation. The tufa and other sediments represent the MIS 11 interglacial, which followed the Anglian, and were deposited in hollows and small channels in the top of a subglacial channel infill. From the molluscan viewpoint the most interesting aspect of this site is that the assemblage from the tufa represents the '*Lyrodiscus* biome', also described here from St Acheul in the Somme, with which it correlated. Beeches Pit, indeed, is the type locality of *Lyrodiscus skertchlii* (Figure 2). A paper has been submitted to *Quaternary Science Reviews*.

Funtham's Lane (King's Dyke), Cambridgeshire (Fenland Basin). A complex series of fluvial deposits in channels cut into Oxford Clay bedrock occurs at this site. It is one of only three sites in Britain to yield the striking gastropod, classically attributed to a Rhenish influence, *Theodoxus serratilineiformis (danubialis)*. The other two are Swanscombe and East Hyde, Tillingham, both attributed to MIS 11. This fenland site was visited as part of a Quaternary Research Association Short Field Meeting in September 2003, organized by Dr Harry Langford.

Hackney Downs, London (DHK with Green, Coope, Field, Schreve, and others). River Thames. Snail and insect counts are done, work on plantmacrofossils is in progress. A paper is in press in *Quaternary Science Reviews*.

Latton, Gloucestershire (DHK with Coope, Field, Lewis, & Scott). Upper Thames river system. This site has mammalian, molluscan, insect and plant records from MIS 7, possibly MIS 5e and the Devensian. A paper on this complicated sequence is in press in the *Journal of Quaternary Science*.

Lynford, Norfolk, River Wissey (AHOB Project and Norfolk Archaeological Unit). At this recently discovered Mousterian site, where over 2000 individual vertebrate finds have now been identified by Danielle Schreve, evidence from Mollusca (D.H. Keen) and beetles (G.R. Coope) suggests a palaeoenvironment that was sub-arctic in character, with a landscape of open grassland without trees. The dating of the site by amino acid geochronology (M. Collins, University of York) is equivocal, probably due to acid leaching and/or weathering of the shell resulting in a loss of amino acid. However, Lynford has provided a useful case study for amino acid determinations at other sites affected by acidic sediments. Luminescence dates suggest an age for the site in the latter part of MIS 5e, although the archaeology and vertebrate palaeontology is more consistent with an age in MIS 3. A monograph on all aspects of the site is expected to be ready for publication in early 2005.

Purfleet, Essex (DHK with Allen, Bridgland, Schreve, White and others). River Thames. A paper in *Quaternary Science Reviews* was tagged as a project contribution (Schreve et al., 2002). Additional work from other sites in the area remains to be written up. The published site is thought to represent MIS 9.

Selsey & West Wittering, Sussex; **Stone Point**, Hampshire (Solent River). These fossiliferous sites in the estuarine reaches of the former Solent River were re-investigated for the first time for a generation during 2003. This work is part of the Sussex/Hampshire Coastal Corridor ALSF project. A team comprising Drs M.R.Bates (Lampeter), F.F.Wenban-Smith (Southampton), R.B. Briant (King's, London), D.H. Keen and G.R. Coope (Birmingham) and J.H. Whittaker (Natural History Museum, London) have sampled the above three sites to determine their age and palaeoenvironment.

The most marine of the three, Selsey, has yielded a large brackish and marine fauna of shells and ostracods consistent with a low estuarine position in an interglacial with a climate similar to that of the present. The organic channel fills at West Wittering, 15 km to the West have not been seen since 1890. A programme of machine dug test pits in June 2003 failed to locate the channel sediments due to modern beach sediment cover, but a geophysical survey in September 2003 gave strong indications of a buried channel inland of the modern beach. Boreholes and trenching in 2005 will aim to locate these deposits for sampling. Reappraisal of the published molluscan and plant macro floral fossil lists from 1892 seem to indicate conditions warmer than the present interglacial and the occurrence of the molluscs *Corbicula fluminalis* and *Belgrandia marginata* together in the same deposits may indicate an age in MIS 9.

The sediments at Stone Point are also brackish in character with a restricted molluscan and ostracod fauna, but the extraction for the first time of an insect fauna from the deposits suggests that summer temperatures at the time of deposition were higher than the present and consistent with an age in MIS 5e. Work continues on this site, but if the MIS 5e age is confirmed it would indicate that the Solent River still flowed in the Ipswichian Interglacial and that the dismemberment of the lower reaches of this major river system by marine erosion only occurred in the Last Glaciation or in the Holocene.

Ukraine

Two major syntheses of fluvial records from the rivers flowing south to the Black Sea and the Caspian Sea have been provided by Matoshko *et al.*, 2002, 2004). Brief summaries will be provided here.

Stolnichen Series, Lower Pliocene. Rich faunal assemblages are associated with this series. The most characteristic mollusc is *Plicatibaphia cf. wetzleri* Dunker. Palynological data reveals a subtropical climate during the accumulation of the Stolnichen Series.

The following molluscs have been established in the **Sokol Suite** of the **Kinel' series** of the Kama tributary of the Middle Volga: *Viviparus dresseli* Tournouer, *V. mangikiani* Bogatshev, *V. achatinoides* glogovensis (Stefanescu), *Valvata vanciana* Tournouer, *V. piscinalis* (Müller), *Borysthenia naticina* (Menke), *Bithynia spoliata* Stefanescu, *B. vukotinovici* Brusina, *Lithoglyphus rumanus* Stefanescu, *Unio* ex gr.

rumanus Fontannes, *Potomida sibirica* (Penecke), and *Psilunio serratoradiatus* (Bogatshev). Based on the presence of Levantine (Late Pleistocene of Romania; i.e., Romanian) unionides and some gastropods of the Kuyalnik type, the Sokol Suite has been correlated (e.g., by Goretskiy, 1964) with the Lower Levantine stage, the Lower Kuyalnik and lower Middle Akchagyl (i.e., the early Late Pliocene). Matoshko *et al.* (2004) correlate the Sokol Suite with the **Runkashiv Suite** of the Dniester, which also has *Amphimelania impressa* Bogatshev, *Valvata uralica* G. Popov, *Viviparus mangikiani* Bogatshev and *Bithynia vucotinovici* Brusina.

Molluscs from the **Vadul-lui-Vode Suite** include *Pristinunio davalai* (Porumbaru), *P. procumbens* (Fuchs), along with mammals such as *Elephas planifrons* Falconer, *Archidiskodon meridionalis meridionalis* (Nesti) and *Equus stenonis* Cocchi. This Dniester suite is correlated with the **Uryv Series** of the Upper Don, on the basis of small mammals, and with the **Khapry Suite** of the Lower Don. The Khapry suite is the context for the mammal complex of the same name, characterised by *Archidiskodon gromovi* Garutt et Alexeeva, *A. meridionalis meridionalis* (Nesti), *Equus robustus* Pomel, *Dicerorhinus etruscus* (Falconer) and *Elasmotherium caucasicum* Borissiak. The fossils from the **Rashkiv Suite** of the Dniester are also representative of the Khapry mammal complex and include typical molluscs of the Late Akchagyl Stage: *Bogatschevia tamanensis* (Ebersin), *B. bugasicus* (Ebersin), and *Potomida* (*Wenzinella*) *moldavica* Tchepalyga.

The Lower Pleistocene **Boshernitsa Suite** of the Dniester contains the younger Taman mammalian faunal complex and molluscs such as *Bogatschevia sturi* M. Hörnes, *B. Unio sturi* var. *rodzjankovi* Bogatshev and *Margaritifera arca* Tchepalyga. It is correlated with the middle suite of the **Goryanka Series** of the Upper Don, which is characterized by small mammals (e.g., *Mimomys* ex. gr. *pusillus* Mehely, *M. intermedius* Newton and *Allophaiomys pliocaenicus* Kormos) of the same faunal complex (Holmovo *et al.*, 1985). Molluscs such as *Unio sturi* var. *caudata* Bogatshev, *Unio sturi* var. *scutum* Bogatshev, *Unio* (*Eolymnium*) *pseudochasaricus* Tchepalyga and *Corbicula apsheronica* Andrussov together with mammals of the late Taman complex, with *Archidiskodon meridionalis tamanensis* Dubrovo, characterize the Kisnytsia Series of the Dniester. Faunal remains from the Kairy Series of the Lower Dnieper are also assigned to the Taman complex. Palynologically, the fluvial record shows a decline in temperature at the end of the Early Pleistocene.

The Middle Pleistocene alluvium of the Koshnitsa and Kolkotov suites of the Dniester contains the mammal fauna of the Tiraspol complex, including *Mammuthus trogontherii wusti* M. Pawlow, *Alces latifrons* (Johnson), *Cervus acoronatus* Beninde, *Equus* aff. *sussenbornensis* Wusti, *Lagurus transiens* Janossy, *Microtus* (*Stenocranius*) *hintoni* (Kretzoi) and *Mimomys intermedius* Newton. Molluscs of the **Koshnitsa Suite** are similar to the modern complex, whereas many molluscs of the Kolkotov Suite represent the subtropical zone, such as *Potomida littoralis* Cuvier, *P. kinkelini* (Haas), *Viviparus tiraspolitianus* Pavlov and *V. kagarliticus* Lungershausen. The Koshnitsa Suite correlates with the **Traktemyrv Suite** of the Middle Dnieper, which contains *Unio pseudochasaricus* Tchepalyga and *Crassiana pseudolittoralis* (Clessin). The biostratigraphical correlation of the **Kolkotov Suite** with the **Nikopol Suite** of the Lower Dnieper (Matoshko *et al.*, 2004, Fig. 2), the **Muchkap Suite** of the Upper Don and the **Venedy Series** of the Middle Volga is also well established. Remains from the younger **Kryvichi Series** (Dnieper and Volga), **Strelitsa Suite**

(Upper Don) and **Varnitsa Suite** (Dniester) are attributed to the Singil mammal complex. This follows the *Mimomys-Arvicola* transition recognized throughout Europe (Turner, 1996); in the Middle Dnieper it is characterised by *Arvicola chosaricus* Alexandrova, *Arvicola mosbachensis* Schmidtgen, *Eolagurus luteus* Eversmann, *Microtus (Stenocranius) gregalis* Pallas, *Microtus arvalis* (Pallas), *M. oeconomus* Pallas, *Cricetus praeglacialis* (Schaub) and *Lagurus lagurus* (Pallas). In the Upper Don this transition seems to occur between the Muchkap and Tafino Suites: the **Muchkap Suite** contains *Mimomys* but the **Tafino Suite** contains *Arvicola* (Iossifova, 1977; Turner, 1996). This mammal complex is named after the **Singil Suite** of the Caspian basin, which represents a relatively minor transgression of the Caspian Sea, associated with the development of estuarine deposits near its present northern margin (downstream of the Lower Volga cross-section line shown in Fig. 1). The representatives of the **Upper Palaeolithic faunal complex** include *Coelodonta antiquitatis* Blumenbach, *Megaloceros giganteus ruffi* (Nehring), *Cervus elaphus* Linnaeus, *Capreolus capreolus* Linnaeus, *Rangifer tarandus* Linnaeus, *Bison priscus* Bojanus and *Mammuthus primigenius* Blumenbach; this complex is characteristic of the 3rd, 2nd and 1st Terrace suites but is especially common in the basal alluvium of the **Modern Suite** of the Middle Dnieper, along with remains of the modern fauna.

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Report of the IGCP 449 Subgroup on Crustal Deformation and Uplift Modelling

Rob Westaway & Andrei Matoshko

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One of the most significant results to emerge from the early stages of IGCP 449 was that many uplift histories, revealed by long-term river terrace staircases, are predictable as the non-steady-state isostatic response to climate-induced changes in rates of surface processes: sedimentation, erosion, and cyclic loading of the Earth's surface by ice sheets or sea-level fluctuations, in the presence of a mobile lower crustal layer which flows in order to maintain isostatic equilibrium. The year 2002 saw publication of two very detailed papers, by Westaway et al. (2002) and Westaway (2002a), that explain the theory and numerical methods being used in such calculations. A third paper, by Westaway (2002b), summarised this topic in a more accessible, qualitative manner; a fourth paper (Westaway, 2002c) presented preliminary solutions for the uplift histories of many regions, in Europe and world-wide, obtained using these techniques.

The pace of this research gathered further momentum during 2003. First, as a result of invited contributions from many authors (notably from eastern Europe) to IGCP 449 conference volumes, detailed fluvial records are becoming accessible to an international audience from regions where this material was formerly only known in the local literature. Work promptly began on modelling the uplift histories revealed by these records.

Probably the most important point to emerge in 2003 was the realisation that the nature of fluvial records is strongly dependent on the nature of the crust over which a river flows; specifically, on its thermal history.. The reason, for instance, why most major rivers in western and central Europe have very similar terrace staircases is not only the similarity in the climate histories of these regions, but also their similarity in crustal structure and rheology. The relatively young (Palaeozoic age), hot, low-viscosity lower crust encountered in these regions is the primary reason why the observed typical ~300 m of surface uplift observed since the Miocene, has been feasible. In contrast, several of the major rivers in eastern Europe flow across Early-Middle Proterozoic age cratons, where the crust is much colder and so more viscous, but nonetheless some lower-crustal flow still occurs. The much smaller amount of surface uplift (<100 m; Matoshko et al., 2004) observed and its different characteristic history seem readily explicable in terms of this difference in rheology. Finally, as Westaway et al. (2003) have pointed out, regions of Archaean crust (such as southern Africa, western Australia, and India) show no systematic incision indicative of regional uplift during the Late Cenozoic: rivers in these regions instead typically aggrade repeatedly around the same level. This effect is explicable given that no lower-crustal flow is expected, so the physical mechanisms that enable such flow to contribute to surface uplift elsewhere do not occur. The same is true of rivers that flow over

ancient ocean basins that have become infilled with sediment, as the underlying oceanic crust is also expected to lack a mobile lower-crustal layer.

These new ideas have stimulated lively discussion, for instance with Americans who believe that the terraces of rivers that drain into the Gulf of Mexico (such as the Mississippi, which flows over infilled parts of the Gulf of Mexico ocean basin) should serve as a useful analogue for rivers in western Europe that flow over highly mobile lower continental crust: a view that now seems unsustainable. The contrary view that lateral variations in crustal and lithospheric rheology are negligible is also supported by many modelling studies of ice-unloading from the most recent global glaciation. The realisation that such lateral variations are instead of fundamental importance probably means that such studies contain major unreported systematic errors. As a result, new techniques are being developed to enable modelling of ice-unloading data-sets in a manner consistent with the recent modelling of long-term river terrace staircases.

Following the international meeting of IGCP 449 for 2003 at Belem, Brazil, work began on applying similar modelling techniques to the evolution of the Amazon river system - the world's largest – in relation to the uplift history of the Andes mountain range. A manuscript summarising the results from this work has been submitted to the special volume for this meeting (Westaway, 2005a). This study provides an example where the evolution of a major river system is linked to that of regional topography, which is itself linked to climate change, with each of these processes feeding back to affect the others. This potential importance of long-timescale fluvial records as evidence of climate change has been further emphasised in a review article (Bridgland and Westaway, 2005). The IGCP 449 excursion to western Amazonia, which followed the Belem meeting, provided clear evidence for the control exerted by crustal properties on fluvial morphology: as noted by Westaway (2005b), rivers in the cratonic part of Amazonia lack terrace staircases, indicating high stability of the crust, whereas rivers in the younger crust have incised by tens of metres since the Late Miocene, resulting in the development of fluvial terrace staircases.

As the number of well-dated fluvial sequences, suitable for quantitative modelling, is limited, work has also progressed on generating new dating evidence to facilitate further studies in future. This work to date has concentrated in volcanic regions of Europe and the eastern Mediterranean region, publications so far including Westaway et al. (2003, 2004, 2005), Bridgland et al., (2003), Demir et al. (2004, 2005), and Westaway (2004).

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IGCP 449 activity in Argentina

C.G. Ramonell

Litoral National University, Santa Fe, Argentina
cgramonell@yahoo.com.ar

Argentinian researchers began to participate in the IGCP 449 project in 2003. We expect that the Argentinian contribution will increase during the future activities of the project and in IGCP 518.

Results on the Plio-Pleistocene limit in the Argentinian Andes were presented in the IGCP 449 Symposium during the Latin American Congress of Sedimentology in Belém, by Dr. P. Milana from the National University of San Juan, Argentina.

C. Ramonell, from the “Litoral” National University participated in the International Field Conference “Amazon 2003” (see Brazilian Report) and presented results for discussion on the Parana fluvial system, Argentina. Also C. Ramonell helped in the field discussions in the Amazon field conference, because of his research experience in the area. Ramonell participated in the 1990s in geological research on fluvial sequences in southwestern Amazonia, in collaboration with E.M. Latrubesse.

Type profiles and sedimentological sections will be provided by Argentinian researchers to the IGCP 449/518 internet data-base.

IGCP 449 Activity in Australia

Gerald Nanson

Meetings & field excursions relevant to the project

Activity in Australia was launched during 2002, with the hosting of the FLAG/GLOCOPH/IGCP 449 meeting in June - July entitled “**Quaternary River Regimes of Central Australia**” It included the following components:

Field Expedition to Eastern Central Australia (June 29th – July 14th) – Led by Gerald Nanson & Brian Jones

The expedition looked at the extensive geomorphic and stratigraphic evidence for Quaternary fluctuations in precipitation and runoff in central Australia. While most of this largely arid continent has been unaffected directly by Quaternary glaciation, there is widespread evidence from its rivers, lakes and groundwater that there have been major changes in moisture regime with the passage of each full glacial cycle. Specific field sites visited include:

- (1) Cooper Creek in the vast Channel Country of southwestern Queensland, a region of anastomosing suspended load rivers and palaeo source-bordering sand dunes;
- (2) the linear dunefields of the Simpson Desert;
- (3) the beach ridges and lacustrine deposits of the worlds’ largest saline playa, Lake Eyre;
- (4) the high-level Pleistocene overflow channel between Lake Gregory and Lake Eyre;
- (5) the steepland rivers of the Flinders Ranges;
- (6) Lake Mungo, Australia’s most intensely studied archaeological site and dry-lake system (formed by wind modification of fluvial meanders);
- (7) the palaeochannels and source-bordering dunes of the Riverine Plain.

Results from detailed research projects conducted at each location were presented for discussion.

One-day conference: Evidence for Climate and Flow Regime Change in the Quaternary (July 15th, University of Wollongong) – organized by Gerald Nanson & David Price

One-day visit to the Upper Shoalhaven terrace system, SE New South Wales (July 16th).

A party of ten travelled to the area around Larbet, near Braidwood, where a Quaternary terrace sequence dating back to c. 0.5 Ma was studied by Jonathan Nott (Nott *et al.*, 2002). Nott’s main sample sites were examined. It would appear that there is considerable scope for further dating work and more detailed mapping of these terraces, and that an extremely valuable fluvial record exists in the Upper Shoalhaven. A more detailed summary

diagram, incorporating the Tertiary as well as the Pleistocene fluvial history, would be a valuable contribution to IGCP 449.

In 2003 Gerald Nanson attended the Annual Meeting of IGCP 449 in Belem, Brazil, and participated in the associated field meeting in southwest Amazonia. Here plans were discussed between Gerald Nanson and Edgardo Latrubess for undertaking a major collaborative research project comparing the Quaternary evolution of large anabranching river systems in the humid Amazon basin and in arid central Australia.

Research projects

In 2003 Tim Cohen completed a study of late Holocene river and floodplain processes on the north coast of New South Wales

Gerald Nanson *et al.* (2003) published a substantial paper reviewing major climate and flow regime changes over the past 100,000 years using mostly luminescence evidence from alluvial deposits on New South Wales coastal rivers. The largest coastal rivers transported extensive coarse gravels during periods of Marine Oxygen Isotope Stage (OIS) 5 between 110 and 90ka, and between about 85 and 73 ka. Basal gravels were again reworked in OIS Stage 3 at about 50 to 40 Ka. These episodes correspond closely to evidence from earlier published work on the Riverine Plain of inland southeastern Australia. Clearly these rivers were at those times, powerful, actively-migrating systems driven by greatly enhanced precipitation whereas today they have almost no ability to work such deposits. This evidence shows a remarkable change in Quaternary flow-regimes for rivers not affected by headwater glaciation.

Small confined coastal catchments have retained only part of their alluvial record in the form of a relatively sensitive indication of recent Holocene flow-regime changes that were much less pronounced than those occurring throughout most of the late Pleistocene. Nanson *et al.* (2003) and Cohen (2003) have shown that a period of enhanced flow-regime occurred after the LGM and is widely preserved as the oldest major terrace system in these small valleys. The early to mid Holocene (12-3ka) was marked by much flows, lower than those of the late Pleistocene but 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 is these low-energy, laterally stable rivers that European land clearance has so dramatically destabilised.

Cohen (2003) has shown that terrace preservation in partly confined valleys is highly site specific. Importantly for the use of terraces in such valleys as indicators of flow regime change, down valley continuity of terrace profiles is not an accurate indication that such surfaces are coeval.

In tropical northern Australia Ward (2003) has completed a study describing the cyclical formation and erosion of extensive alluvial and colluvial sandsheets proximal to ancient sandstone plateaux. The latter are eroding at about 5mm/kyrs with sandsheet alluviation nearly doubling from the late

Pleistocene to the Holocene, probably due to the return of the monsoon to northern Australia after the last glacial.

Kevin Pucillo has just completed a very detailed PhD thesis on the Quaternary evolution and stratigraphy of palaeochannels on the Riverine Plain of New South Wales. This study reveals stacked palaeochannels that range in age from the early Quaternary to the Holocene. The work is based on logged data from more than 10,000 boreholes, manipulated with sophisticated GIS technology, with luminescence dating undertaken in the near surface palaeochannels and source bordering dunes.

In December 2004, Professor Gerald Nanson and Dr Tim Cohen, organised a meeting of the the *Australian and New Zealand River Research Network* in the School of Earth and Environmental sciences at the University of Wollongong. The network was instigated in 1996 by Dr Gary Brierley as an local informal forum focusing on coastal New South Wales rivers. At the Wollongong meeting it was resolved to form an Australian and New Zealand wide organisation focusing on fluvial geomorphology, Quaternary history and related management issues in the two countries. Papers presented at this meeting included topics such as postglacial knickpoints in bedrock rivers, climate and flow regime changes from ~ 750 ka to the present in the Channel country of Queensland and South Australia, palaeochannel stratigraphy on the Riverine Plain, NSW, rapid alluvial induration and resulting channel morphology in the Australian tropics, late Holocene fluvial records for south-eastern Australia; climatic forcing or erosional thresholds, recent and ancient controls on riverine landscapes of the Gulf of Carpentaria, how modern and ancient history shed light on management of the Geomorphic diversity of the Ganga Plains, India and its controls , anf palaeoflood slackwater records from the Macdonald River, NSW. The group will meet again in New Zealand in association with the next meeting of the Australian and New Zealand Geomorphic Research Group in February, 2006.

Publications:

Nott, J.; Price, D. & Nanson, G. 2002. Stream response to Quaternary climate change; evidence from the Shoalhaven River catchment, southeastern highlands, temperate Australia. *Quaternary Science Reviews* 21, 965-974.

Cohen, T.J. 2003. Late Holocene floodplain processes and post-European channel dynamics in a partly confines valley of New South Wales, Australia. Unpublished PhD thesis, University of Wollongong.

Hollands, C.B., Nanson, G.C., Jones, B.G., Price, D.M., Pietsch, T.J. and Bristow, C.S. 2005. Aeolian-fluvial interaction: evidence for Late Quaternary channel change and wind-rift linear dune formation in the northwestern Simpson Desert, Australia. *Quaternary Science Reviews*. (in press).

Nanson, G. C., Cohen, T.J., Doyle C.J. and Price, D.M. 2003. Alluvial evidence of major Late-Quaternary climate and flow-regime changes on the

coastal rivers of New South Wales, Australia. In K.J Gregory and G. Benito (Eds), *Palaeohydrology: Understanding Global Change*, Wiley, Chichester, p. 233-258.

Nanson, G.C., Jones B.G. and Price, D.M. 2005. Rivers turned to rock;: Late Quaternary alluvial induration influencing the behaviour and morphology of an anabranching river in the Australian Monsoon tropics. *Geomorphology* (in press).

Page, K. J.; Nanson, G. C. & Frazier, P. S. 2003. Floodplain formation and sediment stratigraphy resulting from oblique accretion on the Murrumbidgee River, Australia. *Journal of Sedimentary Research* 73, 5-14.

Pucillo, K. (2005) Quaternary palaeochannel evolution and groundwater movement in the Colleambally Irrigation District, New South Wales. Unpublished PhD thesis, University of Wollongong

Stockton, S and Nanson, G. 2004. Cranebrook Terrace revisited. *Archaeology in Oceania*, 39: 59-60.

Ward, I.A.K. 2003. Hidden in the sands of time: geoarchaeology of sandstone landscapes in the Keep River region, Northern Territory, Australia. Unpublished PhD thesis, University of Wollongong.

IGCP 449 Activity in Belgium

F. Gullentops, Institute of Earth Sciences, University of Leuven, Belgium.

Work was carried out during IGCP 449 on different lines on the flight of terraces of the Meuse. Several members of the Leuven Institute have continued their research on the evolution of the Meuse River Basin, which provides a record of environmental change in Western Europe since the Cretaceous. Koen Beerten read a contribution in the 2001 Strasbourg- E.U.G-meeting, XI, which will be printed in the Floodplains, ed. by Ph. Collins, probably as: Gullentops, F., K.Beerten & J.Janssen: Recent changes in the fluvial dynamics of the River Maas in Limburg (Belgium, Netherlands).

K.Beerten attended the 7th International Conference on Fluvial Sedimentology, 6-10 August 2001, Lincoln-Nebraska, USA.

The mapping of the Quaternary Geology along the Meuse Valley in Northern Belgium was finished and several maps are now available. Beerten K., Gullentops F., Paulissen E. & Vandenberghe N., 2000. Quartairgeologische kaart van kaartblad (18) Maaseik, 1/50.000. Kaartenbundel, digitale databank, legende, begeleidende tekst en stratigrafische tabel. Ministerie van de Vlaamse Gemeenschap, Afdeling Natuurlijke Rijkdommen en Energie. Brussel.

Frans Gullentops organised excursions on the Stratigraphy of the Meuse Terraces and their loess-cover for the European Congress of Prehistory in Liège, held in September 2001 and for the Belgian Society of Geology.

Koen Beerten has started a 4-year program of ESR-dating of the Meuse terraces. Several methodologies have been tried out this year. This research is funded by the Flemish IWT. In 2002 will be finalised several subjects:

- Stratigraphy of the Geistingen terrace at Aldeneik.
- A well preserved Meuse Valley of the Late Weichselian at Graethem, Netherlands.
- The Elsterian Meuse.

Frans Gullentops contributed to the FLAG 2002 Meeting in Clermont-Ferrand, France, in September 2002. His title: Some phenotypes of the Border-Maas, Belgium, during the last 30ka.

Publications:

Gullentops, F. & Paulissen, E., 2001- Fluvial Sediments, Meuse Group, in eds: *P.Bultynck & L.Dejonghe: Lithostratigraphic Scale of Belgium, Geologica Belgica*, 4, 157-159.

Beerten, K. & Gullentops, F. 2001- Post-Pleniglacial Evolution of the River Meuse Floodplain in Limburg, Abstract p.177, E.U.G. Conference Strasbourg.

Beerten, K., Pierreux, D. & Stesmans, A. 2002- Towards single grain ESR dating of sedimentary quartz: first results, abstract in Reno-Conference, article accepted in Quat. Sc. Rev.

Gullentops, F., Beerten, K., Janssen, J. & Paulissen, E. 2002- Some phenotypes of the Border-Maas, Belgium, during the last 30ka, abstract in Clermont-Ferrand Meeting, p.20.

IGCP 449 Activity in India

Rajiv Sinha

Late Cenozoic Fluvial Deposits : Focus on India Current Science, vol. 84 (8), 25 April, 2003 (Guest editors: R. Sinha & S.K. Tandon)

The special issue of Current Science carrying a special section on “Late Cenozoic fluvial deposits” was published in April, 2003 and has the distinction of the first major publication of IGCP 449. The special section contains a set of fourteen papers that deal with various aspects of Late Cenozoic fluvial deposits. The first five papers of this thematic set are on the fluvial deposits of the Himalayan Foreland. The paper by S.B. Bhatia presents a correlation of the Late Miocene (7.9 to 5.1 Ma) fluvial sequences of the Siwalik Group (Chuarua Group) in Nepal over a distance of 700 km on the basis of molluscan, ostracode, and charophyte assemblages. Kumar et al. recognise two major events of sedimentation patterns and drainage organisation at 10 Ma and 5 Ma in the Panjab sub-Himalaya. In a related study, Sangode et al. have compiled the data on the magnetic polarity of the Siwalik Group from the Indian part of the Himalayan Foreland. In addition to a discussion of the use of magnetic fabrics and rock magnetic ratios of pedogenic horizons as correlation tools, Sangode et al. discuss the stratigraphic utility of the polarity data for identifying tectonic and climatic events in the Himalayan hinterland. Jain and Sinha have emphasized on the geomorphic diversity of the river systems and sedimentation patterns in the Gangetic Plains in their review paper, and explore the utility of this data for understanding the sedimentary environments of ancient fluvial sequences in foreland basins. Shukla and Bora highlight yet another diversity of the Gangetic plains and describe a sedimentary sequence from the piedmont zone in the northern Gangetic plains. The piedmont fan deposits are characteristically made up of both fluvial and debris flow facies and are distinguish them from the (alluvial) megafan deposits. R.J. Wasson has used published data on sediment load to proposed a sediment budget for the Ganges-Brahmaputra catchment. The computations based on and Nd/Sr tracers show that $80\pm 10\%$ of the total contribution from the Ganges tributaries comes from the High Himalaya and $20\pm 10\%$ from the Lesser Himalaya. The actual contributions from the Siwaliks, Plains, and Peninsular region are unknown but each of these is likely to be less than 10 per cent.

The next set of four papers deal with the fluvial deposits of western India. Jain and Tandon have used the clay mineral ratios of smectite/chlorite and smectite/illite from the alluvial palaeosols of the Sabarmati sequence at Mahudi as proxy indicators of climate change. Wet phases are recognised during OIS 5 and OIS 1 in these sequences. Maurya and others have shown from the less studied area of southern mainland Kachchh that the Late Quaternary fluvial sequences form three distinct geomorphic surfaces- a featureless alluvial plain (S1 surface), the extremely dissected S2 surface characterised by deep ravines,

and the low flat S3 terrace surface. Deposition of the successions associated with the S1 and S2 surfaces took place in ephemeral rivers in a semi-arid to arid climate. Bhatt and Bhonde have shown the influence of marine flooding in the river valleys of south Saurashtra, and suggest that the marine flooding can be linked to OIS 5. Kale and others have used slack water deposits of bedrock gorges to assemble a 2000- year chronology of large floods on Narmada and a less than 500 year chronology of floods for the Tapi. They have noted clustering of flood events, and a possible link between palaeofloods and Holocene climatic changes.

Terrace staircase sequences are important for modelling the relationships between regional-scale surface uplift and large scale fluvial incision over long time-scales. Bridgland and coworkers have presented the records of a long Quaternary terrace sequence in the Orontes river valley, Syria with reference to uplift and human occupation. Similarly, the terrace sequences of western Turkey have been used by Westaway and others to investigate Pliocene and Quaternary surface uplift.

The paper by Raymahashay and Khare on the arsenic cycle in fluvial sediments, though not in line with the main theme of this compilation of papers, touches upon a very important geo- environmental problem of the delta region of the Ganges in India and Bangladesh. Finally, the thematic set includes a suggestion by Westaway regarding the use of the effect in the earth's moment of inertia during glaciation on geomagnetic polarity excursions and reversals for Quaternary chronology.

Science of Shallow Subsurface Studies (SSS)

The Department of Science and Technology had set up a Committee to develop strategies and to promote work that helps in developing a data base for the shallow subsurface zone of different parts of India. Major applications of such a data base would include (a) evaluation of natural resources viz. water, food, fuel, and minerals, (b) infrastructure development e.g. roads, tunnels, dams, industries, (c) location of waste disposal sites – municipal, industrial, mining, nuclear, (d) public health and safety – groundwater and soil contamination, ground response to natural hazards, climate change, (e) archaeology, and (f) lithosphere-biosphere interaction.

In general, the SSS committee intends to promote research in the area of **earth and environmental science** through funding of projects. It also aims to expand and modify the geoscience curriculum in academic institutions to incorporate the new concepts. For professional geoscientists, continuing education opportunities would be provided through contact programmes. It is also expected that general public education programmes would be initiated to simplify earth sciences for common people and market the knowledge. The Committee recently met in Bangalore and recognized that major floodplain and delta areas of the country

should be studied on a priority basis. Some of the key areas suggested for investigation by the Committee are as follows:

1. Ganga Plain
2. Cauvery - Pennar deltaic Plain
3. Gujarat Alluvial Plains
4. Brahmaputra valley
5. Intermontane valley of Kashmir

A large number of IGCP 449 participants would be involved in the Ganga Plains studies which constitute one of the world's most extensive alluvial tracts and are home to hundreds of millions of people, mostly dependent on agriculture. They constitute a dynamic fluvial region traversed by big rivers (Ganga - Yamuna) that are sourced in the Himalayan orogen, as well as rivers such as the Betwa, Chambal, Ken, and Son that are sourced in the central Indian Craton. Additionally, many smaller, plains – fed rivers are sourced within the plains. The underlying Ganga Basin contains up to several kilometers of alluvial strata.

The Ganga plains are of great significance from an academic standpoint, as they hold important clues regarding the tectonic and climatic factors that governed the interaction between the Himalayan orogen and the Foreland. Understanding the landforms of the Ganga Plains, - their origin, development and dynamic imprints is therefore of critical significance to plan effectively for sustainable development of the region. It is necessary to study the plains to track changes in the alluvial landscape on different time scales – for example decadal, century, millennial and higher order time scales of 10^4 – 10^5 years. For a comprehensive understanding of the plains, multiple approaches must be adopted that combine modern process studies, Holocene environmental change, and alluvial stratigraphic development in the shallow sub-surface (~100 m depth).

Evolutionary history of most landforms (mega- and meso- scale) in the Ganga Plains remains poorly understood because of the methodological difficulties associated with the study of subsurface deposits. This aspect, notably the general non-availability of sub-surface geological data and drill cores has been a serious impediment on advancing our understanding of the history of alluvial plain sedimentation.

In order to improve our understanding of the Ganga Plains, the Committee set up by the DST has stressed that a holistic approach should be adopted, an approach that relies on multi-disciplinary analysis and synthesis of surface and sub-surface geological, geophysical, pedological, mineralogical, geochemical, mineral magnetic and geomicrobiological data. It is desirable, therefore, to initiate a coordinated multi-disciplinary program in a north-south corridor of the Ganga Basin. Under this program, the emphasis would be to study scientific problems regarding the evolutionary history of the mega- and meso- scale

landforms of the Ganga Plains that require an integration of surface and sub-surface data.

The SSS project has been funded in principle and we await the details. The project requires in-situ subsurface features and materials (rocks, soils and sediments) for studying their various physical, chemical and biological properties. In many areas, exposed sections, wherever they are, may be of the order of a few meters to a few tens of meters. Sections exceeding 20-30 m depths are exceedingly rare. Therefore, we have to employ drilling techniques to obtain data and samples up to ~ 100m depth. Because drilling is expensive, recovered cores have to be catalogued, preserved in boxes and kept in cold storage for present and future use. This calls for creation of regional nodal centres for preservation of drills cores. The IIT Kanpur has been recognized as one of the drill core nodal centres.

Research Activities

R. Sinha at IIT Kanpur and S.K. Tandon at Delhi University have been involved in a multi-disciplinary study of the parts of the Gangetic plains for the last couple of years. We follow an integrated approach starting from mega-geomorphic mapping from satellite images, followed by the study of exposed sections along the river banks to establish the first level stratigraphy in the selected windows. Our present focus lies in the following windows:

1. Ganga Yamuna interfluvium (Kanpur-Kalpi region)
2. Yamuna-Betwa interfluvium (Kalpi-Kotra region)
3. Ganga-Ramganga interfluvium (Delhi-Moradabad region)
4. Haryana plains NW of Delhi

During the last few years, we have completed the geomorphic mapping of the first three windows and the work is starting in the Haryana plains. We have also studied some of the stratigraphic sections in these windows exposed along the river banks through photomosaics and field studies. However, the exposed sections are widely separated and it has not been possible to establish any correlation amongst them to evolve a generalized lithostratigraphic model for this region. It was therefore decided to fill in the gaps through drilling and coring in the Ganga-Yamuna interfluvium. We have so far generated continuous cores from 7 locations along the Kanpur-Kalpi transect with the objective to correlate the stratigraphic sections at Bithur (Ganga river, 9 kms NE of Kanpur) and Kalpi (Yamuna river), to understand the competition between the Himalayan and cratonic river systems and to pick out the cycles of floodplain aggradation and degradation vis-a-vis the forcing factors such as climate and tectonics. Work on these cores is continuing involving detailed description, sedimentological characterization and geochemical analysis including stable isotope analysis of the carbonate fraction.

In the next phase of our work under the SSS programme, we would like to take up the coring in the following windows:

- (a) **Yamuna-Betwa interfluve:** It is planned to extend the N-S transect from Kanpur to Kalpi to further south in the Yamuna-Betwa interfluve towards the cratonic margin of the basin. Two additional holes are planned in this region and one more hole close to the Yamuna-Betwa confluence to investigate the dynamics of the rivers. An additional hole is planned north of this confluence.
- (b) **Ganga-Gomati interfluve:** Apart from the cores from the floodplains, it is also planned to raise cores from some of the lakes in the Ganga-Gomati interfluve region with the objective of reconstructing paleoclimate. Apart from the sedimentological and geochemical data, the lake cores are likely to provide data on pollen and microfossils.
- (c) **Haryana plains NW of Delhi:** This window lies at the north western margin of the Gangetic plains close to the desert. We intend to drill around 10 cores in this region in the old alluvial plain, desert fringe and dune lake sequences to understand the climatic transitions and lake expansion during some intervals of the Quaternary period.

S.B.Bhatia is continuing his work on the ostracode faunas of the Siwalik group. An interesting assemblage of stagnophile ostracodes has been discovered in the grey carbonaceous overbank mudstones of the Tatrot formation near Nada Sahib, east of Chandigarh. Further work is in progress.

Significance of the fluvial sequences of the coastal rivers in evaluating the Quaternary sea level changes and neotectonics has been established by various studies globe over. The detailed investigations have been carried out in this regard in the SW Saurashtra, western India by the present worker. The physical stratigraphy, fluvial litho-facies and marine flooding events have been documented in the Bhadar, Ojat and Noli rivers of this part. The study has been extended to the rivers of the south Saurashtra viz., Hiran, Saraswati, Singvado, Machhundri, Dhantarvadi and Malan. The primary results have clearly shown the possibility to decouple the role of neotectonics and Quaternary climate change in the evolution of this part of the region. A DST funded project has been implemented with the other collaborators in the May 2003 to investigate the subsurface structures and sediment body geometries using Ground Penetrating Radar (GPR) technique at selected sites in Saurashtra.

Ongoing Research projects

1. Mega-Geomorphic Elements in Ganga-Yamuna (GY) Alluvial Plains and their stratigraphic significance interpreted through sedimentology and geochemistry (ongoing), Dept. of Science & Technology, Govt. of India (R. Sinha, IIT Kanpur V. Rajamani, JNU Delhi & S.K. Tandon, Delhi University)
2. Tracking Environmental Change and Human Impact in The Ganga Plains, Ministry of Human Resources and Development, Govt. of India (R. Sinha, IIT Kanpur)
3. Modernization of geosciences UG Laboratory, Ministry of Human Resources and Development, Govt. of India (R. Sinha, IIT Kanpur)
4. Acquisition of Drill Core Scanner, IIT Kanpur grant (R. Sinha, IIT Kanpur)
5. Reconstruction of Quaternary tectonics and delineation of sub-surface faults in Gujarat region using GPR funded by DST (L.S. Chamyal, D.M. Maurya, M.S. University, Vadodara)

Workshops/short courses organized

1. DST sponsored Contact Programme cum field workshop on Structure, Tectonics and Mesozoic Stratigraphy of Kachchh , January 2002 (L.S. Chamyal, M.S. University, Vadodara).
2. Meeting of the Committee on Science of Shallow subsurface Studies, Bangalore, August, 2003 (V. Rajamani & S.K. Tandon)
3. DST sponsored Brainstorming workshop on “Tectonic Geomorphology”, May 3-7, 2004 (S.K. Tandon and R. Sinha, IIT Kanpur)
4. DST sponsored school on “Concepts in Quaternary Geology”, 27 March-16 April, 2005 (R. Sinha, IIT Kanpur)

Recent Publications by IGCP 449 participants

1. Sinha, R. (in press). Why do Gangetic rivers aggrade or degrade? Current Science.
2. Tandon, S.K., Gibling M.R., Sinha R., Singh V., Ghazanfari P., Dasgupta A., Jain M. and Jain V. (in press.) Alluvial valleys of the Gangetic Plains, India: causes and timing of incision. SEPM Special volume on Incised Valleys.
3. Sinha R (in press) Geomorphology of the Ganges fluvial system in the Himalayan foreland: an update. Revista Brasileria.
4. Latrubesse, E.M., Stevaux J.C. and Sinha, R. (2005) Tropical Rivers. Geomorphology, 70 (1-2), in press (available online 4 May 2005).
5. Sinha R., Jain V., Prasad Babu G., and Ghosh S. (2005) Geomorphic characterization and diversity of the fluvial systems of the Gangetic plains. Geomorphology, 70 (1-2), in press (available online 14 April, 2005).

6. Jain V. & Sinha, R. (2005) Response of active tectonics on the alluvial Baghmata river, Himalayan foreland basin, eastern India. *Geomorphology*, 70 (1-2), in press (available online 18 April, 2005).
7. Roy, N. and Sinha, R. (2005) Alluvial geomorphology and confluence dynamics in the Gangetic plains, Farrukhabad-Kannauj area, Uttar Pradesh, India. *Current Science*, 88(12), 2000-2006.
8. Gibling, M.R. Tandon, S.K., Sinha, R. and Jain, M. (2005). Discontinuity-bounded alluvial sequences of the southern Gangetic plains, India: aggradation and degradation in response to monsoonal strength. *Journal of Sedimentary Research*, 75(3), 373-389.
9. Sinha, R., Tandon, S.K., Gibling M.R., Bhattacharjee, P.S. and Dasgupta, A.S. (2005) Late Quaternary geology and alluvial stratigraphy of the Ganga basin, *Himalayan Geology*, 26(1), 223-240.
10. Sinha, R., Gibling, M.R., Tandon, S.K., Jain, V. & Dasgupta, A. S. (2005) Quaternary stratigraphy and sedimentology of the Kotra section on the Betwa river, Southern Gangetic plains, Uttar Pradesh. *Jour. Geological Society of India*, 65, 441-450.
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13. Sinha, R. & B.C. Raymahashay (2004) Evaporite mineralogy and geochemical evolution of the Sambhar Salt Lake, Thar Desert, Rajasthan, India. *Sedimentary Geology*, 166, 59-71.
14. Jain, V. & Sinha, R. (2004) Fluvial dynamics of an anabranching river system in Himalayan foreland basin, Baghmata river, north Bihar plains, India, *Geomorphology*, 60, pp. 147-170.
15. Jain, M. & Tandon, S.K. (2003) Fluvial response to Quaternary climate change, western India, *Quaternary Science Reviews*, 22, 2223-2235.
16. Jain V. & Sinha, R. (2003) Hyperavulsive-anabranching Baghmata river system, north Bihar plains, eastern India, *Zeitschrift für Geomorphologie (Annals of Geomorphology)*, 47/1, p. 101-116.
17. Jain, V. & Sinha, R. (2003) River systems of the Ganga plains and their comparison with Siwaliks: a review, *Current Science*, v.84 (8), 1025-1033.

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IGCP 449 activity in Brazil

Edgardo M. Latrubesse (Federal University of Goias, Brazil)

The highlight of Brazilian project activity was the 2003 (June 8-11) IGCP 449 Symposium in Belem do Pará, Brazil, organized as part of the 3rd Latin American Congress of Sedimentology. This meeting was chaired by Edgardo Latrubesse (Federal University of Goias-Brazil) and Gerald Nanson (University of Wollongong, Australia). Participation included researchers from the United Kingdom, Brazil, Australia, Argentina and India, who presented important results in oral sessions.

During this Belem meeting an official administrative meeting of the IGCP 449 project also took place.

A total of nineteen contributions were published in the Annals of the Latin American Congress of Sedimentology.

Immediately after the Congress, between June 12-18, an IGCP 449 Field Conference, "*Neogene palaeogeography, palaeohydrology and palaeoecology, present-day geomorphologic processes, and geomorphologic risks in Southwestern Amazônia*", took place, organized by Edgardo Latrubesse (Federal University of Goias-Brazil) and José Stevaux (UEM-Brazil). A total of 35 participants from 10 countries (Argentina, Australia, Brazil, Germany, India, Italy, Japan, Spain, the UK, and the USA) participated in this field conference.

Although most of Amazonia has never been studied in detail, because of its inaccessibility, southwestern Amazonia is one of the most studied areas of the Amazon. Research here in recent years has resulted in significant advances in knowledge of the Tertiary sedimentary successions and paleohydrology of its large fluvial systems. This field trip offered the opportunity to discuss the Tertiary stratigraphy and the Quaternary evolution of two large fluvial systems from this region: the Madeira and the Purus rivers. The Upper Tertiary is represented here by the Solimões Formation, which is characterized by its high diversity and abundance of Mio-Pliocene fossil vertebrates (mammals, reptiles and fish). The Madeira River is the largest tributary of the Amazon in terms of water discharge (up to 32,000 m³/s) and sediment inflow; were it not an Amazon tributary, in its own right it would count as the fifth largest river in the World. It supplies 0.45 billion tonnes of sediment per year into the Amazon (the total from which is 1.2 billion tonnes). The Purus River has an annual water discharge averaging 11,000 m³/s at its mouth and it is possibly the largest monozonal river in the world (being completely contained within the equatorial Amazon rain forest and lacking Andean tributaries). The Quaternary sediments from these two rivers were analyzed and discussed, together with the paleoenvironmental implications of the available Quaternary vertebrate fauna, as well as the modern geomorphology and hydrology of these large tropical systems

Another IGCP 449 administrative meeting with all the participants was convened during the field conference.

Two field Guide books were published with information on the Tertiary and Quaternary fluvial record of Southwestern Amazonia. One provides descriptions of localities visited on the IGCP 449 field excursion (Latrubesse and Stevaux, 2003); the other is an edited volume of selected papers to support the aims of the meeting.

A special issue of the *Journal of South American Earth Sciences* is being produced, based around the Belem conference, edited by Dr Carina Hoorn (Amsterdam) and others, which will include contributions to IGCP 449. It is scheduled for publication in late 2005.

Publications:

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IGCP 449 Activity in Bulgaria

Ivan Zagorchev
Bulgarian Academy of Science, Sofia

R. Westaway, project webmaster, visited Bulgaria in 2001 and commenced collaboration with an active Bulgarian group. A major theme has been analysis of the sequences of the Struma and Mesta Rivers, with a view to determining the regional uplift history, especially in comparison with neighbouring regions. Preliminary results were presented at the FLAG 2002 meeting in Clermont Ferrand.

At the 2004 International Geological Congress, based in Florence, the Bulgarian group was involved in the following:

1. Field trip B26 "Neotectonic transect Moesia - Apulia"
2. During-congress workshop DWO 017 "Tertiary tectonics of SE Europe: extensional collapse and rifting, or detachment tectonics?"

The B26 field trip provided a comprehensive overview of the Alpine orogen, including the Mid-Cretaceous Morava and Strouma zones, the Late Cretaceous Srednogorie mountain range, the Palaeogene - Neogene Balkanide and Hellenide belts of the Balkan Peninsula, and their exhumation during Palaeogene, Neogene and Quaternary times.

Publications:

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- Westaway, R. 2002. Observation and physical modelling of Late Cenozoic surface uplift from fluvial sequences in south-east Europe and the eastern Mediterranean region: Bulgaria, Central Greece and western Turkey. FLAG 2002 Abstract volume, 52.
- Yaneva, M. 2002. Mineralogical and geochemical features of some fine-grained sediments from Gotse Delchev Basin, Neogene, SW Bulgaria. - C. R. Acad. Bulg. Sci. (in press)
- Yaneva, M. 2002. Composition and origin of sand in Neogene Sofia Basin. - Minno Delo & Geology (in press) (in Bulgarian, English abstract).

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IGCP 449 Activity in Canada

Serge Occhietti

The Canadian Contribution to IGCP 449 was initiated in 2002 with the coordination of Special Session 24 at the Geological Association of Canada Annual Meeting in Saskatoon, Saskatchewan, May 24-29, 2002. The goal of this group is to coordinate studies in Canada of paleo-fluvial deposits covering the late Cenozoic. The initial session at the GAC meeting was a success, bringing together fluvial researchers from across Canada (representation from British Columbia, Alberta, Saskatchewan, Ontario and Quebec) covering fluvial systems research in both northern and southern Canada.

The official IGCP 449 2002 regional meeting in Clermont-Ferrand, France was attended by D. Froese and S. Occhietti (representing Canada). Froese made presentations on the record of the Yukon River system (oral presentation) and the Cenozoic record of the Klondike goldfields (poster) Both participants made presentations on Canadian river systems.

Members of the Canadian group were intimately involved in the 2003 Annual meeting in Agadir, Morocco, with Serge Occhietti assisting the local meeting organizer, Ali Ait Hssaine. Much of the work presented in Morocco stems from collaboration between French, Moroccan and Canadian workers. Serge Occhietti will be editing (with David Bridgland and Rob westaway) a collection of papers arising from the Agadir meeting to be submitted to *Géographie Physique et Quaternaire* (Montreal).

The group persists with its main objectives, these being activity in the areas of **fluvial sedimentology**, **stratigraphy**, **geomorphology**, **biostratigraphy**, **modeling**, **archeology** and **chronology**.

Publications

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- Froese, D.G. and Smith, D.G. 2002. Late Cenozoic history of the middle Yukon River, central Yukon and Alaska. GAC/MAC Annual Meeting, Saskatoon, Saskatchewan, Program and Abstracts Volume
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- Froese, D.G., Smith, D.G., Ager, T.A., Westgate, J.A., Preece, S.J., Sandhu, A., Enkin, R.J. and F. Weber 2003. Recurring middle Pleistocene outburst floods in east-central Alaska. *Quaternary Research*, 60, 50-62 .
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- Livingston, J.M., Froese, D.G., and Smith, D.G. Reconstructing the late Holocene ice-jam flood history of the Yukon River - Dawson City, Yukon to Circle, Alaska. GAC/MAC Annual Meeting, Saskatoon, Saskatchewan, Program and Abstracts Volume
- Occhietti, S. 2002. The sedimentary system of the St. Lawrence basin during the climatic optimum of the last interglacial (substage 5e). FLAG/IGCP 449 meeting Clermont-Ferrand France, September 9-11, 2002.
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- Westgate, J. A., Preece, S. J., Sandhu, A. S., and Froese, D. G. (2003). Age of the gold-bearing White Channel gravel, Klondike District, Yukon. In "Yukon Exploration Geology 2002." (D. S. Emond, and L. L. Lewis, Eds.), pp. 241-250. Exploration and Geological Services Division, Yukon Region, Indian and Northern Affairs Canada.

IGCP 449 2003 Activity in China

Liping Zhou

In the absence of a Chinese meeting within IGCP 449, a number of Chinese delegates participated in the IGCP 449 Business meeting and workshop at INQUA, in Reno Nevada, 24th July 2003. These were Liping Zhou, Fahu Chen, Xiaoze Li and Anzhi Sheng. All were involved in wider participation in the INQUA Congress.

A China meeting/workshop will be a priority for follow-up project IGCP 518. It will be led by Prof. Zhongyuan Chen (East China Normal University, Shanghai) with, as its theme, the Late Cenozoic evolution of the River Yangtze. Prof. Chen visited project leader David Bridgland's department (Durham, UK) during 2004.

Project reports:

Yellow River

Yang Liankang (Ministry of Geology and Mineral Resources)

The above has undertaken an exhaustive survey of the Yellow and Yangtze Rivers, on foot, taking 1111 days. This has shown that the World's highest river terrace occurs 1250m above the Yellow River, which also has the largest number of terraces, 32 in the Longyang Gorge, and the thickest loess (315m). The Yellow and Yangtze records are thus confirmed as the World's most outstanding, reflecting their location in relation to the uplifting Qinghai-Tibet Plateau. This work has led the author to put forward a recommended plan for regulating river and watercourses, the importance of which was shown by major flood disasters in China in 1998 and 1999 and the serious breach of the Yellow River course. The value of the recommended plan is expected to be further proved in the future by the project for transferring water from the water-abundant south to the water-deficient north, as well as the development of the rich hydro-electric resources of the mountainous areas. At present the losses brought about each year by water-induced disasters amount to 1,000 billion RMB, about 10% of the GDP of China. In this connection, the plan could also be helpful for the reduction of flood disasters elsewhere in Southern and Southeast Asia.

Dating of fluvial deposits

L.P. Zhou (Laboratory of Earth Surface Processes, College of Environmental Sciences, Peking University, Beijing).

Results of methodological evaluation research on the application of OSL dating, using fluvial sediments exposed in construction sites in Beijing, have been published in *Quaternary Science Reviews* (Zhang et al., 2003). A technique was developed to evaluate the degree of bleaching of individual quartz grains. This allows age estimates to be made by selecting well-bleached grains and averaging results from these.

Publications:

ZHANG, J.F., ZHOU, L.P. & YUE, S.Y. 2003. Dating fluvial sediments by optically stimulated luminescence: selection of equivalent doses for age calculation. *Quaternary Science Reviews* 22, 1123-1129.

IGCP 449 Activity in France

Pierre ANTOINE, Nicole LIMONDIN-LOZOUET & Jean-Francois PASTRE

There has been consistent activity in France during the life of IGCP 449. The following activities have been noteworthy :

- Saint-Acheul, River Somme (Northern France)

A new tufa deposit was recognized within the terrace sequence here, at the type locality of the Acheulian Palaeolithic Industry. A paper was published in "Quaternaire" 2004 issue 1/2 :

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..

Abstract

Recently a new cleaned profile at Saint-Acheul in the Somme valley (type section for the Lower Palaeolithic Acheulean industry), has provided an opportunity to undertake malacological analysis and ESR dating on a tufa deposit at the top of the fluvial sequence. The context of the basal alluvial sheet within the terrace system of the Middle Somme valley allows attribution of the fluvial deposits of Saint-Acheul to the Garenne Formation (Formation V of the system), which has been previously allocated to MIS 12 and 11. The upper part of the Saint-Acheul sequence (slope deposits) is mainly composed of Upper Saalian loess, overlain by Upper Pleistocene deposits and soils, separated from the fluvial beds by erosion and a long hiatus. The Upper Pleistocene succession includes an arctic brown soil horizon (the so-called "Sol de Saint Acheul"), representing the results of pedogenesis throughout the Weichselian Middle Pleniglacial (MIS 3). Chronostratigraphic interpretation of the underlying fluvial deposits is now consolidated by an ESR age determination on quartz (403 ± 73 kyrs BP), consistent with a MIS 11 allocation. Malacofaunas recovered from the tufa deposit are rich and diversified (60 taxa) and the presence of no less than 21 forest species point unequivocally to climatic optimum conditions. Fluvial taxa are represented by 17 aquatic species of slow-flowing water. Terrestrial habitats consist of open-grassland, as demonstrated by the strong development of *Pupilla*, *Vallonia* and *Trichia* species, and of wooded areas. Among the forest molluscs several species are out of their modern ranges (*Platyla polita*, *Ena montana*, *Ruthenica filograna*, *Clausilia pumila*, *Macrogastrea ventricosa*, *Perforatella bidentata*, *P. incarnata*). Most noteworthy of all is the occurrence of the extinct Zonitid *Retinella (Lyrodiscus) skertchlyi*. These species belong to the particular "Lyrodiscus biome" recognised in several tufa deposits from north-west Europe, all allocated to MIS 11. Finally, these results reinforce the interpretation of the Somme terraces system as a model of river response to Milankovitch cycles during the Pleistocene.

A second paper is in preparation:

LIMONDIN-LOZOUET N., ANTOINE P. A new *Lyrodiscus* assemblage at Saint-Acheul (Somme Valley): reappraisal of Stage 11 malacofaunas from Northern France.

Abstract

Recent studies undertaken at Saint-Acheul, the type site of the Acheulean industry, in the Somme Valley (France) have provided opportunity to recover malacological assemblages from a tufa deposit located at the top of a Middle Pleistocene 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*, *Macrogastera 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 strengthened the originality and biostratigraphical value of the "*Lyrodiscus* assemblage".

- La Celle-sur-Seine, river Seine (Northern France)

This site is well-known in the literature since the end of the 19th century for its thick tufa sequence (nearly 12 metres) rich in molluscs and leaf prints.

Recently an old malacological collection has been rediscovered at Jussieu University. Work undertaken on this material (N. Limondin-Lozouet) have allowed to increase the faunal list from 40 taxa, as previously reported in old publications, up to 77 species. First results show that despite absence of *Lyrodiscus*, many species, now extinct or out of their modern range, reported from others sites allocated to MIS 11 are present at La Celle sur Seine (*Aegopis acieformis*, *Aegopinella bourdieri*, *Bradybaena chouquetiana*, *Perforatella bidentata*, *Platyla polita*, *Ruthenica filograna*, etc). This hypothesis will be improved by further study on this material and new field work is planned for 2003.

Field work has been performed in June and July 2003, a stratigraphic survey has allowed to observe some 10 metres of tufa accumulation. Samples were undertaken for malacology, sedimentology, palynology; ostracods and Ur/Th dating. Mammals remains were recovered from a silty level, early observations (P. Auguste) mention the presence of horse, Cervidae and rhino. The same level yielded a few artefacts (N. Connet). The first Ur/Th results indicate an age older than 350 kyr (J.J. Bahain). Analyses are in process.

- Caours, Somme basin (Northern France)

A stratigraphic survey has been done in November 2002, by Pierre Antoine, Jean-François Pastre and Nicole Limondin-Lozouet, on this tufa formation located near Abbeville in the Scardon valley. First stratigraphic observations indicate an allocation of the deposit to the Eemian. Several levels within and below the tufa appear rich in malacofaunas.

In March 2003 a malacological succession was sampled in a pit 4 m deep (P. Antoine & N. Limondin-Lozouet). First malacological results show a complete interglacial succession: 1) early faunas with abundant open-ground species and a few thermophiles, 2) optimum faunas characterized by a diversified community of shade-demanding species and 3) late assemblages with return of mesophilous elements. Mammals remains were recovered and presence of Auroch identified (P. Auguste). Ur/Th dating is in process (J.J. Bahain) and coring of the deposit is planned for October 2003.

- Condat, river Coly (Southern France)

MIS 5: Firstly studied by Richard Preece (JQS, 1 (1) 1986), the site has been visited again in September 2003 (N. Limondin-Lozouet) in order to organize new field work in 2004 for detailed multidisciplinary sampling. Comparison with northern sites is expected.

- Thérain valley (Oise basin)

Lateglacial/Holocene. Mesolithic excavations are undertaken at the site since 2000 (T. Ducroq), samples were undertaken for several bioproxies. Molluscan study (N. Limondin-Lozouet) show for the first time in Northern France the *Discus ruderatus*/*Discus rotundatus* succession which is an important marker in early Holocene sequences from North-West Europe (Preece and Bridgland, 1999 ; Meyrick, 2001). Radiocarbon dates associated with malacological assemblages are in process.

- Massif Central

Work continued on the Plio-Pleistocene of the Massif Central (J-F. Pastre et al.). It included dating of lava-flows from the Upper Allier Basin, tephrae from the surroundings of the Mont-Dore strato-volcano. These new data were presented at the FLAG/IGCP 449 meeting in 2001 in Clermont Ferrand.

- Paris basin

J-FP, NL & PA, together with Philippe Ponel and Chantal Leroyer, are working on a new rich Lateglacial sequence near Beauvais and other correlations and dating projects are on-going on other sites.

- Yonne valley

Six lower Palaeolithic sites within Middle Pleistocene alluvial deposits were recovered from a gravel pit quarried at Soucy in the Yonne valley (France). The alluvium age is assigned to marine isotopic stages 10 and 9, according to amino-chronology and ESR dating. Malacofaunas from the upper sandy and loamy sand formations indicate temperate continental conditions (Chaussé et al., 2001; Limondin-Lozouet N., 2001).

Meetings:

Regional IGCP 449 meeting within FLAG 2002, Clermont-Ferrand:

The 2002 FLAG (Fluvial Archive Group) meeting was held in Clermont-Ferrand, Auvergne, France, 9-11th September 2002. It included a 3-day excursion in the Upper Loire-Allier basin, 12-14 September.

The field trip focused mainly on the Late Cenozoic fluvial evolution of the Upper Loire and Allier basin between le Puy (Haute-Loire) and Clermont-Ferrand (Puy-de-Dôme), where many fluvial and fluvio-lacustrine deposits interfering with volcanism from ca. 4 Ma to ca. 8 ka can be observed. It resulted in a special issue of *Quaternaire* (2004, 1-2).

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IGCP 449 Activity in Germany

Raimo Becker-Haumann

German participation in IGCP 449 has been concentrated in certain key areas:

Rhine valley – FLAG 2000 meeting, Mainz, 19th-23rd March 2000

This was a 4-day meeting, with 2 days of lectures and a field excursion, including a cruise down the Rhine, from which the classic terrace sequence could be observed. The meeting included the following sessions:

- (1) Global correlation of Late Cenozoic fluvial sequences
- (2) Fluvial activity and crustal instability
- (3) Fluvial response to rapid environment change during the last glacial-interglacial cycle
- (4) Holocene fluvial system response to frequent and rapid periods of environmental change: identification and modelling of forcing factors

Session 1 was devoted to the aims of IGCP 449 and was used to promote the project, the official go-ahead for which was received from IGCP only days before the Mainz conference took place. Other parts of the conference were relevant to IGCP 449, particularly Session 2 and the field excursion. A special issue of the Netherlands Journal of Geosciences was used to publish papers from the conference, several of which were identified as contributions to IGCP 449. This was jointly edited by Prof. Frank Sirocco of the University in Mainz, who was also conference organizer.

Central Germany (Thuringia and Saxony) - Quaternary Research Association short field meeting, Weimar, 12-17/5/02

Rich Meyrick and Danielle Schreve were joint leaders of this meeting, which provided a focus for project activity in this region. Several key fluvial sequences were visited. Highlights were:

- Glacial and fluvio-glacial sequence around Leipzig (Eissmann, 2002)
- Untermassfeld – Lower Pleistocene fossiliferous sediments of the River Werra
- The staircase of river terraces and MIS 11 archaeological site at Bilzingsleben, River Wipper (Dietrich Mania)
- Late Middle-Late Pleistocene travertines at Weimar-Ehringsdorf, part of a terrace sequence of the River Ilm
- Travertine cascades of Burgtonna, in the River Unstrut valley.

Full details of sites visited are given in the field guide (Meyrick & Schreve, 2002), which is identified as a contribution to IGCP 449.

Following the end of IGCP 449:

International Conference on "The Fluvial System - past and present dynamics and controls", May 16 - 22, 2005, Bonn, Germany
organized by Jürgen Herget

Research projects

The Alpine Foreland (Bavaria)

Iller-Lechglacier area:

The meltwater terraces of the Iller and Lech (Bavaria) are reconstructed by using GIS-based 3D-modelling software. This technique, applied for the first time for this kind of sediments, includes all available information such as altitudes of terrace bases, petrographic results, paleocurrent directions etc. The terrace bodies (about 20 since the Pliocene) are modelled by creating two surfaces (base, top) in the very high resolution of 10 m in reality. Taking the dip, bank regions and pools of the former valley fill into account, all field observations are explained by the resulting models. They reveal excellent approve for the stratigraphic assignment of the terrace levels, the paleogeologic situation as well as mass balance calculations.

The work is focused mainly on the methodology of 3D-modelling and the regional stratigraphy (setting up a stratigraphic system of the whole Pleistocene within the Iller-Lechglacier Foreland) and fluvial history of Iller and Lech.

Lake Kempten:

Detailed investigations of the laminated sediments of the former Lake Kempten (Bavaria) revealed good indications for the existence of two proglacial lakes in the front of the Würmian Iller glacier. This reconstruction is important for studies of Last Glacial fluvial evolution in the region. The older sediments document a Mid-Würmian ice advance that is not commonly accepted for the Alpine region, but is identified in some other countries. The younger lake resulted from the LGM and represents a timespan of less than 1 ka. The study will be finished within one year and focused upon the regional geological setting, the last glaciation and some new methods for investigate laminated sediments by X-ray photographs.

"Wanderblock-Formation" in the Jura mountains, Switzerland:

Relict coarse gravels of late Tertiary age, which can be observed in the mountainous region south of Basel, were investigated in order to get information about their genesis and age. In some recent publications a glacial provenience was proposed, but the new, systematic investigations suggest that

the gravels were deposited in a large alluvial fan draining the Black Forest. As the fan was located within a small graben south of the Upper Rhine embayment, the sediments can be traced far southward. They document a tributary to the huge river system draining the Alpine Foreland during the Miocene and Pliocene.

GIS-based 3D-modelling of fluvial deposits: Examples from Pleistocene meltwater terraces of the Alpine Foreland, Germany

The recent work integrates all available data of the Iller glacier Foreland and calculates geometric consistent 3D-modells of all Pleistocene meltwater terraces of pre-Riss age. The aim of the recent study is to establish a stratigraphic and paleogeographic concept of the Iller glacier Foreland using three-dimensional models of the terraces by Geographic Information Systems (GIS). In addition the paleoenvironmental conditions are reconstructed by numerous sedimentologic and petrographic data. The innovative concept is the use of hydraulic basics for the three-dimensional modelling of fluvial terraces. The hydraulic parameters support stratigraphic correlations of terrace occurrences as well as paleogeographic reconstructions. By using GIS-supporting software exact maps, cross-sections and 3D-views are calculated.

Five terrace levels from the Biber glaciation and seven from the Donau glaciation are described indicating piedmont glaciations during the Lower-Pleistocene. During the Biber the southwest-northeast oriented Iller valley shifted northward. A change of the main flow direction of the river Iller happened before Donau 4. Prior to the Brunhes/Matuyama boundary wide areas between the cities of Ulm, Augsburg and Memmingen are covered with glaciofluvial gravels, which can be subdivided into several accumulations by means of petrography. A further change in the flow direction took place prior to the Günz glaciation and was supported by local brooks, which was occupied by meltwater. The new orientation of the valleys used by the meltwater, that originates from the Iller glacier, was to the north. During the Haslach iceage, which is correlated with the Cromerian, the ice advance came to its maximum. The Mindel glaciation is subdivided into three stades characterised by distinct ice advances. During the stade Mindel 1 the high stand of the Iller glacier can be recognized. Paleosoils mark the stratigraphic boundaries of the Mindel to the Haslach and the next younger iceage, called Paar. From Mindel 1 till Mindel 3 the main outlet of meltwater moved from the glacial tongue basin of Obergünzburg westward to the Kempten basin. The Paar ice age is defined as a distinct stratigraphic unit between Mindel and Riss by a paleosoil (Mindel-Paar Interglacial) and glacialic sediments.

Sediment budget of Pliocene and Quaternary unconsolidated deposits of the Rheingletscher area, Swiss Midlands and the Upper Rhine Graben.

M. Hinderer (coordinator), J. Lämmermann-Barthel

Institut für Angewandte Geowissenschaften, Technische Universität Darmstadt,
Schnittspahnstr. 9, 64287 Darmstadt, Germany

D. Ellwanger, I Neeb

Landesamt für Geologie, Rohstoffe und Bergbau, Albertstr. 5, 79104 Freiburg,
Germany

M. Frechen

Leibniz Institute for Applied Geoscience, GGA-Institut, Stilleweg 2, 30655
Hannover, Germany

The Pliocene and Quaternary unconsolidated rocks of the Alpenrhein valley/Bodensee amphitheatre, Hochrhein, Swabian terrace landscape, Swiss Midlands, and the Upper Rhine Graben together with its Alpine drainage areas represent an almost closed denudation-accumulation system. Based on a newly developed combined stratigraphy valid in all five landsystems and a voluminous data base (e.g. drillings, outcrop studies, mapping, seismics, pollen analysis) the sediment volumes of a minimum of four megacycles will be quantified during the total runtime of the project by using an electronical data base and GIS techniques. New insights are expected into (i) the morphodynamic response of the Alps to climate change and the interplay with their uplift, (ii) the mechanisms of the growth and decay of Alpine foreland glaciers, (iii) the morphogenesis of the Alpine foreland inclusive changes in the drainage pattern, (iv) the correlation of the Alpine sedimentary record with extra-Alpine continental regions and the marine record, (v) new concepts of sequence stratigraphy in discontinuous continental deposits, (vi) the reasons and the magnitude of the global increase of terrigenous sediment fluxes in the Quaternary. In the second period of the project most effort is put on the control of the stratigraphic framework by OSL and TIMS U/Th dating and the set-up of a GIS for the key regions Alpenrhein/Bodensee amphitheatre and the southern Upper Rhine Graben. We plan to present a first sediment budget for the mid- to late Pleistocene major glacial cycles in these regions at the end of the second running period.

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IGCP 449 Activity in Hungary

Annamaria Nador

Geological Institute of Hungary
H-1143 Budapest, Stefánia 14. (nador@mafi.hu)

With information supplied by Dr. Gyula Gábris

Eötvös Loránd University, Department of Physical Geography
H-1117 Budapest, Pázmány P. sétány 1/c (gabris@ludens.elte.hu)

During the course of IGCP 449, research has been focused on the thick Pleistocene fluvial succession in the central and eastern part of the Pannonian Basin. Our results have been presented at the IGCP Annual Meetings in Prague (April 2001), Agadir (December 2002), at the INQUA Congress in Reno (July 2003), at the 22th IAS Regional Meeting in Opatija (September 2003) and in the Final IGCP 449 meeting in Malaga (December 2004). Gyula Gábris and Annamaria Nador have written a synthesis paper on the Hungarian fluvial record for the IGCP 449 special issue of *Quaternary Science Reviews* (currently in review).

Hungarian IGCP 449 activity can be summarised under the following project headings:

Large-scale cyclicity and sequence stratigraphy

Based on the complex sedimentological and paleontological analysis of continuous cored boreholes, previous studies (Nádor et al. 2000, 2003) revealed a 100 and a 40 kyr cyclicity in the nearly 500 m thick Pleistocene fluvial sequence at the eastern part of the Pannonian Basin. Based on subsurface facies analysis and interpretation of some 60 water-prospecting wells in the same area, a basin-scale facies mapping of the overall Quaternary sedimentary succession was carried out. On several areas dominated by multi-storey sandy channel fill sediments, the pre-existing channel-belts can be reconstructed. In the deepest central part of the basin muddy floodbasin (floodplain and wetland) sediments are dominant. In the eastern part the well-log patterns show the distal part of an alluvial fan where sandy sheet-flood deposits alternate with floodplain sediments.

Interpreting the alluvial depositional elements, different facies types and facies associations were recognised, showing characteristic stacking patterns on the logs. The recognised facies associations show 40-100 m thick fining upward fluvial cycles. The most characteristic and ideal cycles can be observed in the area of the former channel belts and in the proximal floodplain zone. The basal member of the cycle is made up of multi-storey channel fill beds cutting into the underlying floodplain deposits. This is overlain by an alternating sandy-muddy succession of channel fill and floodplain deposits forming the intermediate member. The upper member is composed of silty-clayey floodplain deposits sometimes with very thin discrete silty-sand bodies. These three members represent a fining upward sedimentary cycle and was interpreted as low-, increasing- and high accumulation space deposits respectively. As the basal multi-storey channel fill sandstone facies association generally lies above an extensive erosional surface which can be correlated regionally in the basin, allocyclic controls can be assumed. In some parts of the basin this ideal cycle is not complete, as the incised channels can be single, so the low

accumulation space deposits can be missing and the high accumulation space deposits (i.e. aggrading floodplain sediments) can be truncated. In regional scale six extensive cycles were differentiated above each other. Although these cycles were allocyclic, it is still an open question if they were tectonically or climatically driven. However, the fact that six of them have been identified suggests that they represent large-scale 400 ky Milankovitch cycles during the Pleistocene.

Neotectonic study of the basin margins and tectonic control on fluvial sedimentation

The eastern part of the Pannonian Basin represents a key-setting of a transitional zone from uplift to subsidence. A detailed analysis of seismic profiles, supporting with digital elevation models, geological cross-sections, and neotectonic field data showed, that NE-SW to E-W striking faults, connected with basement highs correspond to the previously analysed paleo-river morphologies. A preliminary conclusion is that tectonics was an important allogenic control on the development of river dynamics that manifested in the form of alternating meandering and braided patterns.

The other study area, the Somogy Hills is the western marginal area of the Pannonian Basin, which is a slightly hilly area elevated by 200-300 metres above the sea level, are located immediately south of Lake Balaton, Hungary. 90% of it is covered by Quaternary formations, but outcrops are relatively scarce, in spite of the well developed dissected morphology. It has two well defined valley systems: (1): few tens of kilometres long and nearly parallel „transversal” valleys with N-S to NNW-SSE direction, (2): „longitudinal” valleys of NE-SW – E-W strike.

The ideas about the neotectonic behaviour of this area can be divided into four groups.

1. The neotectonics is characterised by normal faulting, vertical displacement and tilting.
2. The tectonics of young sediments is dominated by folds with axes oriented in E-W direction.
3. The third model treats the structures as thrusts resulting of NW-SE compression.
4. The origin of the neotectonics is an E-W directed dextral shear zone in the crust.

We analysed Quaternary and directly underlying Late Miocene (Pannonian) outcrops by structural, tectono-morphological and sedimentological methods to quantify the main fault directions, to separate mass movements from faulting and folding and to separate earthquake-induced sediment deformations from other (e.g. periglacial) effects.

Quaternary outcrops showed several consistent directions of faulting, and co-depositional seismic activity (seismites). Three different Mohr-sets of faults could be differentiated in Quaternary sediments. In Pannonian outcrops four different sets were separated, three of which are common to Quaternary ones. The three sets are considered Late Quaternary since all cut young loess sections and have morphological expressions.

On the basis of the microtectonical measurements and morphotectonical investigations the following sequence of events can be explained:

1. ENE-WSW Late Pleistocene compression with NWN-SES striking folds. Morphologically it corresponds to the transversal valley system.

2. NNW-SSE Late Pleistocene compression. Morphologically it corresponds to the longitudinal valley system with overthrusting along the valleys. In theory it can be earlier than the phase 1 st.

3. NW-SE Late Pleistocene – Holocene compression. In the transversal valleys NNE-SSW striking en echelon folds, normal and Riedel faults can be detected. Both affected the present day surface. Riedel faults can be seen as renewed small valleys opening since the last decade until present. On the basis of the fault and fold patterns these movements refer to a marked left lateral transpression along the transversal valleys. NE-SW – E-W longitudinal valleys show right lateral strike slips at the same time.

Two hypotheses are presented to explain this richness in fault sets. The first supposes subsequent development of fault sets due to a change in external stress directions. The second, based on recent stress measurements in the Pannonian Basin, supposes coexistence of differently oriented stress-fields, which are temporarily active and which create their respective fault sets. In a geological time scale the development of several, differently oriented fault sets could be synchronous. The present day a left lateral transpression lead the (re)formation of the transversal valley systems.

An integrated study of the Quaternary fluvial sequences of the Körös Basin, SE-Hungary

A complex study of the thick and continuous Quaternary fluvial sequences (400-500m) in the Körös Basin, E.Hungary, is the focal research topic of the Department of Basin Analysis of the Geological Institute of Hungary (Annamaria Nador). This ongoing research programme includes the detailed study of boreholes, focusing on a cyclostratigraphic approach, and a complex sedimentological, paleontological, geochemical and geochronological investigation of a new fully cored 300 m deep borehole, drilled in 2001. The alluvial architecture of the thick fluvial sequence at basin scale is studied by the correlation of numerous well logs, a sequence stratigraphic approach contributes to the better understanding of continental sequence stratigraphy. The origin of the fluvial sediments and the former transport directions are studied by micro-mineralogical methods. The latest phase (Holocene) of drainage pattern development and its neotectonic control is studied by the interpretation of aerial photographs, digital elevation models, as well as field observation and seismic profiles. The most important results of this research are as follows:

Interplay of climate and sediment supply control on the Pleistocene fluvial sedimentary cycles

An almost 500 m thick sequence of cyclic fluvial sediments in the south-eastern part of the Pannonian Basin have been preserved due to continuous basin subsidence. Magnetostratigraphy has revealed that the sediment sequences span the last 2.6 Ma. Average grain size distribution (Mz) and magnetic susceptibility (MS) were measured and studied in two key boreholes (Dévaványa D-1 and Vésztő V-1). By comparing the Mz and MS records with the ODP 677 $\delta^{18}\text{O}$ proxy, it was shown that despite the

two vastly different environments, the inter-mountain fluvial Pannonian Basin and the ocean, the sedimentary cycles of the D-1 and V-1 boreholes clearly show a cyclicity of 100 kyr for the borehole succession younger than 1 Ma, and a 40 kyr cyclicity down to the bottom of the Matuyama, similarly to the marine record, showing there was an orbitally forced control on the fluvial sedimentation.

Pollen and gastropod data, as direct paleoclimate indicators, have been used to calibrate the magnetic susceptibility proxies of the boreholes. It was shown that in almost all cases, paleontological data indicating a warm climate corresponded to high values of susceptibility, while pollen and molluscs indicating a cold climate correlated with low susceptibility values. Based on this correlation, and the good fit of the MS borehole records and the ODP 677 $\delta^{18}\text{O}$ proxy, a major conclusion is that the sedimentary cycles clearly represent climate driven Milankovitch cycles.

A close correlation was also found between the average grain size distribution (Mz) and the magnetic susceptibility values. Sands and coarse silts generally had high values of magnetic susceptibility, while silts and clays normally carry low MS values. Mineralogical analyses showed that the main cause for high susceptibility is magnetite.

The correlation between average grain size distribution and climate indicator MS records led to the development of a model which describes the variations in fluvial sediment supply to the basin between dry glacial periods as opposed to that characterising more humid interglacials. The model emphasises the differences between the proximal and the distal parts of a basin during both warm and cold climate periods due to the time lag caused by erosion and subsequent deposition of the sediments. In the studied Körös-sub basin major sand was deposited under interglacials due to the high average precipitation and transport capacity of the rivers, which were able to carry sediments to the distant parts of the basin. During cold climate periods, only limited, fine grained sediments reached the distal part of the basin, while coarse grained alluvial fans were restricted to the basin margin.

A new 300 m continuous record of a Pleistocene fluvial sequence: Tiszainoka-1 borehole

In 2001 a 300 m deep continuously cored borehole was drilled by the Geological Institute of Hungary (Tiszainoka-1) (Fig. 7) near to the confluence of the Körös and Tisza rivers, where a thick Pleistocene sequence is expected on the basis of nearby borehole data and seismic sections. A special drilling technique (a triple core barrel) provided nearly full core recovery of the semi-soft sediments with 10 cm core diameter. The core was macroscopically described then cut in half, one half stayed for documentation. The other half was sampled for the following analyses:

Type of analysis	Sampling interval
Magnetostratigraphy	2.4 m
Grain size distribution	20 cm
Magnetic susceptibility	20 cm
Pollen	20 cm
Diatoms	20 cm
Molluscs	20 cm
Other macrofossils (vertebrates, macroplant remnants, etc.)	20 cm
Geochemistry	From each strata, but min. at 1 m

Laboratory analyses are ongoing in Hungary, but any interest for further analyses or on the cores are welcome.

Alluvial architecture analysis based on well-log interpretations

A basin-scale facies mapping and alluvial architecture analysis was based on subsurface facies analysis of well logs of numerous water prospecting wells. Interpreting the different alluvial depositional elements, various channel types were identified. On several areas dominated by multi-storey sandy channel fill sediments the pre-existing channel belts can be presumed. In the central and deepest part of the basin muddy floodbasin (floodplain and wetland) sediments are dominant. In the eastern part the well-logs show sandy sheet-flood deposits alternating with floodplain sediments.

In addition to the areal distribution of the different facies, several facies associations were recognised in the fluvial succession with characteristic stacking pattern above each other. The basal unit is made up of multistorey channel fill beds cut into the underlying floodplain deposits. This is overlain by the alternating sandy-silty succession of channel fill and floodplain deposits forming the intermediate facies

association. The upper facies association comprises silty-clayey floodplain deposits sometimes with very thin, isolated silty-sandy bodies. These facies associations are superimposed into a vertical succession. This threefold division represent a fining upward sedimentary cycle and was interpreted as an increasing rate in the accumulation space and correspond to lowstand, transgressive and high stand systems tracts in sequence stratigraphic terms. As the basal multistorey channel fill sandstone facies association generally lies above an extensive erosional surface, which can be correlated regionally, a sequence stratigraphic approach was introduced. In a regional scale six mega-cycles, comprised of this threefold facies associations were identified. These cycles were allocyclic, but it is still an open question if they were tectonically or climate driven. However, the fact that six mega-cycles represent the whole Quaternary, strengthen the probability that they represent 400 ky Milankovitch cycles during the Quaternary.

For further information contact:

Dr. Györgyi Juhász
Geological Institute of Hungary
H-1143 Budapest, Stefánia 14. (juhaszgy@mafi.hu)

Transport directions based on heavy mineral studies

Changes in transport directions in the Pleistocene fluvial sediments on the south-eastern part of the Pannonian Basin have been studied by cluster analysis of detrital heavy minerals from modern rivers and two key boreholes covering the whole Pleistocene period. Samples within the same cluster have a similar composition, and they originated from the same source area. Based on a similar paleogeographical setting of the potential source areas during the Quaternary, the present transport directions of the rivers with a well known catchment area geology and heavy mineral composition have been extrapolated to the Pleistocene borehole data. The results of cluster analysis showed that the samples group into two major clusters, and within those, some sub-clusters. Cluster I is characterised by hornblende, orthopyroxene, epidote, garnet and magnetite. Within this group, sub-cluster Ia is characterised mostly by hornblende, orthopyroxene and epidote, indicating a SE transport direction. Sub-cluster Ib is characterised by a high garnet content, referring to a NE transport direction. Cluster II is characterised by a high chlorite content, which is not known from the present river sediments, but it is supposed to have a north-eastern origin.

In the D-1 and V-1 boreholes, there is a clearly defined change in the detrital heavy mineral composition at about 1.95 Ma characterised by the occurrence of epidote and hornblende minerals indicating a switch in provenance areas and a change in transport direction from a north-eastern to south-eastern one. This time coincides by an increased sediment flux to the basin, shown by the higher rate of sedimentation.

Due to the inter-mountain basin setting, the Pleistocene fluvial sediments under discussion share the same regional subsidence, where base-level changes were unaffected by eustatic changes. The Pleistocene climatic signal is preserved in the sediment record as 5th order Milankovitch cycles, identical in the two boreholes, therefore climate can also be considered as a regional influence on the river systems of the area. Variations in transport direction, determined on the basis of detrital micro-mineral composition, as revealed by cluster analysis were caused by changes

in sediment supply, source areas, and drainage pattern reorganisation. These changes have been shown to be comparable to transport directions predicted on the basis of a theoretical tectono-morphological model, based on sedimentological observations and tectonic data, as well as on analogues for basin evolution with similar stress fields.

The tectonic model implies two phases of uplift of the Apuseni Mountains source area during the Late Neogene and Quaternary, which was strongly controlled by the evolution of the subduction zone along the East Carpathians. During the Pliocene and Early Pleistocene, due to continent-continent collision, a compressional stress field was operating in the East Carpathians region, which resulted in thrust-driven uplift of the Apuseni Mountains and the formation of a syn-sedimentary trap at the western margin of the mountain chain. For this phase transverse drainage is envisaged, characteristic for actively uplifting orogens, whose sediments have been captured in the thrust fault bounded syn-sedimentary trap, parallel to the mountain front. In addition to capturing the sediments of the transverse rivers, this trap favoured the development of axial drainage, and sediments were transported from the NE to the study area, also inferred from micro-mineralogical data of detrital heavy minerals. The second phase of uplift of the Apuseni Mountains was characterised by an erosion driven, isostatic uplift, due to the relief of the compressional stress field, resulting from the waning collision. As a result the trap ceased to be active and was filled up rapidly by the sediments of the transverse rivers, and also allowed the spread of alluvial fans over the basin to the west. This is indicated by the occurrence of SE transport directions in the boreholes at about 1.95 Ma ago, which also gives the timing for the tectonic processes.

For further information contact:

Dr. Edit Thamó-Bozsó
Geological Institute of Hungary
H-1143 Budapest, Stefánia 14. (bozso@mafi.hu)

Drainage pattern reconstruction: neotectonic control on changes in river dynamics during the Holocene

The reconstruction of the paleo-drainage system of the Körös Basin was mostly based on the interpretation of aerial photographs, of 1:60 000 scale, covering an area of about 4000 km², and digital elevation models edited from 1:10 000 scale topographic maps for certain areas. Due to the lack of C14 data, a large number of Neolithic finds were used to give a time constrain on certain processes. Finally for the tectonic interpretation seismic profiles were also used to depict young faults for the area.

Three characteristic channel types were recognised (using aerial photographs): (1) large meanders, where the lateral accretion of the belts is represented by bundles of oblique, or sigmoidal parallel clinofolds, referring to point bar development, (2) a dense network of much smaller size meander like little loops, which were interpreted as remnants of an anastomosing type river, and (3) linear arrangements of morphological heights and lows, which were interpreted as remnants of a former braided river.

These paleo-channels are clearly arranged in three roughly E-W striking zones, which turn gently to a NW-SE strike, and very sharp boundaries separate these zones from each other. The large meanders are found on the north, in the central

zone is characterised by the so-called anastomosing pattern, while on the south the braided pattern occurs. The main question is the link between these zones. Do they represent the paleo-channels of three different rivers, as it was assumed in the previous works, or they possibly show a chronological development of one river system. The main controls on the development of such different river patterns also have to be understood.

Dating has made use of archeological evidence. The area was densely populated by different Neolithic cultures (who turned up in the Early Atlanticum in the Pannonian Basin), which had a very strong link to the fluvial systems as they settled down on the highest parts of interfluvial areas, which were not prone to floods, and they also stayed nearby the rivers, as this was the major route for transportation, fishing etc. These Neolithic finds are common in the northern zone of large meanders and in the central zone of the anastomosing pattern, but there are no settlements on the southern braided zone. This gives some sort of time constrain: it can be concluded that the southern braided zone was already inactive during the Atlanticum, which means its formation was pre-Atlantic, and the meandering and anastomosing zones may have an age of Atlanticum–Early Subboreal, or younger.

The relative chronology of the three different zones is also supported by morphological differences: The S-ern braided zone is found at the highest topographic position at 88-89 m asl and there is a 3-4 m morphological step separating it from the anastomosing zone which is found in the deepest part at 85-86 m asl. The anastomosing zone is separated from the northern zone of large meanders which is found at 87 m asl also by a sharp morphological step.

According to our model on river development, the first stage of river development was characterised by a braided pattern and the age is somewhat pre-Atlantic, based on the lack of Neolithic finds. Then a neotectonic faulting caused a step, and the next stage of river development occurred at a lower topographic height, characterised by a meandering river style. In other words this meandering river was flowing on the subsided former braided plain. The question if the change from braided to meandering was caused by climate change or also by tectonics still needs further investigation. Anyhow many other studies on Holocene river development throughout Europe suggest climate controls on river development between the Boreal and the Atlantic periods.

The next stage of development included another neotectonic faulting which further lowered the topography and led to the formation of the present lowest part of the alluvial plain, which was a sort of minor depression between the former braided and meandering zones, and was occupied by a river system of an anastomosing pattern, which was flowing on the subsided former meandering plain, underlain by the oldest braided plain remnant. This deepest zone had a very low gradient and could have represented a very similar pattern to the historical times with swampy environment, so all conditions for the development of an anastomosing river pattern were given.

The climate controlled models on river development of Vandenberghe suppose incision phases between changes in river style from braided to meandering under changing climate, which could have also led to the formation of these morphological steps, however in this case the very sharp boundaries between these zones, and all other evidences for neotectonic activity on this area rather favour a tectonic control, as a primary factor.

For further information contact:

Dr. Árpád Magyarai
Geological Institute of Hungary
H-1143 Budapest, Stefánia 14. (magyari@mafi.hu)

Late Pleistocene-Holocene river development in the Middle Tisza Region

A detailed study of the Late Pleistocene-Holocene river development in the central part of the Tisza river and its surroundings have been carried out at the Department of Physical Geography, Eötvös Loránd University, Budapest. A PhD thesis discussed the development of the Sajó-Hernád alluvial fan (northern part of the middle Tisza region) in 2002.

The Late Pleistocene-Holocene development of this area can be divided into nine major phases, extending from the Upper Pleniglacial (sand ridges and covering loess) through Lateglacial braided and meandering river deposits to the meander products of the Holocene floodplain.

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IGCP 449 2003 Activity in Lithuania

Petras Sinkunas

Project participation from Lithuania has been consistent, with attendance of meetings in 2000 (Flag, Mainz), 2002 (Australia) and 2004 (Malaga, final IGCP 449 meeting).

The investigation team comprises the following scientists from the Department of Quaternary Research, Institute of Geology and Geography. T. Sevcenkos 13, LT-2600, Vilnius, Lithuania, kvartgeo@geologin.lt <http://www.geo.lt/>

Ass. Prof. Petras Sinkunas (sedimentology),

Dr. Vaida Seiriene (diatom analysis)

Dr. Migle Stancikaite (pollen analysis),

Dr. Dalia Kisieliene (plant macrofossils),

PhD Vaiva Barzdziuviene (sedimentology),

PhD Sonata Gadeikyte (computer modelling, Vilnius University).

A further team operating from the Department of Natural Sciences, Vilnius University, has also contributed to the project, comprising: Leader: Algirdas Gaigalas; Members: Vytautas Dvareckas, Albinas Pilipaitis, Vaidotas Kazakauskas, Monika Melešytė

Investigations within the IGCP 449 project have focused on the palaeogeography of fluvial sedimentation during the interglacial and interstadial time span of warm climate in Lithuanian territory which was repeatedly glaciated during the Quaternary.

Research of interglacial palaeogeography was carried out to ascertain the distribution of the lithofacies and depositional conditions during the interglacials to reveal the character of fluvial systems existed. All the geological and geomorphological information from about 3000 boreholes was prepared for palaeogeographical reconstructions of Holsteinian and Eemian Interglacials. For this purpose the structure of all glacial sequence in territory was analysed as well. Lithological and palaeobotanical data were analysed and interpreted. Various topographical, geological, geomorphological and interglacial sediment distribution schemes were compiled to derive the information on the pattern of fluvial sedimentation. The schemes of fluvial sedimentation at a scale 1:1 000 000 are under the preparation. Field investigations in outcrops of River Neris were carried out to test the results obtained earlier and to take sediment samples for dating, palaeobotanical and lithological study. The fluvial environments existed prior to the glaciation of the territory preliminary studied in the numerous Neogene outcrops along the seacoast of Sambia peninsula in Kaliningrad district, Russia. The Holocene fluvial-lacustrine systems are under the investigation as well as related archaeological sites.

Lithuanian State Science and Studies Foundation supported investigations within the IGCP 449 project in 2003. Some work was done within the project "Reconstruction of palaeogeographical and palaeoecological conditions of Anthropogen" implemented by the Department of Quaternary Research at the final stage of the State scientific program "Litosphere" (1997-2003) which was conducted by Institute of Geology and Geography.

Further investigations

The research already done demonstrates that the dense net of boreholes and outcrops of deeply incised Holocene rivers in Lithuania allows to compile the digital spatial model of Quaternary sequence. Such a model based on thousands of boreholes after the lithostratigraphical correlation of deposits and its facial analysis allowed interpolating the interglacially related palaeosurfaces of the deposits. The available database on the aquatic sediments investigated by means of plant-fossils in hundreds of sites and sedimentologically investigated sediment sequences from the outcrops supported this as well. Using the digital spatial model of Quaternary sequence together with the results of sediment study is planned to investigate the change of the palaeohydrological pattern during the Quaternary.

Field investigations in outcrops are planned to test the results obtained and to support further interpretations. The Neogene and Quaternary fluvial environments existed before the glaciations became of great interest as well. By this reason the study of numerous Neogene outcrops along the seacoast of Sambia peninsula in Kaliningrad district will be continued. Also the Holocene fluvial-lacustrine systems will be under the investigation as well as related archaeological sites.

The application for the financial support for the research in 2004 is planned to be sent to the Lithuanian State Science and Studies Foundation as well.

Other meetings:

6th European Paleobotany-Palynology Conference, August 29-September 3, 2002, Athens, Greece.

The 5th Baltic stratigraphical Conference "Basin stratigraphy—modern methods and problems". 2002, Vilnius, Lithuania.

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IGCP 449 activity in Papua New Guinea

R.H. Findlay

Assistant Director, Geological Survey of PNG, Port Moresby, Papua New Guinea.
Email: rhfindlay@hotmail.com

I finally succeeded in attending a project meeting by participating in the final meeting in Malaga, December 2004. During the conference I delivered an oral paper on aspects of fluvial development indicating very rapid uplift in PNG and a poster on the fluvial geohazards resulting from rapid uplift (9mm/yr) in the Finisterre Mountains of northern PNG. I used the conference to invite collaboration with the GSPNG and I proposed to Dr Westaway that he consider carrying out work in PNG with the GSPNG as part of the EU-sponsored SYSMIN geological mapping and aeromagnetic programme starting in 2005.

Publications

I anticipate publishing the oral paper through the auspices of IGCP449. The work behind the poster has already been submitted to a previous IGCP 449 publication.

Oral presentation: Fluvial geomorphology as an indicator of extremely rapid uplift in Morobe Province, Papua New Guinea.

The meeting created the opportunity for collaboration between the European workers and the GSPNG to study fluvial processes and neotectonics in PNG.

IGCP 449 2003 Activity in Morocco

**ALI AIT HSSAINE,
Département de géographie, Université Ibn Zohr
Agadir, Morocco**

The highlight in Moroccan project participation was the convening of the 3rd Annual International Meeting of IGCP 49 in Agadir during December 2002.

Ali Ait Hssaine attended several other meetings, notably the FLAG meeting in Clermont Ferrand (September 9-14th, 2002) and the final IGCP 449 meeting in Malaga (December 2004). At Clermont Ferrand the Moroccan contribution involved a communication on the relevance of the Taroudant badlands in the context of planetary climate change and the application of dating methods, effected in collaboration with the University of Montréal (Canada). In Addition, Le Colloque International sur les "Espaces marginaux" took place in Sfax (Tunisia) March 6-8th 2002. The Moroccan IGCP group contributed on the topic 'Mutations d'un espace en bordure du désert par voie d'exploitation massive de ses ressources hydriques: la vallée du Souss, Maroc'.

The group intends to continue research on fluvial systems in semi-arid and arid regions, notably the Wadi Souss and its affluents, their response to tectonic activity, desertification, problems of water shortage and other environmental problems in this region. This continued research will contribute to follow-up project IGCP 518.

Publications:

Bhiry, N. & Occhietti, S. 2004. Fluvial sedimentation in a semiarid region: the cone and intercone system of the middle Souss Valley, Morocco. *Proceedings of the Geologists' Association*, 115, 313-324.

Boudad, L., Kabiri, L., Weisrock, A., Wengler, M., Fontugne, M, El Maataoui, M., Makayssi, A. & Vernet, J.-L. 2003. Les formations fluviatiles du Pléistocène supérieur et de l'Holocène dans la « Plaine » de Tazoughmit (Oued Rheris, piémont sud-atlasique de Goulmima, Maroc) [*Upper Pleistocene and Holocene fluvial sedimentation in the « Plain » of Tazoughmit (Oued Rheris, High Atlas southern piedmont of Goulmima, Morocco)*]. *Quaternaire*, 14, 139-154.

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Wengler, L., Weisrock, A., Brochier, J.-A., Brugal, J.-P., Fontugne, M., Magnin, F., Mathieu, J., Mercier, N., Ouammou, A., Reyss, J.-L., Senegas, F., Valladas, H. & Wahl, L. 2002. Enregistrement fluviatile et paléoenvironnements au Pléistocène supérieur sur la bordure atlantique de l'Anti-Atlas (Oued ASSAKA, S-O marocain). *Quaternaire*, 14, 179-192.

IGCP 449 Activity in the Netherlands

Tom Veldkamp

Scientists from the Netherlands have been consistently active participants during the life of IGCP 449, in particular with regular attendance of FLAG meetings with their IGCP components – as well as INQUA 2003 in Reno, Nevada. This activity culminated in the organization of the final project meeting in Malaga, Spain, by the Dutch team from the University of Wageningen, (leader, Jeroen Schoorl) based on their ongoing work in that part of Europe. This meeting was also attended by Meidert van den Berg; he, Veldkamp and others will be contributing to the special issue of *Quaternary Science Reviews* that arises from the project.

The extensive Quaternary fluvial deposits of the Netherlands comprise both layer-cake depositional sequences in the subsiding northern part of the country and the terrace staircase of the River Maas in the uplifting southern part. Both environments are currently being intensively researched. Boreholes in the subsiding northern region penetrate numerous Quaternary fluvial depositional sequences, both cold-stage gravels and temperate organic deposits that yield plant and small mammal remains.

A major ongoing research objective is to tie this record to the global chronology of oxygen isotope variations from the oceans. A significant milestone in this work was the OIS 11 conference, under the auspices of the SEQS (Subcommission of European Quaternary Stratigraphy), in Leiden, 14-15/7/02. Quaternary scientists based in the Netherlands are increasingly falling into line with the rest of the scientific community in correlating OIS 11 (not OIS 9) with the Holsteinian interglacial, which post-dates the Elster glaciation that is OIS 12 (not 10).

The uplift history revealed by the Maas terrace staircase continues to attract attention. The publication of several quantitative chronologies (Van den Berg and Van Hoof, 2001; Westaway, 2001; Van Balen et al., 2001), all contributions to IGCP 449 and which each differ, has focussed attention on the need to establish a definitive chronology. Work by RW thus began in 2002, to correlate the reach of the Maas in the Netherlands with its upstream counterpart in Belgium.

Publications:

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- Kooi**, H. 2001. Land subsidence due to compaction in the coastal area of The Netherlands: the role of lateral fluid flow and constraints from well-log data, *Global and Planetary Change*, vol. 27 Pages 207-222.
- Meijer**, T. and Preece, R.C. 2000. A review of the occurrence of Corbicula in the Pleistocene of North-West Europe. *Netherlands Journal of Geosciences*, 79, 241-255.
- Mol**, J., Vandenberghe, J. & Kasse, C. 2000. River response to variations of periglacial climate in mid-latitude Europe. *Geomorphology*, 33, 131-148.
- Nivière**, B. and Winter, T. 2001. Pleistocene northwards fold propagation of the Jura within the southern Upper Rhine Graben: seismotectonic implications, *Global and Planetary Change*, vol. 27 Pages 263-288.
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IGCP 449 ACTIVITY IN POLAND

Leszek Marks

Scientific achievements

- Study of the Pleistocene fluvial sequences in the Polish-Belarusian cross-border region;
- Based on previously presented procedure, concise review of the Middle and Late Pleistocene fluvial pattern reconstruction was completed for central Poland and its correlation with the Polish-Belarusian cross-border region was presented;
- L. Marks contributed to the XVIth INQUA Congress in Reno, Nevada, 23-30 July 2003, with a poster (co-authored by I.E. Pavlovskaya from Belarus) on *Correlation of Holsteinian fluvial series in Poland and Belarus*, presented during the Poster Session No. 3 *Fluvial Archives of Environmental Change* and published in the Abstract Volume;

Vistula Drainage Basin

In 1996-1999 research on the Vistula valley fluvial archives has been supported by grants of the Polish Geological Institute and the Warsaw University. The new research undertaken in this context has focused on examination of various fluvial sequences. Two basic procedures were applied for reconstruction of the Middle and Late Pleistocene drainage system in Poland. The first combined the local data comprising lithology and geological setting of fluvial deposits. The second examined regional relationships between fluvial series, their respective underlying and overlying deposits, and incorporated distant correlation with the Pleistocene marine sediments in the Baltic Basin. These analytical data were supplemented with information from numerous published and unpublished sources.

Most Pleistocene fluvial sediments do not outcrop at the land surface in central Poland and can be analysed only in the boreholes. Among these, research boreholes for a Detailed Geologic Map of Poland (scale 1:50,000) created the foundations for an accurate spatial correlation of buried fluvial sediments. Lithological evidence from the research boreholes was supplemented with geologic information from sheets of this map and other published sources, critically revised. The resulting reconstruction of the Middle and Late Pleistocene palaeovalley system is based on a variety of geologic evidence, but it is still incomplete in many places, particularly to the east of Warsaw.

L. Marks attended the SEQS-INQUA Conference in Ufa (Russia), 30 June – 7 July 2002, with an oral presentation on *Transformations of the fluvial drainage system in Poland during the Pleistocene*, published in the Abstract Volume.

Three project-related papers were in press during 2002.

Proposed activities

- The mapping project (Detailed Geologic Map of Poland, 1:50,000) funded by the Polish Fund for Environmental Protection is in progress and it will supply with primary information on buried fluvial sediments.
- The studies can bring original contributions to the Global Correlation of Late Cenozoic Fluvial Deposits programme connected with transformations of the

fluvial network and migration of the watershed between the Baltic and the Black Seas during the Pleistocene.

Ongoing research relevant to the project:

- Preliminary arrangements were undertaken in 2003 to hold an international workshop in Poland to discuss correlation of the Pleistocene river systems in several countries of central and eastern Europe namely Belarus, Germany, Lithuania, Latvia, Poland and Ukraine. This workshop has been postponed to the very beginning of 2004. Discussion during the workshop is expected to found the basis for palaeogeographical reconstruction for the Pleistocene river systems in the area of the participating countries.
- The mapping project (Detailed Geologic Map of Poland, 1:50,000) funded by the Polish Fund for Environmental Protection is in progress and it keeps supplying with original contribution for accurate spatial correlation of buried fluvial sediments during the Pleistocene. Data are still incomplete in several areas, particularly in northern part of the country and to the east of Warsaw.

Publications:

MARKS, L., 2002. Transformations of the fluvial drainage system in Poland during the Pleistocene. INQUA-SEQS 2002 Conference *Upper Pliocene and Pleistocene of the Southern Urals Region and its significance for correlation of the eastern and western parts of Europe*. Volume of abstracts, Ufa, Publishers “Dauriya”: p. 50.

MARKS, L. 2004. Middle and Late Peistocene fluvial systems in central Poland. *Proceedings of the Geologists' Association*, 115, 175-182.

MARKS, L. 2005. Peistocene river systems in the southern peribaltic area as indication of interglacial sea level changes in the Baltic basinc. *Quaternary International*, 130, 43-48.

MARKS, L. & PAVLOVSKAYA, I.E. 2003. The Holsteinian Interglacial river network of mid-eastern Poland and western Belarus. *Boreas*, 32 (2): 337-346.

MARKS, L. & PAVLOVSKAYA, I.E. 2003. Correlation of Holsteinian fluvial series in Poland and Belarus. XVIth INQUA Congress, Reno, Nevada, Programs with Abstracts: 68.

STARKEK, L., 2003. Climatically controlled terraces in uplifting mountain areas. *Quaternary Science Reviews*, 22, 2189-2198.

IGCP 449 Activity in Russia

Valentina Drouchits

All Russian Meeting on Quaternary Research, September, 2002, Smolensk (organized by the Commission for Quaternary Research of the Russian Academy of Sciences)

Most of papers were devoted to European part of Russia. Some key sections on the area of Smolensk-Moscow elevation were visited during field excursion. Abstracts concerning the problems of IGCP-449 were as follows:

- Antciferova G.A. & Osipova O.M. - Mikulino (Eem) deposits of the Yachroma river valley in the northern part of Moscow region.
- Danilov A.B. - New sites of limnitic and terrestrial mollusks in Low Neopleistocene sediments of Upper Don basin.
- Iosifova Yu. I. - Middle Pleistocene climatic stratigraphy of Upper Don basin.
- Pakhomova O.M. & Okhorzin N.D. - Age and formation conditions of watershed alluvium in Upperkam elevation
- Starodubtcev N.V., T.F. - Tregub Stratigraphic division of Early Pleistocene on the basis of vegetation evolution in the Don river valley.
- Sycheva S.A. Dynamics of evolution of small rivers flood plains of Russian Plain in Holocene (on palaeosoil data)

Publications:

- Alekseev M.N. & Drouchits V.A. 2001. Climatic events of Kazantsev interglacial and Holocene in the eastern part of Russian shelf and Siberia. In. Bulletin of Russian Commission for Quaternary research N64, 78-88.
- Alekseev, M.N. & Drouchits, V.A. 2004. Quaternary fluvial sediments in the Russian Arctic and Subarctic; Late Cenozoic development of the Lena River system, north-eastern Siberia. Proceedings of the Geologists' Association, 115, 339-346.
- Andreicheva L.N. 2002. Stratigraphy and correlation for Pleistocene in the Bolshezemelsk tundra (river Tchernaya basin). // Stratigraphy and Geological Correlation. V.10, N 4, p.91-104.
- Babich D.B., Korotaev V.N., Magritckiy D.V., Mikhailov V.N. 2002. Low Indigirka: mouth and channel processes. Moscow. GEOS, 2001(end) 201p.
- Dodonov, A.E., Tchepalyga, A.L., Mihailescu, C.D., Zhou, L.P., Markova, A.K., Trubikhin, U.M., Sunakova, A.N. & Konikov, E.G. 2000 Last-interglacial records from Central Asia to the Black Sea shoreline: stratigraphy and correlation. Netherlands Journal of Geosciences, 79, 303-311.
- Ivanov V.V., Korotaev V.N., Svitoch A.A., Mikhailov V.N. 2002. Low Volga: geomorphology, palaeogeography and channel morphodynamics. Moscow, GEOS, 2002, 236 pp.
- Patyk-Kara, N.G. & Ivanova, A.M. In press. Evolution of placer formation on continental margins (Russia) and types of placer provinces. In: Special

- volume dedicated to academician I.S. GrambergTjubilee. Sankt-petersburb, VNII Okeangeologia press.
- Patyk-Kara, N.G., Ivanova, A.M.& Ushakov, V.I. 2002. Placer mineralogy of the continental shelf and inland seas of Russia (on paleogeographic basis). In: Geology and mineral deposits of shelves of Russia, 40 pp.
- Patyk-Kara, N.G. & Postolenko, G.A. 2004. Structure and evolution of the Kolyma river valley: from upper reaches to continental shelf. Proceedings of the Geologists' Association, 115, 325-338.
- Stefanovskiy V.V., Borodin A.V. 2002. Eopleistocene and Low Neopleistocene key section of Southern Transural.// Stratigraphy and Geological Correlation. V.10, N 4, p.79-90.
- Ufimtcev G.F., Shibanova I.V.,Kulagina N.V. Matshuk I.M., Perevalov A.V., Rezanova V.P., Fogt T., Ignatova N.V., Misarina V.A. 2002. Upper Pleistocene and Holocene sediments of Tunkin rift (Southern Pribaikal).// Stratigraphy and Geological Correlation. V.10, N 3, p.90-99.

Another significant publication, published at the end of 2002 by the “GEOS” publishing house, is the book “The Lower Volga: Geomorphology, Palaeogeography and Current Morphodynamics” (Moscow , GEOS, 242pp., 2002).

The planned regional meeting in Perm, Russia, was postponed until August 2005, and will now form the inaugural meeting of new IGCP Project 514 'Fluvial Palaeosystems: Evolution and Mineral Deposits'. It will be promoted as part of 449's follow-up project IGCP 518.

IGCP 449 Activity in Spain

Juan I. Santisteban Navarro

Meetings:

“*Quaternary Climatic Changes and Environmental Crises in the Mediterranean Region*”. Alcalá de Henares University. 15th-18th July, 2002.

Some remarkable presentations were:

Lateglacial and Holocene vegetational change in the Pyrenees and the central Ebro Valley (NE Spain). González-Sampériz, P.; Valero-Garcés, B.L.; García-Ruiz, J.M. & Martí, C.

Paleoclimatic evolution during the last glacial cycle at the NE of the Iberian Peninsula. Burjachs, F. & Allue, E.

Preliminary dating of glacial and fluvial deposits in the Cinca River Valley (NE Spain). Sancho, C.; Peña, J.L.; Lewis, C.; McDonald, E. & Rhodes, E.

Paleoflood magnitude and frequency in the context of the Late Pleistocene-Holocene climatic changes (Tagus River, Central Spain). Benito, G.; Sopena, A.; Sánchez-Moya, Y.; Machado, M.J. & Pérez-González, A.

“*Spanish Limnology Association XI Congress and Iberian Limnology III Congress*”, Madrid, 17th-21th June, 2002.

“*IV National Meeting on Geoarcheology*”. 16th-18th September, 2002. Almazán (Soria). Spanish Association on Quaternary Studies.

Some remarkable presentations were:

- *Reconstrucción paleoambiental y geoarqueológica del curso medio del Segre (Alòs de Balaguer, Lleida) durante el Pleistoceno superior e inicios del Holoceno superior*. M. M. Bergadà, J. L. Peña, R. M. Poch, D. Serrat & J. M. Fullola
- *Interpretación geoarqueológica de las terrazas aluviales del Pleistoceno medio del Guadalquivir (Cerro Higoso, Sevilla)*. J. A. Caro Gómez, F. Díaz del Olmo & R. Baena Escudero
- *Caracterización geoarqueológica de los depósitos cuaternarios del arroyo de la Gavia (cuenca del río Manzanares, Madrid)*. M. López Recio, H. Romero Salas, I. Manzano Espinosa, S. Escalante García, A. Pérez-González, J. Baena Preysler, E. Carrión Santafé, C. Conde Ruiz & R. Velázquez Rayón
- *Nuevos datos sobre los depósitos cuaternarios del río de la Femosa (sector artesa de Lleida-Puigverd) y sus industrias paleolíticas*. J.L. Peña, C. Sancho, M. López, J. Morín, F. Sánchez, R. Velázquez, M. Escolà, E. Carbonell, X.P. Rodríguez & C. Fernández
- *Puente Pino: un yacimiento achelense en Alcolea de Tajo (Toledo)*. J.M. Rodríguez de Tembleque, M. Santonja & A. Pérez-González

“*Palaeofloods, Historical Data & Climatic Variability: Applications in Flood Risk Assessment*”. 16th-19th October, 2002.

“*VIIIth National Meeting on Geomorphology*”. 12th-19th September, 2002. Valladolid.

“*XI Reunión Nacional sobre el Cuaternario*”. Oviedo University. 2th-4th July, 2003.

Research Projects:

- “*Analysis of recent evolution of the sediments, waters and biome on the Las Tablas de Daimiel National Park*”. DGICYT Project: REN2002-4433-

- C02-01. Subproject leader: Dr. Rosa Mediavilla (Spanish Geological Survey).
- “*Analysis of the climatic change during the last 3000 years on the sedimentary sequences of the Las Tablas de Daimiel National Park*”. DGCYT Project: REN2002-4433-C02-02. Subproject leader: Dr. M^a José Gil (Alcalá de Henares University).
 - “*Caracterización geomorfológica, sedimentológica y geoquímica de depósitos tobáceos fluviales cuaternarios y actuales de la cordillera ibérica: implicaciones paleoclimáticas y dinámica actual*” DGCYT Project REN2002-03575. 2002-2005. Project Leader: M^a Concepción Arenas Abad (U. Zaragoza)
 - “*Evolución de los extremos hídricos en la península ibérica en los últimos 500 años: recopilación de proxy-data y modelización regional en el litoral mediterráneo*”. DGCYT Project REN2002-04584-C04-03. 2002-2005. Subproject Leader: M^a del Carmen Llasat Botija (U. Barcelona).
 - “*Procesos hidrológicos en áreas seminaturales mediterráneas. Estudio de las variaciones espacio-temporales en sistemas adhesionados*”. DGCYT Project REN2001-2268-C02-02. 2001-2004. Subproject Leader: Susanne Cecilia Schnabel (Universidad de Extremadura).
 - “*Procesos hidrológicos en áreas semi-naturales mediterráneas*”. DGCYT Project REN2001-2268-C02-01. 2001-2004. Subproject Leader: Francesc Gallart Gallego (C.S.I.C.).
 - “*Incorporación de datos de paleocrecidas e inundaciones históricas al cálculo de la avenida de proyecto de presas*”. DGCYT Project REN2001-1633. 2001-2004. Project Leader: Gerardo Benito Ferrández (C.S.I.C.).
 - “*Systematic, Palaeoflood and Historical data for the improvement of flood Risk Estimation*”. SPHERE Project. European Union. EVG1-CT-1999-00010. Project Co-ordinator: Gerardo Benito.
 - “*Geomorphology, sedimentology and palaeohydrology of the floodplain recent dynamic and proposals for flood control in the Tagus River in Talavera de la Reina and Jabalón in Valdepeñas (Castilla-La Mancha Region, Spain)*”. FEDER Project: 1FD97-2110-CO2-02 Years: 2000-2003. Sub-Project Head: Dr. Gerardo Benito Ferrández.
 - “*Flood and Palaeoflood magnitude and frequency in the Júcar and Segura River Basins*”. CICYT Project: HID99-0858. Years 2000-2002. Project Head: Dr. Gerardo Benito.

Publications:

Alonso P., Dorronsoro C. & Egidio J.A., in press. Carbonatation in palaeosols formed on terraces of the Tormes river basin (Salamanca, Spain). *Geoderma*.

Alonso-Zarza A.M., 2003. Palaeoenvironmental significance of palustrine carbonates and calcretes in the geological record. *Earth-Science Reviews*, 60, 261-298.

Benito G., Sopeña A., Sánchez-Moya Y., Machado M.J. & Pérez-González A., 2003. Palaeoflood record of the Tagus River (Central Spain) during the Late Pleistocene and Holocene. *Quaternary Science Reviews*, 22, 1737-1756.

Benito, G., Thorndycraft, V.R., Sopeña, A., Sánchez, Y. & Rico, M. 2001. Palaeoflood hydrology of the Llobregat River, NE Spain. European Geophysical Society. XXVI General Assembly, Nice. Geophysical Research Abstracts Session NH4 03 *The use of historical data in natural hazard assessment: floods*.

Díaz-Hernández J.L., Barahona-Fernández E. & Linares-González J., 2003. Organic and inorganic carbon in soils of semiarid regions: a case study from the Guadix–Baza basin (Southeast Spain). *Geoderma*, 114, 65-80.

Fernández de Villalta, M., Benito, G. & Díez Herrero, A. in press. Historical flood data analysis using a GIS: the Palaeotagus database. *Advances in Natural & Technological Hazards Research*. Eds. T. Glade et al.

Jiménez-Espinosa R. & Jiménez-Millán J. 2003. Calcrete development in Mediterranean colluvial carbonate systems from SE Spain. *Journal of Arid Environments*, 53, 479-489.

Llasat, M.C. in press. Long-term variability of floods in Mediterranean areas. Published by: Grupo Nazionale per la Difesa de les Catastrofi Idrogeologiche.

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Llasat, M.C., De Batlle, J., Rigo, T. & Barriendos, M. in press. Las inundaciones del 10 de junio del 2000 en Cataluña *Revista Ingeniería del Agua*

Llasat, M.C., Quintas, L. and Capó, E. in press. Stationarity of monthly rainfall series, since the middle of the XIXth century. Application to the case of Peninsular Spain. *Advances in Natural & Technological Hazards Research*. Eds. T. Glade et al.

Lobo F.J., Dias J.M.A., Gonzalez R., Hernández-Molina F.J., Morales J.A. & Del Rio V.D., 2003. High-resolution seismic stratigraphy of a narrow, bedrock-controlled estuary: The Guadiana estuarine system, SW Iberia. *Journal of Sedimentary Research*, 73, 973-986.

Rico, M. and Benito, G. in press. Combined use of palaeohydrological and rainfall-runoff methods for estimating temporal and spatial occurrence of floods in small ungauged mountain streams of the Spanish Pyrenees. *Journal of Hydrology*

Thorndycraft V.R., Benito G., Barriendos M. & Llasat M.C., (eds.) 2003. *Palaeofloods, Historical Data & Climatic Variability*. CSIC. 378 pp. ISBN-84-921958-2-7. [* see below]

Uribelarrea D., Pérez-González A. & Benito G., 2003. Channel changes in the Jarama and Tagus rivers (central Spain) over the past 500 years. *Quaternary Science Reviews*, 22, 2209-2221.

Viseras C., Calvache M.L., Soria J.M. & Fernández J., 2003. Differential features of alluvial fans controlled by tectonic or eustatic accommodation space. Examples from the Betic Cordillera, Spain. *Geomorphology*, 50, 181-202.

Vidal Romaní, J.R. & Yepes, J. 2001. The Miño river terraces in the sector Chantada-As Neves (Galice-Portugal border). *Acta Geologica Hispanica*, 36, 149-164.

* - This book collects the Proceedings of the PHEFRA International Workshop held in Barcelona, 16-19th October, 2002, and it is organized in 6 parts:

INTRODUCTION

PART 1: PALAEOFLOOD RECORDS – SEDIMENTARY ARCHIVES OF PAST FLOOD EVENTS.

PART 2: DOCUMENTARY RECORDS OF FLOOD EVENTS DURING THE LAST MILLENNIA.

PART 3: HYDRAULIC MODELLING OF PAST FLOODS.

PART 4: STATISTICAL ANALYSIS OF LONG-TERM FLOOD AND HYDROLOGICAL RECORDS.

PART 5: FLOODS AND CLIMATIC VARIABILITY.

PART 6: FLOOD HAZARDS, GIS APPLICATIONS AND FLOOD RISK MANAGEMENT.

IGCP 449 2002 Activity in Uruguay

Martín Ubilla

Research projects:

“Continental Cenozoic of Uruguay: biostratigraphic and palaeoenvironmental topics”. 2000-2002. Leader: Dr. Martin Ubilla. Sponsor: CSIC-Universidad de la República, Uruguay. Completed in 2002.

Related project:

“Quaternary and present climates of the Paraná and Uruguay basins, SE South America (Argentina, Brazil, Uruguay, Paraguay)” . INQUA. Director: Dr. Martín Iriondo (Paraná). Associate research.

Meetings attended:

Martin Ubilla and Richard Farina both attended the Inaugural Meeting of IGCP 449 in Prague, April 2001. Presentations:

- R.A. Fariña "Large river ruled life and death of large South American Pleistocene mammals"
- M. Ubilla "Mammals as a biostratigraphic tool in correlation of Pleistocene fluvial deposits in mid-latitudes of South America: northern Uruguay as a case study, problems and criticism"

Martin Ubilla, M. attended the First International Palaeontological Congress in 2002, at MacQuarie University, Sydney. Poster presentation:

- Pleistocene continental mammals of northern Uruguay (South America): biogeographic and climatic connotations.

Publications:

Bond, M., Perea, D., Ubilla, M., & Tauber, A. 2001. *Neolicaphrium recens* Frenguelli, 1921, the only surviving Protheroheriidae (Litopterna, Mammalia) into the South American Pleistocene. *Palaeovertebrata*, 30, 37-50.

Ubilla, M. 2002. Pleistocene continental mammals of northern Uruguay (South America): biogeographic and climatic connotations. Poster Presentation. Abstracts First International Palaeontological Congress. Geological Society of Australia, MacQuarie University, 288-289. Sydney. Australia.

Ubilla, M. 2004. Mammalian biostratigraphy of Pleistocene fluvial deposits in northern Uruguay, South America. *Proceedings of the Geologists' Association*, 115, 347-357.

Ubilla, M., Perea, D., Goso, C. & Lorenzo, N. In press. Late Pleistocene vertebrates from northern Uruguay: tools for biostratigraphic, climatic and environmental reconstruction. *Quaternary International*, 114, 129-142.

Veroslavsky, G. & Ubilla, M. Submitted. The “Salto Depositional Sequence” (Pleistocene, Uruguay, South America). A “snapshot” on the evolution of the Paraná River System. *Quaternary Science Reviews*.

IGCP 449 activity in Syria

Maryam Bshesh, Ma'amoun Abdul Karim, Graham Philip, Andrew Shaw, Anthony Beck, David Bridgland, Rob Westaway & Nico Galiatsatos

River Orontes: Homs Regional Survey

Further continued throughout the course of IGCP 449 on the Pleistocene sequence in the Upper Orontes valley (as part of the Homs Archaeological Survey, funded by the Council for British Research in the Levant). A series of terrace gravels of the Orontes has been mapped in this area, represented in the landscape as calcreted conglomerates. Occasional deep exposures showed that these are cemented gravels filling former channels of the Orontes, sometimes interbedded with fine-grained calcareous floodplain alluvium. Lower and Middle Palaeolithic artefacts found during field surveys are thought to be associated with these gravels, possibly weathered directly from them or the stone from the gravels having been used as raw material for later tool-making on the terrace surfaces, or both. A preliminary publication of this work appeared in 2003 (Bridgland *et al.* – see below).

In April 2005 DB, GP, AS & RW attended a conference in Damascus, run by the Council for British Research in the Levant, at which the results of this project were disseminated:

- Anthony Beck: GIS, remote sensing and landscape investigation: Some examples from the SHR project in the Homs region of Syria
- David Bridgland: A dating framework for the Lower and Middle Palaeolithic of Syria: river terraces and sediments.
- Ma'amoun Abdul Karim: Archaeological survey in the Homs region
- Graham Philip: Homs Regional Survey: Site recognition and mapping.
- Andrew Shaw: The Paleolithic Archaeology of River Terraces: Current State of Research and Future Directions.
- Rob Westaway: A dating framework for the Lower and Middle Paleolithic: Geology and Uplift

River Euphrates

Further work was undertaken on the Euphrates during 2004, including the procurement of samples of basalts overlying Pleistocene terrace deposits. In association with similar research in on the same river in Turkey, it is planned to undertake a dating programme using these and other proxies (see below).

Nar el Kebir

Probably Syria's third most important river, the Kebir rises in Hatay Province (Turkey) and flows to the Mediterranean at Latakia. Like the other two rivers (above), its deposits have yielded numerous Palaeolithic artefacts. Casual reconnaissance has revealed that numerous exposures of calcreted gravels exist, showing much potential for a modern study based around geochronology.

Future work

An application is being assembled with the intention of undertaking a major project on both sides of the Turkish border, using the fluvial sediments as a framework for dating the local archaeological and Quaternary sequences. The following UK personnel will be involved: David Bridgland, Andrew Shaw, Anthony Beck (University of Durham); Keith Challis (University of Birmingham) Jean-Luc Schwenninger (Luminescence Dating Laboratory, University of Oxford); Rob Westaway (Open University). The project will have collaborators in both Turkey and Syria.

Publications

Bridgland, D.R., Philip, G., Westaway, R., & White, M. 2003. A long Quaternary terrace sequence in the Orontes River valley, Syria: a record of uplift and of human occupation. *Current Science* (New Delhi). 84, 1080-1089.

Demir, T., Seyrek, A., Yesilnacar, I., Kartal, M., Celik, B., Westaway, R., Kopar, I. & Bridgland, D. In press. Terrace staircases of the River Euphrates in southeast Turkey, northern Syria and western Iraq: evidence for regional surface uplift. *Quaternary Science Reviews*.

Donoghue, D.N., Galatsatos, N., Philip, G. & Beck, A.R. 2002. Satellite imagery for archaeological applications: a case study from the Orontes valley, Syria. In Bewley, R.H. & Raczowski, I (eds), *Aerial Archaeology*. IOS press, Omsa, 211-223.

IGCP 449 Activities in Turkey

Tuncer Demir, Ali Seyrek, Metin Toprak, Bahattin Celik, Sema Yurtmen
& Rob Westaway

The following fieldwork was carried out during 2004 on Late Cenozoic fluvial projects in Turkey:

The Euphrates in eastern and south-eastern Turkey and in northern Syria

(Tuncer Demir, Ali Seyrek, Bahattin Celik, Rob Westaway, David Bridgland & Sema Yurtmen)

Of all rivers in Turkey, the Euphrates has the greatest total length. From a source in the high plateau of eastern Turkey, it flows initially southward onto the Arabian platform. After entering Syria it turns east before passing into Iraq, eventually reaching the Persian Gulf. In August and September 2003, a programme of fieldwork was initiated by Tuncer Demir, Rob Westaway, David Bridgland and Ali Seyrek to investigate Quaternary fluvial evolution of Euphrates River around the Ataturk dam, the Birecik area near the Syrian border and in northern Syria. River terraces were documented and their heights were accurately measured using differential GPS equipment. Basalt samples were taken for dating from localities where Quaternary volcanism interacts with this fluvial system. Field reconnaissance of left-laterally offset river channels was also carried out along the East Anatolian Fault Zone – the active left-lateral fault zone bounding the Turkish and Arabian plates - near Gölbaşı, in the vicinity of the drainage divide between the Euphrates and the Mediterranean river systems. Palaeolithic artefacts (hand-axes) have also been recovered from Euphrates gravels at Birecik and Karababa.

Demir, T., R. Westaway, D.R. Bridgland, A. Seyrek & A. Beck, 2005. Terrace staircases of the River Euphrates in southeast Turkey, northern Syria and western Iraq: evidence for regional surface uplift. *Quaternary Science Reviews*, in press.

Rob Westaway, R., Demir, T., Seyrek, A., Beck, A., Kinematics of active left-lateral faulting in southeast Turkey from offset Pleistocene river gorges: improved constraint on the rate and history of relative motion between the Turkish and Arabian plates. *Journal of the Geological Society*, London, submitted.

The Denizli region of western Turkey:

(Rob Westaway, Sema Yurtmen and Tuncer Demir)

Extensive fieldwork has been carried out around Denizli in western Turkey to document this region's history of surface uplift, which has led to a low relief, mainly aggradational landscape being superseded by fluvial incision. The transition is dated to ~7 Ma, in the Messinian stage of the Late Miocene, by K-Ar dating of volcanism, biostratigraphy and magnetostratigraphy. The total uplift since this time has been ~400 m in the relatively arid interior of western Turkey around Denizli city itself, but increases southward to ~1000 m towards the Mediterranean coastline, where the climate is wetter and higher erosion rates (which are presumed to be what is driving the uplift) are expected.

Westaway, R., Guillou, H., Yurtmen, S., Demir, T., Rowbotham, G., Investigation of the conditions at the start of the present phase of crustal extension in western Turkey, from observations in and around the Denizli region. *Geological Journal*, in press.

The Gediz River around Kula, in the Manisa region of western Turkey

(Tuncer Demir, Sema Yurtmen, David Bridgland, Rob Westaway, Darrel Maddy)

The Gediz is the second longest river draining to the Aegean coast of Turkey. Part of this reach lies within the Kula Quaternary volcanic field, where basalt flows have interacted with the river gorge and in places cap its terraces. The third field season of a project, funded by the UK Natural Environmental Research Council, took place in this area in 2003. The aim of this project is to investigate the river terraces that have developed due to Quaternary surface uplift, which can be dated using this region's volcanism. Like at Denizli, a total of ~400 m of uplift has occurred in this region since the latest Miocene or Early Pliocene. The first and second field seasons of this project took place in October 2001 and 2002. The initial results obtained were published during 2003; others are in press. Dating of the large number of basalt samples collected in 2001 was completed in 2004, and a definitive publication that reconstructs the incision history of this river system in some detail has since been submitted.

Westaway, R., Pringle, M., Yurtmen, S., Demir, T., Bridgland, D., Rowbotham, G., Maddy, D., 2003. Pliocene and Quaternary surface uplift of western Turkey revealed by long-term river terrace sequences. *Current Science*, 84, 1090-1101.

Westaway, R., Pringle, M., Yurtmen, S., Demir, T., Bridgland, D., Rowbotham, G. & Maddy, D. 2004. Pliocene and Quaternary regional uplift in western Turkey: The Gediz river terrace staircase and the volcanism at Kula. *Tectonophysics*, 391, 121-169.

Maddy, D., Demir, T., Bridgland, D.R., Veldkamp, A., Stemerink, C., van der Schriek, T., Westaway, R., 2005. A unique obliquity-controlled Early Pleistocene river terrace record from western Turkey. *Quaternary Research*, 63, 339-346.

Maddy, D., Demir, T., Bridgland, D.R., Veldkamp, A., Stemerink, C., van der Schriek, T., Westaway, R., 2005. The Early Pleistocene development of the Gediz River, western Turkey: an uplift-driven, climate-controlled system? *Quaternary International*, submitted.

Westaway, R., Guillou, H., Yurtmen, S., Beck, A., Bridgland, D., Demir, T., Rowbotham, G., Late Cenozoic uplift of western Turkey: Improved dating and numerical modelling of the Gediz river

terrace staircase and the Kula Quaternary volcanic field. Global and Planetary Change, submitted.

The Ceyhan River around Düziçi, in the Osmaniye region of central-southern Turkey

(Tuncer Demir, Rob Westaway, David Bridgland, Ali Seyrek & Sema Yurtmen)

The Ceyhan River flows from the mountainous interior of eastern Turkey to the Mediterranean Sea. Its middle reach occupies a major gorge through the Amanos mountain range. Like on the Gediz near Kula, this reach flows through an area of Quaternary volcanism, and field investigation analogously revealed a staircase of at least four terraces capped by Pleistocene basalt. During at least one of these eruption cycles the whole gorge was plugged by basalt and subsequently filled by a temporary lake upstream of the basalt dam, before dramatic re-incision occurred through many tens of metres of lake sediment. It is unfortunate that in recent years more than 100 km length of this gorge reach of the Ceyhan has been obliterated by the construction of a series of hydro-electric reservoirs (the Aslantaş, Berke, Sir, and Menzelet dams). Fieldwork, which began in August-September 2003, has thus concentrated on the remaining ~10 km gorge reach downstream of the Aslantaş dam, which is currently threatened by yet another hydro-electric project. Basalt samples were collected for dating, and the remaining river terrace fragments were documented. Dating of this basalt is currently under way, and it is anticipated that – once obtained - the results of this study will be submitted for publication during 2005.

The River Asi (Orontes) in Hatay region, in the extreme south of central-southern Turkey

(Rob Westaway, David Bridgland, Tuncer Demir & Ali Seyrek)

The Orontes flows northward across western Syria for more than 200 km. Downstream, for several tens of kilometres it forms the border between Syria – on its right bank – and Turkey – on its left bank – before passing into Turkey just upstream of the Mediterranean coastline. To complement work in progress on the upper and middle Orontes in Syria (see Syria report), its short lower reach along this border and in Turkey was also investigated during August 2003. As was noted in the Syria report, the upper and middle Orontes transports limestone and chert for long distances away from its headwaters in the Lebanon Mountains. The proportion of chert increases downstream as it resists abrasion better than the limestone. However, this field investigation showed that virtually none of this material reaches Turkey, where the Orontes is instead transporting almost entirely material of a local origin. This appears to be because in NW Syria it flows through a major depocentre, the Ghab Basin, which acts as a sediment trap. A synthesis of work to date on the whole length of the Orontes, in both Syria and Turkey, combining field evidence, dating and remote sensing observations, is in preparation.

River Karasu in Hatay region of central-southern Turkey

(Ali Seyrek, Rob Westaway, Tuncer Demir, David Bridgland and Sema Yurtmen)

The Karasu joins the Orontes near the Mediterranean coastline, having flowed southward along the northern part of the active left-lateral Dead Sea Fault Zone – the boundary between the African and Arabian plates. Its tributaries cross strands of this fault zone at many localities, being offset by the left-lateral faulting. Basalt flows have flowed down some of these tributary valleys, capping the fluvial deposits and also being offset left-laterally. Many basalt samples were collected from this region in 2001, and this region was briefly visited again in August 2003 to collect additional samples. Dating of both sets of these basalt samples is currently under way, and it is anticipated that – once obtained - the results of this study will be submitted for publication. The aim is to date the history of incision and deposition of these tributary systems and to estimate the slip rates on the active left-lateral faults.

IGCP 449 Activity in the UK

Simon Lewis, Andy Howard & David Bridgland,

UK participation in IGCP 449 was maintained throughout the project at a high level. UK participants attended all the plenary meetings and all the major additional meetings sponsored by the project. This was greatly assisted by funding from the UK's IGCP fund, now administered by the Geological Society of London (previously by the Royal Society). In addition to this, UK scientists have contributed to the project through fieldwork, in the UK and further afield, through sample and data analysis, participation in other workshops, meetings and conferences and through a range of publications (see below).

In addition there was a special meeting of the UK IGCP group, at the University of Leeds, April 2002. Convened by Andy Howard, this discussed the strategy for coverage of UK fluvial resources, the results of which will be seen in a UK paper for the project culmination special issue of *Quaternary Science Reviews* (Howard *et al.*).

UK participation is further documented in the 2003 and earlier Annual Report Appendices.

Progress with relevant UK projects

Aggregates Levy Sustainability Fund (ALSF):

A number of UK participants in IGCP 449 have been actively involved in projects funded through the ALSF. Since Quaternary fluvial deposits are a major source of commercial aggregate, it has been possible to direct substantial parts of this new funding resource, which has been administered by English Heritage and English Nature, towards research on such deposits. Thus, in a number of instances these projects have had significant overlap with the objectives of IGCP 449 and generated data that contributed to the project.

Phase 1 ALSF projects (2002-3) included:

Palaeolithic Archaeology of the Sussex/Hampshire Coastal Corridor (Martin Bates and Francis Wenban-Smith)

This project included a reappraisal of the Solent River terraces. Particular emphasis was given to the eastern Solent, which has seen less attention in recent decades than the western Solent. The programme included re-excavation of key sites and the application of dating methods (OSL, amino acid geochronology).

The project has recently moved into Phase 2 follow-up project.

Broom, Devon (River Axe)

(Rob Hosfield and Jenni Chambers)

Research at this site, as part of an ALSF project (Palaeolithic Potential of Secondary Contexts) has included OSL dating, preliminary interpretation of which suggests an age envelope of OIS 8/7/6. The existing artefact collections from Broom are being reinvestigated as part of this programme.

Survey of Mineral Extraction Sites in the Thames Estuary

(Essex and Kent County Councils)

This project, which employed a number of project participants, used a combination of GIS technology, including 3D computer modelling, and field survey to assess the surviving resource of Lower Thames deposits with potential Palaeolithic contents in the area of the Thames estuary (the 'Thames gateway'), which has been designated for concentrated housing development in the near future.

The Shotton Project

(Simon Butteo, David Keen & Alex Lang)

This project, which sought to assess and raise awareness of the Quaternary archaeological record from the English Midlands, involved new investigations at a number of fluvial sites. IGCP 449 participants were heavily involved, notably Andy Howard, David Keen and Danielle Schreve. Of particular interest was a rhinoceros found at Whitemoor Haye, Staffordshire.

This Phase 1 project has evolved into the ongoing 'National Ice Age Network'

<http://www.iceage.bham.ac.uk/network/>

Late Quaternary Landscape History of the Swale-Ure Washlands

(Antony Long, David Bridgland, Wishart Mitchell, Jim Innes, Mairead Rutherford, David Keen and Danielle Schreve)

This project looked at the lowland reaches of rivers flowing eastwards across North Yorkshire from the Pennines. The record here is one of Last Devensian deglaciation and the development of Holocene terraces. This largely geoarchaeological enterprise has been followed up by a Phase 2 project that extends the coverage and involves preparation of publication material (2005 ...).

Till-Tweed Project

(Dave Passmore, Tim Van der Shriek)

This is another northern project applied to a Devensian - Holocene record. It operated from the Geography Department at Newcastle.

Phase 2 ALSF projects (2004...) include (these have come on line as the IGCP project ended, but will feed into its database and into IGCP 518):

The Lower and Middle Palaeolithic Occupation of the Middle and Lower Trent Catchment and Adjacent Areas, as Recorded in the River Gravels used as Aggregate Resources

Mark White, Andy Howard & David Bridgland

The Trent is the most northerly river in Britain to have Palaeolithic artefacts within its sedimentary archive, The project will review the artefact collections in museums and investigate their geological context within the Trent sequence. Its area includes the full sweep of territory between the modern Trent exit to the NorthSea, via the Humber, and its postulated earlier course to the Wash. The project is linked to the Ice Age Network (see above).

Medway Valley Palaeolithic project

F.F. Wenban-Smith

Focused on parts of Kent and Essex either side of the Thames Estuary, this project is about aiding the curatorial community in managing the Palaeolithic resource contained in the aggregate extraction landscape. Within the context of this broad goal, the project will instigate significant new research on the Quaternary sequence of the Medway and Thames-Medway.

Ancient Human Occupation of Britain (AHOB):

This Leverhulme-funded project has provided considerable impetus for research on Pleistocene fluvial sites in Britain. It is primarily concerned with the investigation of the human colonisation of Britain from c. 700kyr - 10kyr BP. However, as part of this project a significant quantity of new field data concerning fluvial sequences has been collected, contributing to the work of IGCP 449. There is a significant overlap with the archaeological subgroup of IGCP 449 (see Appendix li).

Examples of AHOB project activity contributing to IGCP 449 include:

Marks Tey, Essex

(Danielle Screve, David Bridgland and Mark White)

Reconnaissance investigation in 2002 and further work in 2003 focussed on the periphery of the lacustrine basin at Marks Tey, which is believed to be formed in a glacially overdeepened section of the pre-diversion Thames valley. A series of trial pits excavated in a field adjacent to the brick pit confirmed that the Quaternary deposits at Marks Tey feather out gradually over a much wider area than previously thought, and that fluvial gravels are included in this marginal area.

Lynford, Norfolk (River Wissey)

(Danielle Schreve, Simon Lewis, Mark White, David Keen & Bill Boismier)

Excavations in 2002 at this site exposed a sequence of infilled channels with rich organic sediment, yielding pollen, plant macrofossils, molluscs, insects and vertebrate remains. More than 30 Middle Palaeolithic handaxes were recovered, in association

with the remains of 8 individuals of woolly mammoth and specimens of woolly rhinoceros, reindeer and brown bear. Mark White has studied the artefact assemblage.

Other fluvially-based archaeological investigations:

- Investigation of Middle Palaeolithic archaeology associated with terraces of the River Thames in the west London area (Nick Ashton & Simon Lewis);
- Investigation of pre-Anglian fluvial sequences and contained archaeological material in central Suffolk (Nick Ashton & Simon Lewis);
- Investigation of a new fossiliferous archaeological site at Southfleet Riad, Swanscombe, ahead of the construction of the CTRL (Cannel Tunnel Rail-link). [see http://www.soton.ac.uk/~ffws/New_ffws/southfl.html] It would seem that the deposits here were laid down by a south-bank tributary of the Thames.
- The evolution of the Crag basin in the southern North Sea and fluvial development during the early and Middle Pleistocene (Jim Rose, Simon Lewis, Simon Parfitt, Richard Preece, John Sinclair, John Lee & Ian Candy).

AHOB Workshop

A two-day workshop was held in London (September, 2003) and was attended by several members of the IGCP project, including Simon Lewis, Danielle Schreve, David Keen, Jim Rose and Mark White.

Quaternary Research Association (QRA) Annual Discussion Meeting, British Museum, London, January 2005.

Organized in association with the AHOB project, this was on the theme of 'Ancient Human Occupation of Europe', organized by Simon Lewis and Nick Ashton. IGCP 449 co-leader David Bridgland gave a paper entitled 'The Palaeolithic occupation of Europe: evidence from fluvial archives (results from IGCP 449)'

A special issue of *Journal of Quaternary Science* (eds Simon Lewis & Nick Ashton) is being compiled from the papers presented at this meeting.

Publications

Bates, M.R., Keen, D.H. & Lautridou, J.-P. 2003. Pleistocene marine and periglacial deposits of the English Channel. *Journal of Quaternary Science* 18, 319-337.

Bridgland, D.R. 2003. The evolution of the River Medway, S.E. England, in the context of Quaternary palaeoclimate and the Palaeolithic occupation of NW Europe. *Proceedings of the Geologists' Association* 114, 23-48.

Bridgland, D.R. & Maddy, D. 2002. Global correlation of long quaternary fluvial sequences: a review of baseline knowledge and possible methods and criteria for establishing a database. *Geologie en Mijnbouw/Netherlands Journal of Geoscience*, 81, 265-281.

Bridgland, D.R. & Schreve, D.C. 2004. Quaternary lithostratigraphy and mammalian biostratigraphy of the Lower Thames terrace system, South-East England. *Quaternaire*, 15, 29-40.

Bridgland, D.R., Schreve, D.C., Keen, D.H., Meyrick, R. & Maul, L. 2004. Biostratigraphical correlation between the late Quaternary sequence of the Thames and key fluvial localities in Central Germany. *Proceedings of the Geologists' Association*, 115, in press.

Bridgland, D.R., Schreve, D.C., Allen, P. & Keen, D.H. 2003. Key Middle Pleistocene localities of the Lower Thames: site conservation issues, recent research and report of a Geologists' Association excursion, 8 July, 2000. *Proceedings of the Geologists' Association* 114, 211-225.

Bridgland, D.R., Schreve, D.C., Keen, D.H., Meyrick, R. & Westaway, R. 2004. Biostratigraphical correlation between the late Quaternary sequence of the Thames and key fluvial localities in Central Germany. *Proceedings of the Geologists' Association*, 115, 125-140.

Bridgland, D.R., Tandon, S.K. & Westaway, R. 2004. Global Correlation of Late Cenozoic Fluvial Deposits (IGCP 449) Proceedings of the Inaugural Meeting Prague, April 21-24th 2001. *Proceedings of the Geologists' Association*, 115, parts 2 & 4.

Howard, A.J., Macklin, M.G. & Passmore, D.G. (eds) 2003. *The Alluvial Archaeology of Europe*. Swets, Rotterdam.

Maddy, D. 2002. An evaluation of climate, crustal movement and base level controls on the Middle-Late Pleistocene development of the River Severn, UK. *Geologie en Mijnbouw/Netherlands Journal of Geoscience*, 81, 329-338.

Lewis, S., Maddy, D. & Glenday, S.S. 2004. The Thames Valley sediment conveyor : fluvial system development over the last two Interglacial-Glacial Cycles. *Quaternaire*, 15, 17-28.

Schreve, D.C. & Bridgland, D.R. 2002. Correlation of English and German Middle Pleistocene fluvial sequences based on mammalian biostratigraphy. *Geologie en Mijnbouw/Netherlands Journal of Geoscience*, 81, 357-373.

Schreve, D.C., Bridgland, D.R., Allen, P., Blackford, J.J., Gleed-Owen, C.P., Griffiths, H.I., Keen, D.H. and White, M.J. 2002. Sedimentology, palaeontology and archaeology of late Middle Pleistocene River Thames terrace deposits at Purfleet, Essex, UK. *Quaternary Science Reviews*, 21, 1423-1464.

Schreve, D.C., Harding, P., White, M.J., Bridgland, D.R., Allen, P., Clayton., F. & Keen, D.H. In press. A Levallois knapping site at West Thurrock, Lower Thames, UK: its Quaternary context, environment and age. *Proceedings of the Prehistoric Society*.

Westaway, R. 2002. Geomorphological consequences of weak lower continental crust, and its significance for studies of uplift, landscape evolution, and the interpretation of river terrace sequences. *Geologie en Mijnbouw/Netherlands Journal of Geoscience*, 81, 283-303.

Westaway, R. 2002. Long-term river terrace sequences: Evidence for global increases in surface uplift rates in the Late Pliocene and early Middle Pleistocene caused by flow in the lower continental crust induced by surface processes. *Geologie en Mijnbouw/Netherlands Journal of Geoscience*, 81, 305-328.

Westaway, R., Bridgland, D.R. & Mishra, S. 2002. Rheological differences between Archean and younger crust determine rates of Quaternary vertical motions revealed by fluvial geomorphology. *Terra Nova*, 15, 287-293.

Westaway, R., Bridgland, D.R. & White, H.J. In press. The Quaternary uplift history of central southern England: evidence from the terraces of the Solent River system and nearby raised beaches. *Quaternary Science Reviews*.

IGCP 449 Activity in Ukraine

Participants and institutions engaged in an activity within the scope of the Project

- P.Gozhik - *Institute of Geological Sciences, National Academy of Sciences of Ukraine, Kyiv;*
- A.Matoshko, A.Ivchenko, M.Barshtchevsky, V.Palienko - *Institute of Geography, National Academy of Sciences of Ukraine, Kyiv;*
- L. Popova – *Kyiv State University, Kyiv;*
- L.Rekovets - *Institute of Zoology, National Academy of Sciences of Ukraine, Kyiv;*
- B.Vozgrin – *Ukrainian Geological Prospecting Institute, Kiev;*
- O.Adamenko – *Ivano-Frankivsk Oil and Gas University, Ivano-Frankivsk.*

Research topics:

- Comparative review of the materials concerning fluvial archives of the Dniester, Dnieper, Don and Volga rivers (Miocene – Pliocene – Quaternary).
- Detailed stratigraphy and correlation of the late Middle Pleistocene – Holocene alluvial deposits of the Middle Dnieper area;
- Studies of micromammal fauna of the Dnieper modern channel alluvium.
- Change of facial and lithologic composition of the alluvial deposits of the Middle and Lower Dnieper areas during Neogene and Quaternary;
- Stratigraphy and correlation of the alluvial deposits of the Middle and Lower Dnieper areas;
- River basin sedimentogenesis and geomorphogenesis associated with the development of the fluvial processes;
- Review of the materials concerning fluvial archive of the Dnieper River within territory of Ukraine.

Presentations at meetings:

- *Inaugural meeting of the International Geological Correlation Programme (IGCP), Project – 449: “Global correlation of Late Cenozoic fluvial deposits”, Prague, Czech republic, April 21-24 2001.*

Matoshko, A.V., Gozhik, P.F. & Ivchenko A.S.

- *The meeting of Subcommision on European Quaternary Stratigraphy (SEQS) of INQUA: “The Ukraine Quaternary Explored: the Middle and Upper Pleistocene of the Middle Dnieper Area and its importance for the East-West European correlation”, Kiev, Ukraine, 9-14 September 2001.*
Adamenko O., Barshtchevsky M., Gozhik, P.F., Matoshko, A.V., Palienko V., Vozgrin B.
- *The meeting of the International Geological Correlation Programme (IGCP), Project – 449: “Global correlation of Late Cenozoic fluvial deposits”, Kanpur, India, December 20-22 2001.*
Ivchenko A.S.
- *Fluvial archives group. FLAG biennial meeting. Clermont-Ferrand, France. Maison de la Recherche. September 9-11th 2002.*
Matoshko, A., Popova L.
- *IGCP 449 Final plenary meeting, Malaga, Spain. Field Conference Malaga basin 2004. Campanillas, Malaga, 12th-18th of December 2004.*
Matoshko, A.

Publications:

Adamenko O., Barshtchevsky M. & Palienko V. Middle-Late Pleistocene fluvial sedimentogenesis and geomorphogenesis in the basin of the Middle Dnieper. In: *The Ukraine Quaternary Explored: the Middle and Upper Pleistocene of the Middle Dnieper Area and its importance for the East-West European correlation. Kyiv, Ukraine, September 9-14, 2001. Volume of abstracts.* Kyiv, 5.

Matoshko, A., 2001 – Great changes in the fluvial system of the Pripyat, Desna and Dnieper rivers at the end of the Late Pleistocene. *Fluvial archives group. FLAG biennial meeting. Clermont-Ferrand, France. Maison de la Recherche. September 9-11th 2002. Abstract Volume.* p. 39.

Matoshko, A., 2004 – Evolution of the fluvial system of the Pripyat, Desna and Dnieper during the late Middle - Late Pleistocene. *Quaternaire*, vol. 15, 1-2, p. 117-128.

Matoshko, A.V., 2001. Sedimentological background for stratification and correlation of the Middle Pleistocene – Holocene stratum of the Middle Dnieper Area. In: *The Ukraine Quaternary Explored: the Middle and Upper Pleistocene of the Middle Dnieper Area and its importance for the East-West European correlation.* SEQS Kyiv, Ukraine, September 9-14, 2001. Volume of abstracts. Kyiv, 60-61.

Matoshko A., Bugai D., Dewiere L. Skalskyy A. 2004. Sedimentological study of the Chernobyl NPP site to schematise radionuclide migration conditions. *Environmental Geology*, 46, 6-7, 820 - 830.

Matoshko, A.V., Gozhik, P.F. & Ivchenko A.S., 2002 - The fluvial archive of the Middle and Lower Dnieper (a review). *Netherlands Journal of Geosciences*, 81 (3 – 4), p. 339 – 355.

Matoshko, A.V., Gozhik, P. & Danukalova, G. 2004. Key Late Cenozoic fluvial archives in the central and southern part of the East European Plain (a review). *Proceedings of the Geologists' Association*, 115, 141-173.

Matoshko, A.V., Gozhik, P. & Danukalova, G. 2004. – Correlation of the Late cenozoic fluvial events within the East European Plain – main results. IGCP 449 Final plenary meeting, Malaga, Spain. Field Conference Malaga basin 2004. Campanillas, Malaga, 12th-18th of December 2004. Program. Book of Abstracts, p. 33.

Popova L., 2002 - Micromammals fauna of the Dnieper modern channel alluvium: taphonomical and biostratigraphical implications. *Fluvial archives group. FLAG biennial meeting. Clermont-Ferrand, France. Maison de la Recherche. September 9-11th 2002. Abstract Volume. p. 44.*

Popova L., 2004 - Micromammals fauna of the Dnieper modern channel alluvium: taphonomical and biostratigraphical implications. *Quaternaire*, vol. 15, 1-2, p. 233-242.

Popova L., 2004 – Late Pleistocene predator activity and composition: Kotovka vertebrate site, Ukraine. IGCP 449 Final plenary meeting, Malaga, Spain. Field Conference Malaga basin 2004. Campanillas, Malaga, 12th-18th of December 2004. Program. Book of Abstracts, p. 39.

Vozgrin B., 2001 – Structure of the terraces of the Dnieper middle reaches as one of criteria of interregional correlation. In: *The Ukraine Quaternary Explored: the Middle and Upper Pleistocene of the Middle Dnieper Area and its importance for the East-West European correlation. Kyiv, Ukraine, September 9-14, 2001. Volume of abstracts. Kyiv, 100-101.*

IGCP 449 Activity in the United States

Mike Blum, University of Nebraska-Lincoln

MEETINGS:

7TH INTERNATIONAL CONFERENCE ON FLUVIAL SEDIMENTOLOGY, Lincoln, Nebraska, August 2001

This was first highlight of US participation in IGCP 449, organized by Mike Blum. It gave rise to a special publication of the International Association of Sedimentologists (no. 35): *Fluvial Sedimentology VII* (eds Blum, M., Marriott, S. & Leclair, S.).

BIANNUAL MEETING OF THE AMERICAN QUATERNARY ASSOCIATION, Fairbanks, Alaska, August, 2002

SOCIETY FOR ECONOMIC PALAEOLOGISTS & MINERALOGISTS (SEPM) Research Conference entitled "Incised Valleys: Images and Processes" Casper, Wyoming, August 2002

Papers here made comparisons between late Cenozoic fluvial system evolution and that recorded in ancient rocks played a major role.

16TH INQUA CONGRESS, Reno, Nevada, July 2003

This was the second highlight of US participation in the IGCP project. The Reno INQUA was a considerable success in general and included a significant IGCP 449 component, with project participation in the FLAG poster session as well as a separate project Workshop/Business meeting (see separate reports). US participation in the special session was as follows:

LAKE MONROE, POSSIBLE FLUVIAL RESPONSE OF THE OUACHITA RIVER TO PLEISTOCENE ARKANSAS RIVER AGGRADATION

FITZGERALD, Danny, Department of Geosciences, Univ of Arkansas, OZAR-113, Fayetteville, AR 72701, tfitzge@uark.edu and GUCCIONE, Margaret J., Dept. of Geosciences, Univ. of Arkansas, OZAR-113, Fayetteville, AR 72701

FIELD AND EXPERIMENTAL EVIDENCE FOR OUT-OF-PHASE FLUVIAL RESPONSES TO RAPID CLIMATE CHANGE

TÖRNQVIST, Torbjörn E.¹, VAN DEN BERG VAN SAPAROE, Aart-Peter², and POSTMA, George², (1) Department of Earth and Environmental Sciences, Univ of Illinois at Chicago, 845 West Taylor Street, Chicago, IL 60607-7059, tor@uic.edu, (2) Faculty of Earth Sciences, Utrecht Univ, P.O. Box 80021, Utrecht, NL-3508 TA, Netherlands

LATE HOLOCENE ALLUVIAL RESPONSE TO HYDRO-CLIMATIC CHANGE IN THE UPPER REPUBLICAN RIVER BASIN, GREAT PLAINS, USA

DANIELS, J. Michael, Univ Wisconsin - Madison, 550 N Park St, Madison, WI 53706-1491, jmdaniels@geography.wisc.edu.

LATE HOLOCENE BEHAVIOR OF SMALL DRAINAGE BASINS ON THE COLORADO PLATEAU: INFLUENCES OF LITHOLOGY, BASIN FORM AND CLIMATE CHANGE

TILLERY, A.C.¹, MCAULIFFE, J.R.², MCFADDEN, L.D.¹, SCUDERI, L.¹, and FAWCETT, P. J.¹, (1) Earth and Planetary Sciences, University of New Mexico, Albuquerque, NM 87131, atillery@unm.edu, (2) Desert Botanical Garden, 1201 N. Galvin Parkway, Phoenix, 85008

Rich Modola ran a pre-conference field trip to Boulder that looked at a piedmont terrace staircase (South Platte River) dating back to 2Ma (with dating evidence).

RECENT, NEW, AND CONTINUING RESEARCH

Research relevant to IGCP 449 in the United States during 2000-2004, as well as that conducted by US scientists in other countries, is both abundant and highly varied. As previously, this report is restricted to ongoing projects conducted within the continental United States only. This research is being undertaken by a variety of groups associated with a number of universities. The following is organized around the home universities and the relevant principal investigators.

Lehigh University (Lehigh, Pennsylvania)

Research at Lehigh is led by Frank Pazzaglia, and has focused on a variety of settings, including the Olympic Peninsula of Washington State, river systems of the western Great Plains, and the Susquehanna River of the eastern seaboard. Regardless of locality, Pazzaglia's research has concentrated on linking tectonic activity with fluvial landscape evolution through mapping and dating of flights of terraces, and assessment of rates of bedrock incision by fluvial systems. The proposed INQUA field excursion that would have included the Susquehanna sequence was unfortunately cancelled from lack of bookings before it was possible to register IGCP participation!

Purdue University (West Lafayette, Indiana)

Research at Purdue, led by Daryll Granger, has focused on documentation of incision rates and fluvial landscape evolution in the New River of Virginia, and the Ohio River of the central US; in particular using dating of bedrock straths and alluvial deposits with the cosmogenic nuclides method.

Rice University (Houston, Texas)

Research at Rice is led by John Anderson, and focuses on documentation of fluvial responses to glacio-eustasy, as recorded by seismic data on the now-submerged shelf of the Gulf of Mexico. Over the last 15 years, the Rice group has collected data from the Rio Grande along the Mexican border, to the Appalachicola River of NW Florida, and includes all major river systems that discharge to the Gulf of Mexico. This is perhaps the most detailed and geographically extensive data set from glacial period lowstand rivers in the world, and illustrates both the complexity and importance of sea-level change. John Anderson participated in the 16th INQUA Congress in Reno (Session 86, Quaternary History of the Antarctic Ice Sheets from Geochronology of Marine and Terrestrial Glacial Deposits).

University of Nebraska (Lincoln, Nebraska)

Research at Nebraska, led by Mike Blum and Joe Mason, makes considerable use of OSL as a dating method. Work on the late Pleistocene record of the lower Mississippi by Ph.D. student Tammy Rittenour and Mike Blum has provided the first robust geochronological model for the evolution of the Mississippi in response to meltwater flooding, neotectonics, and sea-level change. Ongoing research by Mike Blum along the Texas Coast focuses on evolution of fluvial systems in response to interacting climatic and glacio-eustatic controls. Research by Mike Blum, Joe Mason, and their graduate students on the Platte River system and its tributaries seeks to develop a model for fluvial landscape evolution over the last glacial-interglacial cycle.

University of California-Santa Cruz (Santa Cruz, California)

Research at UC-Santa Cruz, led by Bob Anderson, has focused on cosmogenic nuclide dating and numerical modeling of a flight of Middle to Late Pleistocene terraces along the Wind River in Wyoming.

University of Illinois (Chicago, Illinois)

Research at Illinois-Chicago, led by Torbjörn Törnqvist, focuses on the Prairie Formation of the lower Mississippi valley (thought to represent the flood plain and delta plain from isotope stage 5), and evolution of the Holocene delta of the Mississippi. Törnqvist's efforts feature OSL dating of fine-grained floodplain and deltaic sediments. He contributed at INQUA in Reno, including participation in the FLAG/IGCP 449 session.

University of Texas (Austin, Texas)

Research at Texas is led by Bill Galloway, and is focused on synthesizing Cenozoic stratigraphic evolution of the Gulf of Mexico Basin. A key feature of this dataset is the changes through time in fluvial sediment inputs in response to continental tectonics and drainage network organization.

Utah State University (Logan, Utah)

Research at Utah State is led Joel Pederson, and has focused on terraces and incision rates of the Colorado River in Grand Canyon. Pederson's research is bringing together a range of dating techniques to address this high-profile topic, including cosmogenic nuclides (in association with John Gosse at Dalhousie University, Canada), optical luminescence (in association with Tammy Rittenour and Mike Blum at Nebraska), and U-Th (in association with Warren Sharp at the University of California). Joel Pederson contributed to INQUA Session 31 (Deserts over the last 100,000 years – IGCP 413) on the topic of: “The Grand Canyon, Arizona (U.S.) Record of full-landscape response to Middle-Late Pleistocene climate change”.

Publications:

Blum, M.D., Guccione, M.J., Wysocki, D. & Robnett, P. C. 2000. Late Pleistocene evolution of the Mississippi Valley, Southern Missouri to Arkansas. *Geological Society of America Bulletin*. 112, 221-235.

Blum, M., Marriott, S. & Leclair, S. (eds) 2005. *Fluvial Sedimentology VII*, Special publication of the International Association of Sedimentologists, 35.

Blum, M.D. & Tornqvist, T.E. 2000. Fluvial response to climate and sea-level change: a review and look forward. *Sedimentology* 47 (supplement), 1-48.

Blum, M.D. & Straffin, E.C. 2001. Fluvial responses to external forcing: Examples from the French Massif Central, the Texas Coastal Plain (USA), the Sahara of Tunisia, and the Lower Mississippi Valley (USA). In: Maddy, D., Macklin, M.G. and Woodward, J., *River Basin Sediments Systems: Archives of Environmental Change*. Balkema, Rotterdam, 195-228.

Wisniewski, P.A. & Pazzaglia, F.JP. 2002. Epeirogenic Controls on Canadian River Incision and Landscape Evolution, Great Plains of Northeastern New Mexico. *Journal of Geology*, 110, 437-456.