2003 Project Annual Report - IGCP 449

Global Correlation of Late Cenozoic Fluvial Sequences

1. Website addresses

Main project website:

http://igcp449.co.uk/)

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

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

The promised IGCP 449 Internet resource of summary data on fluvial systems was launched late in 2002 (Appendix A). Consisting of summary diagrams of data from fluvial sequences (maps, longitudinal and transverse profiles, palaeodrainage reconstructions and tables) accompanied by minimal text, it is currently hosted on the University of Durham site*, although linked with the main IGCP 449 site. Initial coverage of N.W. European rivers has already been extended to include coverage of Turkey, Ukraine and southern Russia, with more in the pipeline. However, much remains to be done in the final 15 months of the project to complete this resource. It is anticipated that 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 etc.

* http://www.geography.dur.ac.uk/research/igcp_449/igcp_449.html

All material is taken from publications by project contributors and is (or will be) tagged with reference details of the source publication.

2. Summary of major past achievements of the Project

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.

In the same year, the 2nd IGCP 449 International Meeting was convened, in Kanpur, northern India, during December 2001. This led to publication of a special issue of *Current Science* (New Delhi), which became the first major project publication when it appeared in April 2003. In December 2002 the 3rd International Meeting took place, in Agadir, Morocco. Since this meeting fell within the 12 months since the last annual report was compiled, details will be appear under 3, below.

3. Achievements of the project this year

Since the last annual report was compiled there have been three meetings of major significance in the progress of the project. The first of these was the 3rd Annual International Project Meeting, held in Agadir, Morocco, 13th-19th December 2002 (Appendices B & C). In 2003 the project has sponsored two meetings, first in Brazil (9th – 18th June), 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 (Appendix D). A business meeting was convened in two sessions, one in Belem and the other on the field excursion, in Rio Branco (Appendix E). Finally there was an important IGCP 449 component at the 16th INQUA Congress in Reno, Nevada, USA. The project shared in a poster session with the Fluvial Archive Group entitled 'Fluvial Archives of Environmental Change' (Appendix F). There was also an IGCP 449 workshop and business meeting conducted within the INQUA congress, using the meetings rooms facility (Appendix G). Unfortunately the planned INQUA excursion to the Susquehanna River was cancelled through lack of support at an early date, before any project funding could be allocated to it in support of participation.

3.1 List of countries involved in the project (* denotes activity in 2002/3)

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*

3.2 General Scientific achievements

Reports from various regional and thematic groups within IGCP show that project activity continues to consolidate and expand, based on the initiation of data collection in the Phase 1 area of NW Europe and extension into phase 2 areas and beyond. Active contributors have been identified throughout eastern Europe and in Russia, as well as in the Middle East, India, North Africa, the Far East, North and South America and Australasia, thus giving genuinely global coverage.

In 2003 the following reports were prepared by National Correspondents and group coordinators:

National Reports:

(i) IGCP 449 2002 Activity in Argentina (Appendix Hi)
(ii) IGCP 449 2002 Activity in Australia (Appendix Hii)
(iii) IGCP 449 2002 Activity in Belarus (Appendix Hiii)
(iv) IGCP 449 2002 Activity in Belgium (Appendix Hiv)
(v) IGCP 449 2002 Activity in Brazil (Appendix Hv)
(vi) IGCP 449 2002 Activity in Bulgaria (Appendix Hvi)
(vii) IGCP 449 2002 Activity in Canada (Appendix Hvii)
(viii) IGCP 449 2002 Activity in China (Appendix Hviii)
(ix) IGCP 449 2002 Activity in the Czech Republic (Appendix Hix)
(x) IGCP 449 2002 Activity in France (Appendix Hx)
(xi) IGCP 449 2002 Activity in Germany (Appendix Hxi)
(xii) IGCP 449 2002 Activity in Hungary (Appendix Hxii)
(xiii) IGCP 449 2002 Activity in India (Appendix Hxiii)
(xiv) IGCP 449 2002 Activity in Lithuania (Appendix Hxiv)
(xv) IGCP 449 2002 Activity in Morocco (Appendix Hxv)
(xvi) IGCP 449 2002 Activity in the Netherlands (Appendix Hxvi)
(xvii) IGCP 449 2002 Activity in Poland (Appendix Hxvii)
(xviii) IGCP 449 2002 Activity in Russia (Appendix Hxviii)
(xix) IGCP 449 2002 Activity in Spain (Appendix Hxix)
(xx) IGCP 449 2002 Activity in Syria (Appendix Hxx)
(xxi) IGCP 449 2002 Activity in Turkey (Appendix Hxxi)
(xxii) IGCP 449 2002 Activity in the UK (Appendix Hxxii)

(xxiii) IGCP 449 2002 Activity in Ukraine (Appendix Hxxiii)
(xxiv) IGCP 449 2002 Activity in Uruguay (Appendix Hxxiv)
(xxv) IGCP 449 2002 Activity in the USA (Appendix Hxxv)

Thematic Reports and Individual Studies:

(i) Report of the Subgroup on **Archaeology from fluvial sequences** (Sheila Mishra & Mark White - Appendix Ii)
(ii) Report of the **Biostratigraphy** Subgroup of IGCP 449 (D.H. Keen, N. Limondin-Lozouet, D.C. Schreve & M. Ubilla - Appendix Iii)
(iii) Report of the Subgroup on **Crustal Deformation & Uplift Modelling** (R. Westaway & A. Matoshko - Appendix Iiii)

3.3 List of meetings

3rd International meeting, Agadir, Morocco, December 13th-19th 2002 (Leader: Dr A. Ait Hssaine, University Ibnou Zohr, Agadir)

Attended by >30 participants, representing 8 countries, this meeting was extremely valuable and enjoyable (see Appendix B, which is a report written by participants Martin Stokes and Ann Mather, and published [in abbreviated form] in *Quaternary Newsletter*, No. 100, 35-39). As well as a lecture programme and four days of field visits there was a project business meeting (see Appendix C). A planned workshop on stratigraphical and sedimentological recording was cancelled because its convenor was unable to participate in the meeting for family reasons. The field meeting started with a visit to the internationally renowned marine terraces 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 Marrakesh), looking at fluvial sites.

A special issue or collection of papers arising from the Agadir meeting is being compied for publication in the journal *Géographie Physique et Quaternaire*, under the guest editorship of Serge Occhietti, David Bridgland and Rob Westaway. It will comprise papers in French and English (Appendix J).

The above meeting was the final project activity during 2002. The programme for 2003 comprised two sponsored meetings, both convened as part of larger symposia. Project funding was used to support participation from poorer counties in both these meetings.

Details of 2003 meetings:

IGCP 449 4th Internation Meeting, Belem, Brazil,June June 9-18 2003 (within the 3rd Latin American Sedimentology conference) (Leader: Dr E. Latrubese, , Federal University of Goiás, Brazil)

This meeting, which constituted the Annual meeting of IGCP 449 for 2003, comprised a special session within the 3rd Latin American Sedimentology conference, 9-11th June, followed by a field meeting based at Rio Branco, Brazil, 12-18th June, during which Miocene to Holocene deposits of the Amazon system were examined and discussed (Appendix D). There was a business meeting (convened in two sessions, one in Belem and the other in Rio Branco) – see Appendix E. The Amazon field trip provided an opportunity to visit and examine a very remote region for which the stratigraphy had been subject to diverse interpretations, leading to controversy. A special volume on the Amazon is being prepared, which will include IGCP 449 contributions. Potential contributions from South America to the IGCP 449 database were identified.

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.

16th INQUA [International Union of Quaternary Research] Congress, Reno, Nevada, 23rd – 30th July 2003.

Within this, the principal Quaternary symposium, held every four years, IGCP 449 ran a poster session (jointly with the FLAG group): INQUA Session No. 3: 'Fluvial Archives of Environmental Change' (Appendix F). There were 17 posters, of which 10 were of clear relevance to IGCP 449 and/or identified as contributions to the project, while all the others were of at least peripheral significance to the project (typically they were studies of shorter timescale records than are typical for IGCP 449). During the formal poster session each poster presenter was given 2-5 minutes in which to outline the salient features of his/her poster. There was also an IGCP 449 workshop and business meeting conducted within the congress, using the meetings rooms facility at the Reno Hilton Hotel (Appendix G).

In addition to formal IGCP 449 business, project subtheme (Biostratigraphy) co-leader Danielle Schreve gave a paper in the oral session S8 ' Isotope Stage 11: an Analog for the Present Interglacial?', entitled 'The environment and climate of the MIS 11 interglacial in Europe: evidence from the vertebrate record.

There was also IGCP 449 participation at the following meetings:

Quaternary Research Association Annual Discussion Meeting, January 7 & 8th, 2003. Theme: Land-Ocean correlation

This was organized by project co-leader David Bridgland and International Secretary Darrel Maddy, together with Antony Long (University of Durham), who is UK National Correspondent for IGCP 437 (Quaternary Highstands). IGCP 449 UK National Correspondent Simon Lewis gave a paper on “Correlation of Pleistocene fluvial sequences in the UK: problems and prospects” in which the IGCP 449 project was promoted. The meeting will be published in a special issue of *Quaternary Science Reviews*, jointly compiled by the above three organizers as guest editors.

IGCP 437 UK Working Group meeting, Southampton, UK, 8-10/7/03

This meeting comprised lectures and a field excursion. An IGCP 449 'overlap component' was provided by David Bridgland, who gave an oral presentation entitled 'Fluvial responses to sea level change: the view from IGCP 449', Martin Bates, who contributed to both the oral and field programmes, and Rebecca Briant. Martin Bates's oral presentation further linked the Sussex raised beaches with the fluvial record from the region. He and Rebecca Briant led the field excursion at the Norton Farm OIS 7 raised beach and the Selsey estuarine (marine terrestrial interface) locality, where the inter-relations between raised beach and river terrace evidence was discussed. They are currently engaged in a project funded by the UK's Aggregates Levy Sustainability Fund looking at the terraces of the Solent River (part of the ‘Sussex/Hampshire Coastal Corridor’ ALSF project - see Appendix Ii)

3.4 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). Plans to continue this sequence with a sediment-logging workshop at the Agadir (2002) meeting were thwarted, but this postponed workshop took place in the Amazon basin as part of the 2003 Annual Meeting

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.

3.5 Participation of scientists from developing countries.

Co-leaders Tandon and Zhou are from developing countries (both attended the IGCP 449 component of the INQUA Congress in Reno, July 2003).

The following have also been identified as key members of the project

(*- indicates that activity has been reported during 2001/2; details are given where available)

Dr Ali Ait-Hssaine, University Ibn Zohr, Agadir, Morocco * [Organized the 3rd International Meeting - see above]
Dr Jaime Argollo - Universidade Mayor de San Andrés-Geologia-La Paz, Bolivia *
Dr Sâmia Aquino da Silva – NUPELIA/GEMA, State University of Maringá, Brazil *
Mr Peter Beaumont, McGregor Museum, Kimberley, South Africa *
Dr Alaeddine Belfoul - Department of Geology, Ibn Zohr University, Agadir, Morocco *
Dr Maximilano Bezada - Universidad Pedagógica El Libertador, Caracas, Venezuela *
Dr Adriano Cecioni - Universidad de Concepción, Concepción, Chile *
Dr Bahattin Celik, Archaeology, Harran University, Sanliurfa, Turkey *
El Hassane Chellai - University of Cadi Ayyad, Marrakech, Morocco *
Dr Khalil Chowdhury, Jahangirnagar University Savar, Dacca, Bangladesh
Dr Tuncer Demir, Geography, Harran University, Sanliurfa, Turkey * [has attended IGCP 449 international meetings in every year of the project, including INQUA in 2003; National Correspondent]
Dr Richard Fariña, University of Montevideo, Uruguay *
Dr Robert Findlay, Geological Survey, Papua New Guinea * [Has offered regional meeting in PNG and will be contributing to the Agadir special issue of *Géographie Physique et Quaternaire*]
Dr Elena Franzinelli – University of Manaus, Brazil *
Prof. Algirdas Gaigalas, Lithuania *
Miss Catherine Gray, University of Cape Town, South Africa
Dr Santiago Grosso - Petrobras, Peru *
Mr Ju Yong Kim, Kigam-Korea Institute of Geology, Mining and Minerals
Prof. Edgardo Latrubesse, Federal University of Goiás, Brazil * [Attended Australia meeting in 2002; organizer of 2003 International Meeting, Belem, Brazil and IGCP 449 field meeting, Amazonia - see above]
Dr José Sergio Lopes Siqueira – Federal University of Acre, Rio Branco, Brazil *
Dr Lisa MacDonald, NAMDEB diamond corporation, Namibia/South Africa
Dr Shiela Mishra, Deccan College, Pune, India * [co-convenor of Arcaheology subtheme - see Appendix Ii; taking up a temporary appointment at Alemaya University in Ethiopia, providing project involvement in that country (from November 2003)]
Dr Duowen Mo, Peking University, Beijing, China *
Dr Ma'amoun Abdelkareem, University of Damascus, Syria *
Dr A. Narayama, Cochin University of Science and Technology, India *
Prof. Timothy Partridge, University of Witswatersrand, South Africa
Dr Carlos Ramonell, Litoral National University, Santa Fe, Argentina * [attended 2003 International Meeting, Belem and IGCP 449 field meeting, Amazonia]
Dr Yan Rizal, Bandung Institute of Technology, Java, Indonesia
Dr Dharm.Saxena, Jawaharlal Nehru University, New Delhi, India
Dr Vaida Seronian, Lithuania * [Attended Australia meeting in 2002]
Prof. Ashok Singhvi, University of Ahmedabad, India * [Provided Dating Workshop at the 2nd International Meeting, Kanpur]
Prof. Rajiv Sinha, Indian Institute of Technology, Kanpur, India * [Organized the 2nd International Meeting, Kanpur; editor of Current Science special issue; conducting database pilot project; attended 2003 Belem meeting and INQUA (the only person to attend both)]
Dr Petras Sinkunas Lithuania * [national Correspondent]
Prof. Jose Stevaux, Universidade Estadual de Maringa, Brazil * [Attended Australia meeting in 2002; co-organizer of IGCP 449 field meeting, Amazonia, June 2003]
Dr Martin Ubilla, INGEPA, Facultad de Ciencias, Montevideo, Uruguay * [National Correspondent]
Dr Ali Seyrek, Department of Soil Science, Harran University, Sanliurfa, Turkey *
Dr. Sergio Vizcaíno, Museo de La Plata, Argentina
Prof. Yang Liankang, Chinese Academy of Sciences, Beijing, China *
Dr Wyss Yim, University of Hong Kong, China *

Prof. Rafat Zaki, Egypt * [Attended 2002 Morocco meeting]
Dr Marcelo Zárate, Argentina

The 2001, 2002 and 2003 meetings have all been convened in developing countries (India, Morocco and Brazil). There remains a commitment to holding a meeting in China, although the recent SARS epidemic has raised further difficulties for this. It remains an intention to sponsor a meeting in this part of the World, perhaps linked to the Asia Oceania Geosciences Society meeting in Singapore (July 2004). A China meeting will be a top priority for a follow-up project.

3.6 List of most important publications (2002-date)

Alekseev, M.N. & Drouchits, V.A. 2004. Quaternary fluvial sediments; structure, distribution and genetic conditions in the Russian Arctic and Subarctic. *Proceedings of the Geologists' Association,* 115, in press.

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

Antoine, P. In press. Contexte stratigraphique et paléopédologique ; Interprétation chronostratigraphique et environnementale, in : J.L. Locht (dir.) Le site de Bettencourt-Saint-Ouen (Somme), cinq occupations du Paléolithique moyen au début de la dernière glaciation, *Documents d'Archéologie Française (DAF).*

Antoine, P., Auguste, P, Bahain, J.J., Coudret, P., Depaepe, P., Fagnart, J.P., Falgueres, C., Fontugne, M., Frechen, M., Hatté, C., Lamotte, M., Laurent, M., Limondin-Lozouet, N., Locht, J.L., Mercier, N., Moigne, A.M., Munaut, A.V., Ponel, P., & Rousseau, D.D. 2003. Paléoenvironnements pléistocènes et peuplements paléolithiques dans le bassin de la Somme (Nord de la France). *Bulletin de la Société préhistorique Française*, 100 (1), 5-28.

Antoine, P., Catt J., Lautridou, J.P. & Sommé J. 2003. The loess and coversands of Northern France and Southern England*. Journal of Quaternary Sciences*, 18, 309-318

Antoine, P., Coutard, J.P., Gibbard, P., Hallegouet, B., Lautridou, J.P. & Ozouf, J.C. 2003. The Pleistocene rivers of the Channel Region. *Journal of Quaternary Sciences* 18, 227-243.

Antoine, P., Frechen, M., Locht,J.L., Munaut A.V., Rousseau,D.D. & Sommé, J. In press. Eemian and Weichselian Early-Glacial pedosedimentary records in Northern France : the background of Middle Palaeolithic occupations during OIS 5 and early 4. Publication du Centre d'Études et de Recherches préhistoriques (CERP), Lille.

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

Antoine, P., Munaut, A.V., Limondin-Lozouet, N., Ponel, P & Fagnart J.P. 2002. Réponse des milieux de fond de vallée aux variations climatiques (Tardiglaciaire et début Holocène), d'après les données du bassin de la Selle (Nord de la France). Processus et bilans sédimentaires. In: J.P. Bravard et M. Magny (dir.) *Les Fleuves ont une histoire, Paléoenvironnement des rivières et des lacs Français depuis 15 000*, Errance, Paris, 15-27.

Antoine, P., Munaut, A.V., Limondin-Lozouet, N., Ponel, P., Dupéron, J. & Dupéron, M. 2003. Response of the Selle River to climatic modifications during the Lateglacial and Early Holocene (Somme Basin-Northern France). *Quaternary Science Reviews* 22, 2061-2076.

Auguste, P., Carpentier, G. & Lautridou, J.-P. 2003. La faune mammalienne de la basse-terrasse de la Seine à Cléon (Seine-Maritime, France) : interprétations taphonomiques et biostratigraphiques. *Quaternaire*, 14, 5-14.

Baines, D., Smith, D.G., Froese, D.G., Baumann, P., & G. Nimeck 2002. Electrical Resistivity Ground Imaging (ERGI): A New Tool to Map Lithology and Geometry of Channel and Valley-Fills, *Sedimentology*, 49, 441-449.

Bajpai, V.N. & Mahanta 2003. Hydrogeomorphic classification of the terrain in relation to the aquifer disposition: a case study from Gurgaon-Sohna region, Haryana. *Journal Geology Society of India*, 62, 318-334.

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.

Becker-Haumann, R. 2002. A revised concept of the third last glaciation in the Northern Alpine Foreland (Bavaria, Germany). *Zeitschrift für geologische Wissenschaften*, 30: 173-190; Berlin. (in German).

Becker-Haumann, R. & Kemna, H.A. 2002. Die Wanderblock-Formation im Schweizer Juragebirge südlich von Basel - Neue Daten zu einem alten Problem. *Eclogae Geol. Helv*., 95. (in German).

Becker-Haumann, R. & Sobisch, H.-G. 2002. Die Morphologie mindelzeitlicher Schmelzwasserrinnen des bayerischen Alpenvorlandes modelliert mit GIS-basierter 3d-Modellierungssoftware. *Terra Nostra* 2002/6: 42-45, 2 Abb.; Berlin. (in German).

Beerten, K., Pierreux, D. & Stesmans, A. 2003. Towards single grain ESR dating of sedimentary quartz: first results. *Quaternary Science Reviews* 22, 1329-1334.

Benito, G., Sánchez-Moya, Y. & Sopeña, A. 2003. Sedimentology of high-stage flood deposits of the Tagus River, Central Spain. *Sedimentary Geology* 157, 107-132.

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

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, in press.

Bogaart, P.W., Van Balen, R.T. , Kasse, C., and Vandenberghe, J., 2003. Process-based modelling of fluvial system response to rapid climate change I: model formulation and generic applications. *Quaternary Science Reviews*, 22, 2077-2095.

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.

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., 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.

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. & Sirocko, F. 2002. Preface: Special Issue arising from the meeting in Mainz, Germany, of the Fluvial Archive Group. *Geologie en Mijnbouw/Netherlands Journal of Geoscience*, 81, 263-264.

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, in press.

Břízová E. 2003. Changes of vegetation and climate in sediments of the Morava River in the Protectes Landscape Area Litovelské Pomoraví. Geoscience *Research Reports for 2002*, 52- 54, Czech Geological Survey, Prague.

Břízová E., Havlíček P. & Vachek M. 2003. The protected locality Čejčské jezero – palynological, palaeopedological and geological research. *Geoscience Research Reports for 2002*, 61-65, Czech Geological Survey, Prague.

Bourillet, J.-F. & Lericolais, G., 2003. Morphology and seismic stratigraphy of the Manche paleoriver system, Western Approaches margin. In: J. Mienert, Weaver, P.P. (Eds) (Editor), *European Margin Sediment Dynamics : Side -Scan Sonar and Seismic Images*. Springer Verlag, New-York, pp. 229-232.

Bourillet, J.-F., Reynaud, J.-Y., Baltzer, A. and Zaragosi, S., 2003. The 'Fleuve Manche': the sub-marine sedimentary features from the outer shelf to the deep-sea fans. *Journal of Quaternary Science*, 18, 261-282.

Chamyal, L.S., Maurya, Bhandari, S. & Raj Rachna 2002. Late Quaternary geomorphic evolution of the lower Narmada valley, Western India: implications for neotectonic activity along the Narmada-Son Fault. *Geomorphology*, 46 (3-4), 177-202.

Chamyal, L. S., Maurya, D. M. & Rachna Raj 2003. Fluvial systems of dry lands of western India: A synthesis of Late Quaternary palaeoenvironmental and tectonic changes. *Quaternary International*, 104, 69-86.

Cordier, S., Harmand, D. & Beiner, M. 2002. Les alluvions anciennes de la Meurthe en Lorraine sédimentaire (Est du bassin de Paris, France) : étude morphosédeimentologique et essai de reconstitution paléoclimatique. *Revue Géographique de l'Est* 42, 197-208.

Cordier, S., Harmand, D., Losson, B. & Beiner, M. 2004. Alluviation of the Meurthe and Moselle valleys (Eastern Paris Basin, France): lithological contribution to the study of the Moselle capture and Pleistocene climatic fluctuations. *Quaternaire*, in press.

Csontos L., Magyari Á., Sztanó O., B.Van Vliet Lanoe, Musitz B., Bergerat F. and Mansy J-L. In press. Neotectonics of the Somogy Hills : evidence from seismic sections. *Tectonophysics.*

Demir, T., Yeşilnacar, İ. & Westaway, R. 2004. River terrace sequences in Turkey. *Proceedings of the Geologists' Association*, 115, in press.

Félegyházi, E. & Nagy, B. In press. Late Pleistocene channel pattern changes on the Sajó-Hernád alluvial fan (in Hungarian with English abstract). *Acta Geographica Debrecina*

Froese, D.G., Smith, D.G., Ager, T.A., Westgate, J.A., Preece, S.J., Sandhu, A., Enkin, R.J. & Weber, F. 2003. Recurring middle Pleistocene outburst floods in east-central Alaska. *Quaternary Research*, 60, 50-62 .

Gaigalas, A. & Dvareckas, V. 2002. The evolution of river valleys in Lithuania from deglaciation to recent changes: data from the sediment infill of oxbow lakes. *Geologie en Mijnbouw/Netherlands Journal of Geoscience*, 81, 407-416.

Gladenkov, Yu., Alekseev, M.N.& Krasnov, V.I. 2003. [Correlation of marine and alluvial interglacial deposits for Middle and Late Pleistocene]. In: V.S. Volkova (ed.) *Stratigraphy of oil and gas basins of Siberia» devoted for Cenozoic of Western Siberia.* Novosibirsk: Publ. House of SB RAS, Department “GEO”, 246pp.

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3.7 Activities involving other IGCP projects or the IUGS

A number of participants in IGCP 449 have active involvement in **IGCP 464** 'Continental shelves during the last glacial cycle', which was a new project in 2001 (a follow-on project from **IGCP 396**, Continental Shelves during the Quaternary).

There is also significant overlap with the activities of **IGCP 437** (Quaternary High-stands); IGCP 449 participants provided contributions to the IGCP 437 Working Group Meeting at Southampton, UK, in July 2003, designed to highlight fluvial evidence from highstands and the interrelations between low-stand fluvial records and high-stand marine/coastal records (see above, 3.7). The 2002 Annual International Meeting of IGCP 449 in Morocco included consideration of Quaternary raised beaches and shorelines on the Moroccan coast at Agadir. These provide an important comparison with fluvial sequences in the hinterland, which can be traced to the Atlas mountains. The meeting was open to participation by contributors to **IGCP 437**.

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”.

4. Activities planned

4.1 General Goals

Key aims for the final year of the project are:

(a) To press ahead with the realisation of the project's internet database. Meetings in 2003 enabled the last major missing areas, in terms of participation in database production, to be filled (Argentina and other South American countries). This does not mean that every country or even region will be represented, but there will be coverage from every continent and from the majority of the most important river systems likely to have extensive Late Cenozoic sequences.

(b) To fill remaining gaps in coverage; there remain target regions and rivr systems from which coverage is desirable and attempts to fill these gaps will continue.

(c) To end the project with a successful concluding session; an end-of-project meeting, with resultant special issue of *Quaternary Science Reviews*, is planned for December 2004.

(d) To develop a proposal for a successful follow-on project. It is recognized that the goals of IGCP 449 will not be fully realised at the end of its five-year life. There is considerable enthusiasm for a follow-on project, which will aim to continue and complete the data collection programme, will target areas that received less than the desired attention during the course

of IGCP 449, as well as providing new aims that will engage those countries and participants active during the existing project.

(e) To continue to maintain a high profile, with representation of the project at various meetings during its final year; important amongst these are the IGC in Florence; FLAG 2004 in Sienna, a local meeting in Russia, EuroMam (European Quaternary Mammal Research Association) 2004, in the UK, the International Symposium on Earth System (Turkey) and the Asia Oceania Geosciences Society meeting in Singapore, as well as its own end-of-project meeting (venue yet to be chosen)

(f) To continue dissemination of project results, with publication of special journal issues (see below; Appendices J, K, L, M & N) and individual papers and other publications.

Details:

With commitment to participation in the IGC/FLAG programme in Italy during the summer of 2004, it seems that the repeatedly postponed China meeting will have to await a fpollow-on project, in which it will be made a top priority. The absence of a Far East project meeting will be offset, hopefully, by participation in the Asia Oceania Geosciences Society meeting in Singapore.

Publication of the FLAG/IGCP 449 special issue of *Geologie en Mijnbouw/Netherlands Journal of Geosciences* and the IGCP 449 special issue of *Current Science* (New Delhi) was achieved in 2003 (see Appendices K & M). The special issues of Proceedings of the Geologists' Association and Quaternaire should both appear during 2004 (see Appendices L & N).

4.2 Specific meetings and field trips

(a) Participation in the 32nd International Geological Congress, Florence, August 20-28, 2004

The FLAG 2004 meeting (below, b) is scheduled to follow on from the IGC and will include a major IGCP 449 component. It is anticipated that this timing will allow participation in both meetings. IGCP 449 involvement in the Florence symposium will include 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 will be 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?”.

(b) FLAG 2004, Sienna, Italy, September 2004. Local organizer: Mauro Coltorti

This specifically fluvial meeting (FLAG = Fluvial Archive Group) will consist of 2 days of lectures and meetings at the Department of Earth Sciences in Siena, followed by a 3-day field excursion crossing the Apennine ridge. The theme of the meeting is 'Fluvial architecture and dynamics in rising mountain chains and related basins: tectonics, climatic influence and human impact' (see Appendix O).

(c) EuroMam 2004

A meeting of the European Quaternary Mammal Research Association will take place in the UK from 10th-14th May 2004. This will include a visit to the celebrated Lower Thames sequence, with its key mammalian faunas. IGCP 449 Biostratigraphy subgroup co-leader Danielle Schreve is an organizer of the meeting. Several European project participants will attend.

(d) Local meeting in Russia, 2004, date to be finalized

The Russian group of IGCP 449 contributors plans to organize a local meeting in Russia, with an indoor programme in Perm, followed by an excursion to examine the terraces of the Kama river during 2004. The organizer will be Valentina Drouchits, Moscow.

(e) International Symposium on Earth System (ISES), Istanbul, September 8-10, 2004

The Turkish group and their contacts plan to participate in this meeting, which overlaps in part with FLAG 2004.

(f) Singapore – Asia Oceania Geosciences Society meeting, 5-9 July 2004

Participation in this meeting has been flagged as a possible means of replacing the hoped-for Chinese project meeting, which has had to be postponed until a follow-up project.

(g) Fifth and final IGCP 449 international meeting: End-of-project meeting, December 2004, venue to be finalized

It has been intended to run an end-of-project meeting from an early stage, in conjunction with targeted contributions to a special issue of *Quaternary Science Reviews* that has been agreed in principle with the journal editor, Prof. J. Rose (see Appendix P). The decision to postpone a China meeting until the anticipated follow-on project led to the adoption of the end-of project meeting as the fifth international meeting, although it is intended to share project funding between this, the Florence/Sienna and Singapore meetings. The success of previous December meetings (Kanpur 2001 and Agadir 2002) was influential in making this alteration to the programme. This decision has led to a desire to expand the proposed meeting to include a field element, which has always been an important and enjoyable component of previous international meetings. For this reason the planned London venue is deemed unsuitable and alternatives in Turkey and Spain are being explored. Both share the advantage of longer

December days, accessibility and a good holiday infrastructure that will aid the running of a low-price off-season meeting.

5. Project funding requested

Requested funding level for 2004: HIGH

Justification:

This project is fully global, with resultant high costs involved in assisting participants from developing countries with travel to meetings. All funding to date has been used for this purpose, except for the <10% that has gone towards meeting organizers' costs (all meetings so-funded have been in poorer countries). With a high level of funding awarded in 2002 and 2003 it has been able to support attendance at more than the single annual meeting each year, which as been a huge advantage in achieving a truly global level of activity. With the intention to support attendance of meetings in Italy, Singapore and Spain/Turkey during 2004, it is desirable to have funds to support a good level of attendance at each venue by participants from developing countries (support has always been and will continue to be used only to fund those from poorer countries).

6. Successor Project

It is intended to seek a follow-on project. Debate is continuing about whether such a project should be thematic or regional. A topic is required that is globally inclusive, that would not exclude areas where much work has already been achieved, and yet would still encourage the filling of data gaps and the participation of new areas. It is anticipated that an application will be made in 2004 for a project to follow on without a hiatus, to allow the continuation of database compilation and other unfinished activities from the present project.

Appendices

Attached are the following:

Appendix A – IGCP 449 Internet database (status late 2003)

Appendix B – Agadir meeting report

Appendix C – Business meeting 5

Appendix D – Report of 4th International Project meeting, Brazil, June 2003

Appendix E – Business meeting 6, Belem / Rio Branco, Brazil, June 10 & 17 2003

Appendix F – FLAG / IGCP 449 Poster Session, 16th INQUA Congress, Reno USA, July 24 2003

Appendix G – Business Meeting 7, Reno USA, July 24 2003

Appendix H – National Reports:

(Hi) IGCP 449 2003 Activity in Argentina
(Hii) IGCP 449 2003 Activity in Australia
(Hiii) IGCP 449 2003 Activity in Belarus
(Hiv) IGCP 449 2003 Activity in Belgium
(Hv) IGCP 449 2003 Activity in Brazil
(Hvi) IGCP 449 2003 Activity in Bulgaria
(Hvii) IGCP 449 2003 Activity in Canada
(Hviii) IGCP 449 2003 Activity in China
(Hix) IGCP 449 2003 Activity in the Czech Republic
(Hx) IGCP 449 2003 Activity in France
(Hxi) IGCP 449 2003 Activity in Germany
(Hxii) IGCP 449 2003 Activity in Hungary
(Hxiii) IGCP 449 2003 Activity in India
(Hxiv) IGCP 449 2003 Activity in Lithuania
(Hxv) IGCP 449 2003 Activity in Morocco
(Hxvi) IGCP 449 2003 Activity in the Netherlands
(Hxvii) IGCP 449 2003 Activity in Poland
(Hxviii) IGCP 449 2003 Activity in Russia
(Hxix) IGCP 449 2003 Activity in Spain
(Hxx) IGCP 449 2003 Activity in Syria
(Hxxi) IGCP 449 2003 Activity in Turkey
(Hxxii) IGCP 449 2003 Activity in the UK
(Hxxiii) IGCP 449 2003 Activity in Ukraine
(Hxxiv) IGCP 449 2003 Activity in Uruguay
(Hxxv) IGCP 449 2003 Activity in the USA

Appendix I – Thematic Reports:

(Ii) Report of the Subgroup on Archaeology from fluvial sequences (Sheila Mishra & Mark White)
(Iii) Report of the Biostratigraphy Sub-Group of IGCP 449 (D.C. Schreve, D.H. Keen, N. Limondin-Lozouet & M. Ubilla)
(Iiii) Report of the group for Crustal Deformation & Uplift Modelling (R. Westaway & A. Matoshko)

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

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

Appendix L – Special Issue of *Proceedings of the Geologists' Association*

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

Appendix N – 2004 Special Issue of *Quaternaire*

Appendix O – Programme for the FLAG 2004 Meeting, Siena, Italy

Appendix P – Proposed Special Issue of *Quaternary Science Reviews* (final project outcome)

Appendix Q – List of new participants in IGCP 449, 2003

IGCP 449 2003 Activity in Belarus

News of any meetings or field excursions relevant to the project

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.

News of any new or ongoing 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 continued in 2003.
The main results of the study:

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. Altitudional 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 altitudional 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.

Relevant publications produced by participants during recent years or in press

Published:

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).*

Plans/hopes for future activity

The problem of the correlation of the Late Pleistocene fluvial network in the SE part of the Baltic Sea drainage basin is still unsolved. It is anticipated that this question will be the primary task for 2004. The base for such a correlation exists in the area of interest (lithofacies successions of fluvial series in the key sites, palaeobotanical records, palaeocurrent measurements). All that we need is to co-operate and elaborate joint interpretation of the existing records.

Irina Pavlovskaya
December 2003

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

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

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Contents:

This volume arises from the FLAG meeting in Mainz, Germany, 20th-23rd March 2000.

3rd International Meeting of IGCP 449 'Global Correlation of Late Cenozoic fluvial deposits'

Agadir, Morocco, 13th-17th December 2003

The 3rd international scientific and business meeting of IGCP 449 was held over 5 days in the Atlantic coastal town of Agadir in the SW of Morocco during December 2002. This occasion continued the international momentum of the 449 project by following on from the previously successful inaugural meeting in Prague (April 2001) and the second meeting in Delhi, India (Dec 2001). The Moroccan event was a special occasion for the project as it was the first dedicated project meeting to take place on the African continent. In excess of 30 delegates from Morocco, Egypt, Canada/France, Hungary, Czech Republic, Turkey and the UK participated in the meeting. The format for the meeting was a day of scientific presentations and a project business meeting followed by three days of field excursions examining Late Cenozoic fluvial and marginal marine deposits associated with rivers that drained the principal topographic relief of Morocco, the High Atlas Mountains.

Scientific and business meeting

The scientific meeting was opened with a welcoming address from **Hassan BenHalima**, the Dean of Arts and Human Sciences (Univeristé Ibn Zohr, Agadir) and the event organiser **Ali Aït Hssaine** (Department of Geography, Univeristé Ibn Zohr, Agadir). The first paper was presented by **Jaroslav Tyráček** (Czech Geological Survey) who provided an account of the fluvial response to neoteconic movements in upland central Europe. This was followed by **Ali Aït Hssaine** (Agadir, Morocco) who talked about the Tarodant-Oulad Tiema piedmont area of the southern High Atlas mountains and their geomorphological development from the Oligocene through to the Early Pleistocene. The Late Pleistocene landscape development and a ^{14}C dated fluvial sequence related to the development of the Oued (River) Rheris in SE Morocco was presented by **Larbi Boudad** (Errachidia, Morocco). **Rafat Zaki** (Minia, Egypt) outlined his research on the influence of Late Cenozoic climate change on the River Nile. After a short break an interesting paper was presented by **A.Elmouden** (Agadir, Morocco) and colleagues on their work using clay geochemisty as a provenance indicator in fluvial sediments. They concluded that the erosion from the High Atlas mountains and remobilization of Quaternary fluvial material from the Souss Plain were the principal suppliers of sediment to the Atlantic Ocean. **Rob Westaway** (Open University, UK) presented some of his numerical modelling results that indicated that Quaternary surface uplift was responsible for producing staircases of river terraces in the northern Black Sea, Ukraine and Russia. The surface uplift is attributed to the dynamic coupling between climate induced landscape erosion, cyclic surface loading and the flow response of the lower crust. Some interesting and lively debate followed highlighting the global phenomenon of the timing of the initiation of fluvial incision by many of the worlds river systems during the early-middle Pleistocene. The final paper before lunch was by **Anne Mather** (Plymouth, UK) who outlined some ongoing research in SE Spain where a series of river captures had taken place. The paper discussed some aspects of the timing of capture and its implications for sediment routing between basins.

The afternoon session began with a return to Eastern Europe with a talk by **Pavel Havlíček** (Czech Geological Survey) who outlined the evolution of the confluence area between the Rivers Dyje and Morava. A model for climate-driven evolution was proposed for the Late-Pleistocene/Holocene period with more human influence becoming evident from the Mesolithic through to the 19th century. **Rob Westaway** (Newcastle, UK) presented some recent research undertaken with colleagues on the terrace staircase of the Euphrates in Turkey and Syria associated with surface uplift during the Quaternary. **Martin Stokes** (Plymouth, UK) talked about the creation of transverse drainage in SE Spain using the Río Almanzora as

an example. The creation of such discordant drainage is attributed to differential uplift between sedimentary basins, which in turn has accelerated headward erosion, culminating in river capture and drainage network re-organisation. The final presentation was by **David Bridgland** (Durham, UK) who as project leader for IGCP449 provided the latest updates on the project, using examples from his own work of the River Thames and the initiation of some new research on terrace records from Syria and India.

The final part of the day involved the business meeting for IGCP449. There was a status report for the compilation of a database and its access via the web. The data base is intended to provide researchers interested in Late Cenozoic fluvial deposits on line access to data sets (e.g. dated terrace staircase diagrams). Offers for future IGCP449 meetings were tabled and discussed for the 4th and 5th years of the project. These included the 4th International IGCP449 meeting to be held in Brazil in the summer of 2003, participation in the FLAG/IGC meeting in Siena (Italy) during summer 2004 and the possibility of an end of project meeting in London. Some points for a follow-on project were discussed. These included that having established stratigraphic frameworks from the first (449) project the next stage could focus upon the controlling mechanisms (e.g. tectonism or climate) for the initiation and evolution of Late Cenozoic fluvial records.

Field Excurisons

Agadir and the Atlantic Coast of the High Atlas - This first field excursion provided an introduction to the Late Cenozoic piedmont and coastal geology and geomorphology of the Agadir region. Much of this knowledge is based upon the work by Andre Weisrock (Nancy, France) and his Moroccan colleagues. The field excursion started a few kilometres to the SE of Agadir town at the El Masser section where some early-middle Pleistocene piedmont fan sediments that offlapped tilted Pliocene, Oligocene and Cretaceous sediments were examined. On return to Agadir there were several opportunities to examine the stratigraphy and sedimentology of Pleistocene raised shoreline deposits located in a series of road cuttings. An interesting point of discussion arose from observations made at these sections concerning the identification of neotectonic structures in coarse-grained sediments when they could more simply be explained as the products of sedimentary processes. Lunch took place in a small village to the north of Agadir. Here we had the first of many traditional Moroccan tagines. These were large clay dishes that contained meat and vegetables slow cooked in an oven and eaten with unleven bread. In the afternoon there was a short walk down to the mouth of the Wadi Tamghart where some superb composite Late Pleistocene (Ouljian-Soltanian) raised shorelines were observed (Fig. 1). The final locality was at the Agadir Kasbah (castle) which enabled a panoramic overview down onto Agadir town and the area that was destroyed in the catastrophic 1960 earthquake that involved the loss of some 12-15000 lives.

Fig. 1 - Composite late Pleistocene raised shoreline sequence (OIS5e) overlying Mesozoic sandstones (dipping) at the mouth of Wadi Tamghart, north of Agadir. Section height = c.4.5m.

Southern Piedmont of the High Atlas and Taroudant areas in the Souss Valley - On the second day of field excursions we travelled eastwards, inland from Agadir, with the purpose of examining Quaternary piedmont fan and river terrace sediments and landforms associated with the work of **Ali Aït Hssaine** (Agadir, Morocco). The first stop was on the margins of the High Atlas mountains. In the vicinity of the Dkihla dam a series of Plio-Pleistocene river terrace sediments were observed (Fig. 2) and yet again there was some interesting debate concerning the identification and explanations of neotectonic structures (Morocco) or sedimentary erosion features (UK). We then headed SE back into the low lying middle Souss Valley and examined some late Pleistocene distal fan deposits exposed in sections along the banks of the Wadi Ouaar. Following another traditional tagine lunch we continued our examination of Late Pleistocene-Holocene sediments in the middle Souss Valley and saw for once some convincing evidence for neotectonic activity in the river terrace sediments. We finished the day with a quick visit to the city of Taroudant and were shown round the impressive souk (market) contained within the walled old part of the city.

Fig. 2 - Plio-Pleistocene river terrace and strath landforms of the Wadi Issen, located downstream of the Dkihla dam, southern High Atlas mountains.

The High Atlas Mountains - The third day involved a long 250 km road trip across the High Atlas Mountains from Agadir to Marrakech. The route involved traversing the impressive Imi n'Tanoute pass. En route we stopped for a panoramic overview of the Argana area which contained a well-developed sequence of Quaternary pediments and fan surfaces. There was also a quick stop at a road cutting to examine vertical bedding planes of Triassic sandstones and mudstones covered with large dinosaur footprints. Late in the afternoon we reached Marrakech and had an opportunity to explore the labyrinth of the souk, ending up in the famous main square of Djemma el Fna.

Northern Piedmont of the High Atlas - The fourth and final field day involved an examination of the Cenozoic geology of the northen piedmont of the High Atlas. Our first stop was c. 25km south of Marrakech where we the opportunity to examine in detail some Palaeozoic and Cenozoic sediments lead by **E.H Chellai** (Marrakech, Morocco). We had the opportunity to collect and break open geoids that were weathered out of the Mio-Pliocene part of the succession. There were also opportunities to examine a complex sequence of calcretes that were developed into the Quaternary part of the succession. We then returned to Marrakech and then headed SE to the valley of the Wadi Ourika and Wadi Ghirhaya. Here, some opportunities to examine some Quaternary river terraces that were developed onto a series of tilted and thrust related Tertiary units associated with the growth of the High Atlas. Following a late lunch we headed back across the High Atlas and returned to Agadir where the meeting ended.

Summary

The meeting was a highly successful contribution to the IGCP449 project. Most importantly it brought together European, North American and African geoscientists, all of whom had an

interest in river terraces, long term drainage evolution and their tectonic / climatic controlling mechanisms. We had the opportunity to present some of the latest international advances into research of Late Cenozoic fluvial deposits. The Moroccan hosts organised a very good meeting and were very hospitable indeed! The field excursions were the most important aspect of meeting and it gave the Moroccans the opportunity to showcase some of the fantastic geology and geomorphology that their country possesses. It is highly likely that several collaborative projects will be initiated following the meeting in order to examine some spectacular fluvial records in NW Africa that as yet remain unstudied or have received little attention.

Martin Stokes (Geology, Plymouth, UK)
Anne Mather (Geography, Plymouth, UK)

IGCP 449, Scientific Business Meeting 5

"Village de l'Electricien" Resort and Conference Centre, Agadir, Morocco, 4 pm, Friday 13 December 2002.

Chair: Dr David Bridgland, Durham University, UK, IGCP 449 Co-leader

Minuted by: Dr Rob Westaway, The Open University, UK

Apologies for non-attendance from
Professor Sampat Tandon, IGCP 449 Co-leader
Professor Liping Zhou, IGCP 449 Co-leader
Dr Darrel Maddy, IGCP 449 International Secretary

Dr Bridgland welcomed all participants. He thanked the organizer of the International Meeting of IGCP 449 for 2002 (at which this business meeting was hosted), Professor Ali Ait Hssaine (Ibn Zor University, Agadir, Morocco), for his hard work that had led to a successful meeting, and thanked all participants for the efforts they had made to attend. Several participants had difficult journeys to Agadir because flights were delayed or cancelled.

1. Summary of outcomes from previous meetings & project activity

Dr Bridgland reported on progress with the IGCP 449 fluvial archive database / web site. At the International Meeting for 2001 in Kanpur it had been decided that the original plan for a global database was too demanding. A pilot database would be designed to ascertain it feasibility, but the main aim would become the development of a searchable web site to present key fluvial archive data, enabling material previously published in relatively inaccessible local journals to be made much more widely accessible. Participants were invited to contribute their own data to this web site, and several agreed to do so.

Dr Bridgland explained that the annual report for 2002 had just been submitted. However, contributions would be requested in late 2003 for the 2003 annual report. The continued receipt of a high-level of funding for IGCP 449 would be determined by the quality of these reports.

2. Targets for Year 4

Dr Bridgland explained that the main objectives for year four of IGCP 449, 2003, were:

- Completion of phase 1 of the IGCP 449 web site covering NW Europe and phase 2 of it covering eastern and southern Europe, north Africa, and North America
- Making a start with phase 3 covering the rest of the world.

- Publication of the special volume of Proceedings of the Geologists' Association for the Prague meeting of IGCP 449 (for 2000)
- Publication of the special volume of Current Science for the Kanpur meeting of IGCP 449 (for 2001)
- Hosting of the International Meeting of IGCP 449 for 2003 at Belem, Brazil, in June 2003, and the associated field workshop on the Late Cenozoic evolution of the Amazon Basin.
- Organisation of the IGCP 449 special session at the INQUA Congress at Reno, Nevada, in July 2003.

3. Targets for the final year and final project outcomes

Dr Bridgland explained that the main objectives for the final year of IGCP 449, 2004, were

- Completion of the IGCP 449 web site
- Organisation of an IGCP 449 session at the IGC-32 Congress at Florence, Italy, in August 2004.
- Organisation of an IGCP 449 contribution to the FLAG 2004 Conference at Siena, Italy, in September 2004.
- Organisation of an end-of-project meeting, tentatively scheduled to take place in London at the end of 2004 or in early 2005
- Organisation of an end-of-project special publication, to be included in a major international journal. The first choice would be Quaternary Science reviews, and its editor would be contacted about this in early 2003.

4. Follow-on project

Dr Bridgland led a lively discussion on the question of a follow-up project. It was felt that such a project would be useful, and a number of ideas were put forward. Several participants (including Dr Anne Mather, Plymouth University, UK; Dr Martin Stokes, Plymouth University, UK; and Dr Rob Westaway) felt that this new project should cover relationships between fluvial sequences and crustal deformation, reflecting their own research interests. It was thought that this could form a major theme of a wider project.

5. Any Other Business

The possibility of a special volume for this meeting was discussed. Dr Serge Ochietti (Montreal) offered to edit it jointly with Dr Bridgland, and to host it in the Canadian Journal Géologie Physique et Quaternaire. Participants were invited to contribute manuscripts, to a deadline of 28 February 2003.

The meeting closed at 5.25 pm.

Report on attendance at the 2003 International Meeting (Conference and Field Trip) for IGCP 449, Belem and Rio Branco, Brazil.

Rob Westaway, The Open University, 11 September 2003.

IGCP 449 "Global Correlation of Late Cenozoic Fluvial Deposits" is scheduled to run from 2000 to 2004. In accordance with the emphasis underlying this project, of encouraging involvement of researchers from developing countries, its fourth annual International Meeting was held in Brazil during June 2003.

This meeting comprised a special session at the 3rd Latin American Sedimentology Conference, which took place in Belem in the north of Brazil on 9-11 June, and an associated field excursion based around Rio Branco in the far west of the country (Fig. 1), on 12-18 June. Together with the main port of entry into Brazil, at São Paulo in the south, these points form the corners of a triangle with sides ~2500 km long. The practical difficulties associated with covering such large distances were a major factor affecting participation at this meeting.

This meeting coincided with the merger of Brazil's two main airlines, VARIG and TAM, both of which had been making heavy losses. Associated cutbacks in domestic air services were being made in a chaotic manner before and during this meeting. Because the new air service schedule kept changing, it was repeatedly necessary to rebook my domestic tickets in the month preceding departure, as individual flights were repeatedly cancelled or rescheduled. To avoid the risk of being stranded somewhere in the Amazon Basin due to further domestic flight cancellations, a free day was built into my schedule between the end of the field trip and my return flight to England. This was spent in Rio de Janeiro, providing the opportunity for some brief reconnaissance fieldwork on the local coastal geomorphology (see below). Other field trip participants were not so lucky, and ended up having to either arrive late or depart early due to their original reservations being on what turned out to be non-existent domestic flights. The second major difficulty was that, for some reason, domestic flights in Brazil tend to involve series of intermediate stops, rather than being direct between their end points. As a result, journeys that would only take a few hours by direct flight required entire days, or lasted overnight.

Belem is a vibrant city of ~1.3 million, located at the mouth of the Amazon, with opulent architecture dating from the late 19th century rubber boom. This was the point where much of this valuable cargo was transhipped from river boats to ocean-going ships. Unfortunately, in 1876 a negligent customs official failed to notice a British entrepreneur smuggling out a cargo of rubber tree seedlings. These were cultivated at Kew Gardens and later transplanted to Malaya. After these trees took several decades to mature, the resulting much lower production costs from these commercial rubber plantations wiped out the Brazilian rubber industry.

The conference here was organised by staff at the local University (the Federal University of Para) and held in the Belem Hilton Hotel. It was necessary to stay at this expensive hotel for two main reasons. First, due to the risk of crime visitors were urged to

spend as little time as possible outside on the street. Several conference participants were indeed mugged outside the hotel. Second, at the time reservations were made the schedule called for departure in the early hours of the morning of 11 June, to catch a flight to Rio Branco leaving at 4 a.m. It therefore made sense for everyone making this journey to stay in the same place, to avoid the risk of anyone being left behind, as this was to be the only flight that day. However, at a late stage this flight was cancelled and replaced by one departing at 11:30 a.m.

This sedimentology conference was dominated by sessions relating to the oil industry, with many presentations by personnel from Petrobras, the Brazilian state oil company. For long a major oil importer, Brazil is about to become a net exporter due to the rapid development of its reserves. Most such newly-discovered reserves are offshore, in basins that formed during the Triassic – Early Jurassic rifting of the South Atlantic Ocean and are conjugate to similar oilfields already developed offshore of west African countries such as Nigeria, Gabon, and Angola.

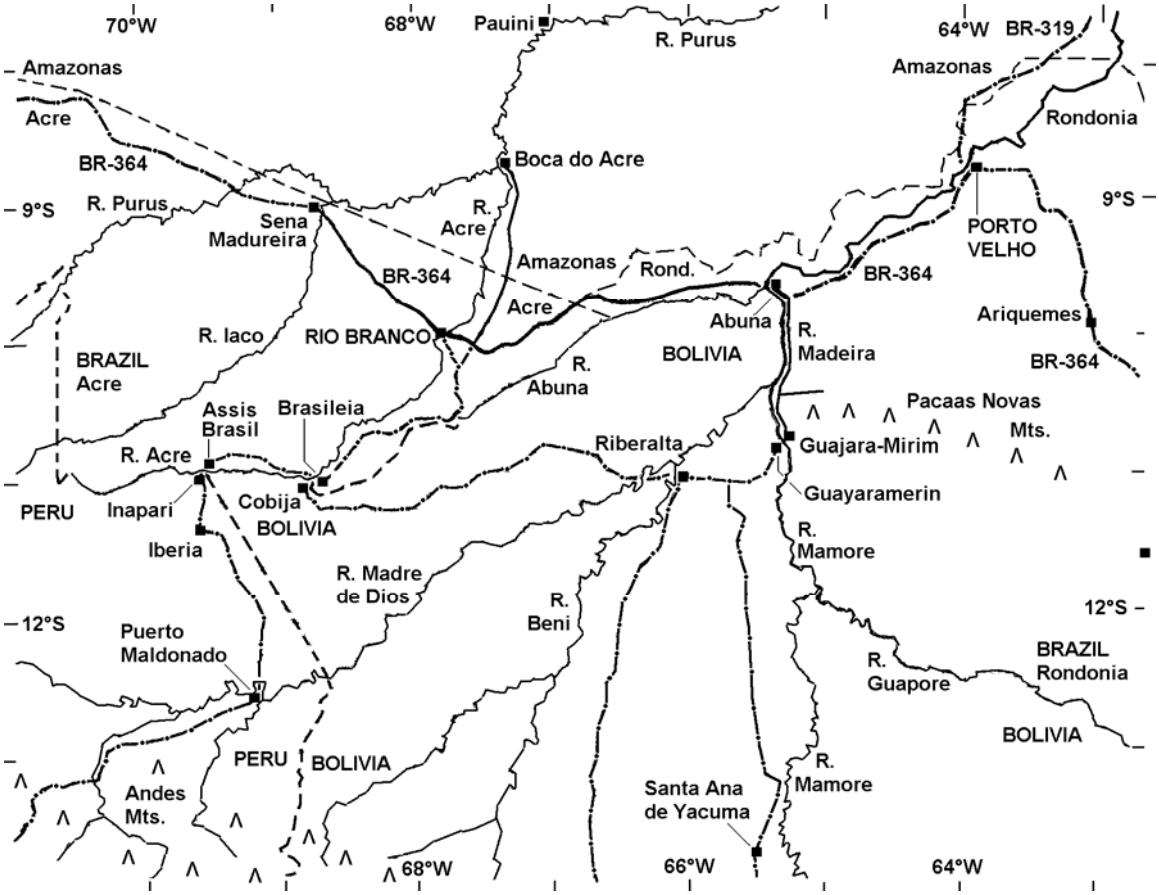

Fig. 1. Map of the field trip area. Dashed lines mark borders: between Brazil, Bolivia and Peru; and also between the Brazilian states of Acre, Amazonas, and Rondonia. Solid lines mark rivers, and dot-dashed lines mark roads. Thick solid lines mark the field excursion route: Rio Branco - Abuna - Guajara-Mirim - Pacaas Novas Mts. - Guajara-Mirim - Abuna - Rio Branco - Boca do Acre - Rio Branco - Sena Madueira - Rio Branco.

For some reason, the IGCP-449 sponsored session on global fluvial sequences clashed with an independently-organised session on the evolution of the Amazon Basin. This meant that opportunities for international delegates (from Europe, North America, Asia, and Australia) to learn about the Amazon were limited, as were opportunities for local specialists to learn about rivers elsewhere in the world. The Amazon is, of course, the world's largest river system, but remarkably little is known about its evolution. Reasons for this information gap became evident later, during the field excursion: exposure of outcrop in the Amazon rain forest is typically non-existent, except along road cuts (which are pretty few and far between) and channel banks (where nothing older than deposits of similar channels from earlier in the Holocene is typically exposed). However, Miocene sediments of the Solimoes Group do crop out in parts of western Brazil and adjacent parts of Peru and Colombia, and are proven in boreholes to thicknesses of up to ~1 km. They represent fluvially-transported material eroded from the Andes before the modern west-east Amazon system draining into the Atlantic Ocean was established. However, they are not well-dated, because in the Miocene (before the present land bridge linking to North America was established) South America supported an endemic fauna whose chronology - for biostratigraphic dating purposes - is not well-constrained. Furthermore, the literature on this topic has involved a history of highly imaginative - some might say, totally barmy - interpretations, possibly influenced by the fact that the remoteness has been thought to make it unlikely that anyone will ever re-visit the same localities to check. An example is the idea, which has featured in recent publications and was also being pushed forward energetically in talks at Belem, that in western Brazil the Solimoes Group does not represent fluvial but *tidal* deposition. One of the aims of the subsequent field trip was to visit some of the localities where a tidal origin for the sediment has been claimed, to examine the evidence for ourselves (see below).

Part of the original reason for my attendance was to chair a business meeting, to explain the achievements of IGCP 449 and to invite suggestions for further activities on this project and for a possible follow-up project. Unfortunately, no such meeting was scheduled by the conference organisers, so part of the IGCP 449 session had to be used for this purpose. However, this meant that it was not possible for people attending the parallel Amazon session to participate.

The daytime flight on 11 June from Belem, to Rio Branco via Manaus provided spectacular views of the Amazon rain forest (Figs 2, 3). At this time of year, right-bank tributaries such as the Acre at Rio Branco, which are located well inside the southern hemisphere, are at their low stage (Fig. 4), whereas left-bank tributaries that lie in the northern hemisphere are in flood (Fig. 2).

The field excursion based around Rio Branco was led by Professor Edgardo Latrubesse (Federal University of Goias, Goias state, Brazil) and Professor Jose Stevaux (State University of Maringa, Parana state, Brazil). Its first day (12 June) was improvised in the vicinity of Rio Branco, to allow participants arriving late due to airline problems to join the rest of the party. Localities along the River Acre (e.g., Fig. 4) were visited, some low (Late Pleistocene and Holocene) terraces were examined, and environmental hazards such as flooding and landsliding were discussed.

Fig. 2. Aerial view looking west along the Amazon trunk channel just west of Manaus, Amazonas state (shortly after takeoff from Manaus airport), on 11 June 2003. The Amazon is locally in flood, due to high seasonal discharge from left-bank tributaries located in the northern hemisphere. Floodwater backs up along minor right-bank tributaries, as illustrated, which appear like minature "rias".

Fig. 3. Aerial view of incipient ribbon-development of cattle ranching along a dirt road just north of Porto Velho, Rondonia state (Fig. 1). The forest has typically been cleared for a few hundred metres distance on either side of this road. The same process has reached a greater stage of completion along the region's main roads: for instance, the forest has typically been cleared along highway BR-364 to a typical distance of several kilometres.

Fig. 4. View upstream along the River Acre on the southern outskirts of Rio Branco, Acre state. This right-bank Amazon tributary is at its low stage, at the same time of year as left-bank tributaries are in flood (Fig. 2). The channel follows an entrenched course, with the water surface ~10 m below the surrounding land surface. However, at times of high discharge this river can fill its channel and flood over the surrounding land surface.

The second and third days (13 and 14 June) involved a trip ~400 km eastward, with an overnight stop in Guajara-Mirim in Rondonia state, to investigate the River Madeira, one of the major Amazon tributaries, and the geomorphology of the nearby Pacaas Novas Mountains (Fig. 1). Most of this route followed highway BR-364, which connects the isolated cities of Rio Branco and Porto Velho with the densely populated eastern part of Brazil. The construction of this surfaced highway in 1983-4, with World Bank funding, was part of a project organized by the military dictatorship of the time to try to solve overpopulation problems in the east of Brazil by colonizing the Amazon basin. Construction of this road was described by the American environmentalist George Monbiot (*Amazon Watershed*, 1991) as "probably the single most destructive piece of engineering in the world". It led to a ten-fold population increase in a decade, and caused immediate social problems because many of these migrants made unsuccessful attempts at arable farming, for which the soil of the Amazon basin is unsuited.

This region's present economy is instead dominated by cattle ranching, achieved by growing coarse, African elephant grass and grazing it with disease-resistant Indian cattle. The rain forest has now been cleared back for several kilometres distance for this purpose along almost the entire length of highway BR-364 (Fig. 3). Local specialists on the field trip reported that no significant increase in rates of soil erosion has been observed to result from this, from inspection of either the geomorphology or rates of sediment transport in rivers. This is potentially significant, because deforestation of the Amazon is generally regarded as environmentally destructive as it is usually thought to be unable to support any form of sustainable agriculture. However, if it *is* possible to develop sustainable cattle ranching in this region, then - regardless of political correctness - there is no difference in principle between Brazilians cutting down their forests in the 1990s and people in Europe cutting down their own forests thousands of years ago.

After a long journey through ranch land in eastern Acre state and western Rondonia state, our route on highway BR-364 crossed the River Madeira by ferry at Abuna, immediately downstream of the northern tip of Bolivia. From here the road follows the Madeira and

Fig. 5. View across the River Madeira, looking westward into Bolivia from a point north of Guajara-Mirim, showing one of the sets of rapids where this river flows over the Early Proterozoic crystalline basement of the Guapore shield.

Fig. 6. Another small fraction of the Amazon rain forest on its way to the sawmills of Guajara-Mirim, crossing a tributary of the Madeira on one of the bridges originally built for the railway from Porto Velho and now used for this region's only major road.

Mamore rivers upstream to Guajara-Mirim (Fig. 5), built on the course of the former 364 km long Madeira-Mamore Railway from Porto Velho (Figs. 6, 7). This stretch of river is not navigable due to many rapids where the Madeira and its Mamore tributary flow through crystalline basement of the Guapore shield (Fig. 5). To permit export of rubber from landlocked northern Bolivia, in 1903 the Bolivian government ceded the region that now forms Acre state to Brazil in return for a treaty commitment to build this railway. Construction took from 1907 to 1912, which meant that the inaugural train service virtually coincided with the collapse of the Amazon rubber boom as plantations in

Malaya came on stream. This railway ceased commercial operations in 1931 but was maintained as a social service before conversion to the present road in 1972.

Fig. 7. Madeira-Mamore Railway Company locomotive no. 20 (built by Baldwin Locomotive Works, Philadelphia, Pennsylvania, in 1909; works no. 34004) on display on a short length of preserved track outside Guajara-Mirim station, which is now the town's natural history museum.

Fig. 8. Part of the northern escarpment of the Pacaas Novas Mountains, northeast of Guajara-Mirim. The flat surface in the foreground, cleared of forest vegetation for cattle ranching, is a pediment developed on the chemically-weathered upper surface of Early Proterozoic granite that forms the crystalline basement in this region. Some corestones are visible; elsewhere tors are also observed. The ~260 m high escarpment in the background is formed of Late Proterozoic conglomerate, deposited in a graben within the granite. Subsequent chemical weathering has lowered the land surface in the granite but not in the conglomerate, creating a topographic inversion.

The main reasons for visiting this area were to briefly examine some of the extensive gold mining operations in placer deposits within fluvial deposits of the Madeira and Mamore - the gold being fluvially transported from the Guapore shield - and to inspect the Pacaas Novas Mountains (Fig. 1). Unlike the River Acre, already observed, which only drains the Amazon lowlands, the Madeira system also drains part of the Andes Mountains (Fig. 1). As a result of higher rainfall, erosion of the flanks of the Andes is rapid and this river system therefore carries a vastly greater sediment load than any of the purely lowland Amazon tributaries. The ~150 km long Pacaas Novas mountain range (Fig. 8) is formed of Late Proterozoic conglomerate, deposited as the fill in a graben in the crystalline basement of the shield. However, because this siliceous conglomerate does not weather chemically whereas the feldspar-dominated basement does, a topographic inversion has developed. Most field trip participants considered this quite an interesting place, but it was generally agreed that its connection with Late Cenozoic fluvial deposits was somewhat tenuous.

Having returned to Rio Branco late on 14 June, we left again the following morning, as the fourth and fifth days (15 and 16 June) involved a second excursion, this time with an overnight stop farther north at Boca do Acre (Fig. 1), at the confluence of the Acre and Purus rivers. Although this destination was only ~150 km from Rio Branco, much slower speeds were necessary on this dirt road. The main function of the town of Boco do Acre is to accommodate travellers arriving or departing on river boats from or to other settlements on the Purus, to which the nearest alternative road access is ~150 km upstream at Sena Madureira, and ~350 km downstream at Labrea. For instance, we observed a boat arriving from the town of Pauini, ~100 km downstream, a journey of a day and a half. River boat trips on the afternoon of 15 August and the morning of 16 August enabled close observation of the channel of the Purus upstream and downstream of Boca do Acre. This lowland river has a similar appearance to the Acre (Fig. 4), but is larger, being also flanked by abandoned Holocene channels.

Day 6 (17 June) involved a traverse along highway BR-364 for ~150 km westward from Rio Branco to Sena Madureira and back, providing the first clear sight of the sediments of the Solimoes Group, which pre-date the establishment of the west-east drainage by the modern Amazon system into the Atlantic (Fig. 9). It seemed obvious to all participants that these Miocene sediments represent a combination of fluvial and lacustrine environments, suggesting deposition in a vast wetland where rivers discharged into lakes. The mineralogy of the fluvial sediments suggests derivation direct from the Andes, in contrast with this region’s modern rivers that drain only the Amazon lowlands.

Although some participants had to leave on 17 June to avoid being stranded as a result of airline problems, the field trip ended after the morning of 18 June (day 7), following a final boat trip to investigate the Solimoes Group sediment exposed along the Acre river channel upstream of Rio Branco. Although most of the length of this river channel is incised into earlier Holocene sediments, the Miocene sediment is exposed in a few places, mainly on the outsides of incised meanders (Fig. 10). Like elsewhere, the tidal interpretation previously proposed for these sediments does not appear to be plausible.

On the afternoon of 18 June, after the organised field trip had ended, I arranged a visit to the Palaeontology Museum at the Federal University of Acre outside Rio Branco. This museum possesses a remarkable collection of vertebrate fossils from the Solimoes Group, including river turtles, rodents, and notungulates (South American endemic herbivorous mammals). The most spectacular exhibits were of the giant Miocene crocodile *Purussaurus brasiliensis* (Fig. 11).

Fig. 9. A typical roadside exposure of the Solimoes Group: in a road cut on the south side of highway BR-364, east of Sena Madureira. This exposure looks like a fluvial channel incised into mud and then filled with sand, with some lateral accretion. No field trip participant could think of any explanation in terms of tidal processes.

On the evening of 18 June I caught a flight from Rio Branco to Manaus. This connected with a flight to Rio de Janeiro departing just after midnight and arriving early in the morning of 19 June. Because I had no confidence, in advance, that either of these domestic flights would operate as scheduled, I arranged an extra day in Brazil before my return flight to Heathrow, to reduce the risk of being stranded and so missing this international flight (as British Airways would be unlikely to have any sympathy for any passenger delayed because VARIG were a shambles, and would almost certainly refuse to rebook my ticket to a later flight). I used the time in Rio de Janeiro to investigate the coastal geomorphology (Figs. 12, 13).

Fig. 10. Exposure of Solimoes Group sediment on the outside of a meander loop in the left bank of the River Acre, just upstream of Rio Branco. This exposure consists of a rhythmic pattern of many sand-mud interbeds, each bed being typically several tens of centimetres thick. This outcrop and others in the region have previously been interpreted as a result of tidal deposition, in part because the measured thicknesses of beds show a cyclicity that has been interpreted as a result of the fortnightly spring-neap tidal cycle. However, these sediments look very similar to alternations between flood (sand) and slack water (mud) deposits observed elsewhere (for instance around Boca do Acre) and can thus be explained instead as a result of repeated seasonal flooding. A major difficulty with the tidal interpretation is that it would require a sedimentation rate of many metres per year, requiring the whole ~1 km thickness of sediment to have accumulated in just a few hundred thousand years. No field trip participant considered a tidal interpretation plausible.

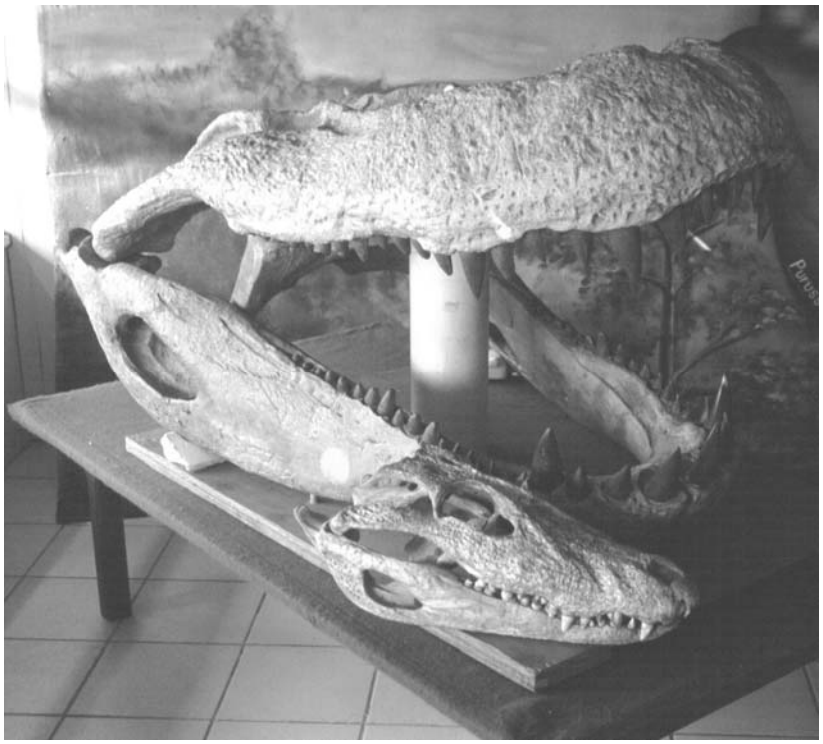

Fig. 11. Skull of the giant Miocene crocodile *Purussaurus brasiliensis* from the Solimoes Group, on display in the Palaeontology Museum at the Federal University of Acre. Its jaw is 1.8 m wide between hinges, and the living animal is estimated to have had a length of ~15 m. In the foreground for comparison is a skull of the largest modern Amazonian crocodile species, *Melanosuchus niger*, the black caiman or jacaré açu, which grows to a length of ~5 m.

Fig. 12. Coastal geomorphology of Rio de Janeiro. View SW from the cable car station at the summit of Morro do Pão de Açucar (Sugar Loaf Hill) to Morro do Leme hill, with the curve of Copacabana beach and Copacabana point in the distance (Fig. 13).

The landscape of Rio de Janeiro is well-known to consist of many rounded hills formed of Precambrian granite or granitic gneiss (Figs. 12, 13), which have intruded into very ancient (Archaean /Early Proterozoic) crustal basement. In regions of younger crust, one typically observes in granite coastlines fossil marine clifflines and associated wavecut platforms above present-day sea-level. Examples include west Cornwall in SW England, at ~130 m above sea-level, and in the Anti-Atlas Mountains of Morocco (visited in December 2002 with Royal Society support) at ~45 m above sea-level. However, these regions are in younger crust (Palaeozoic crust in Cornwall; latest Proterozoic crust in the Anti-Atlas), in which the surface uplift that is revealed by these geomorphological features can be explained as a result of net inflow of mobile lower crust induced by processes such as erosion and cyclic loading of the continental shelf by seawater. In contrast, it is evident that no such features are observed at Rio de Janeiro, suggesting much greater crustal stability, possibly because the thick and cold Archaean lithosphere lacks any mobile lower-crustal layer. A manuscript pointing out these observations and this simple interpretation will shortly be submitted for publication.

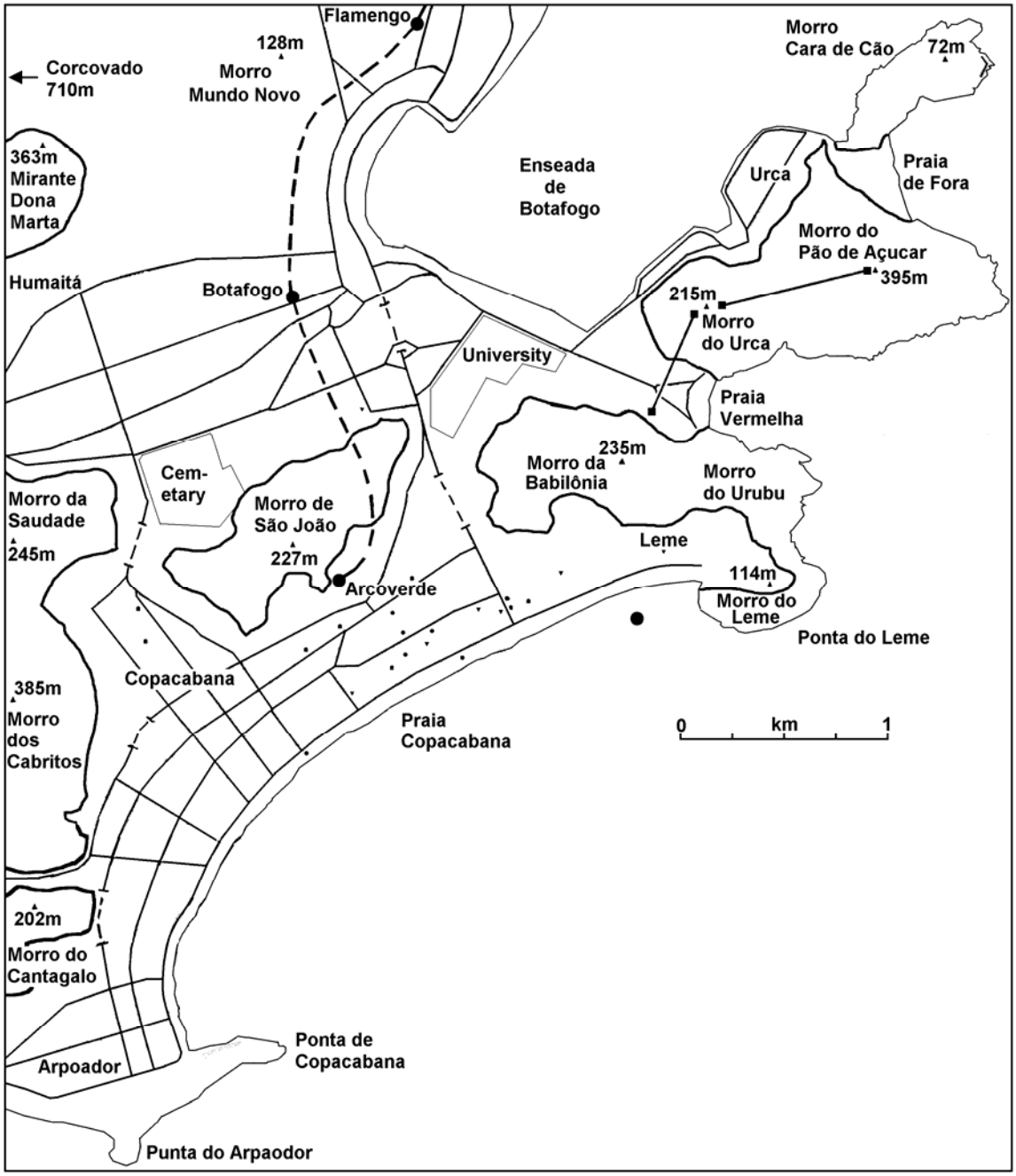

Fig. 13. Map of part of the Atlantic coastline of Rio de Janeiro. Distinctive symbols indicate roads (with tunnels), the metro, and the Pão de Açucar cable car route. Thick lines enclose areas of exposed granite or granitic gneiss that have not been built over.

Finally, on the morning of 20 June I flew from Rio de Janeiro to São Paulo, then waited for the overnight flight back to Heathrow. After another long wait there a connecting flight returned me to Newcastle Airport in the early afternoon of 21 June.

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

Biostratigraphical correlation between the Quaternary sequences of the Thames and key localities in Germany
D.R. Bridgland, D.H. Keen, L. Maul, R. Meyrick, D.C. Schreve .

River terrace sequences in Turkey
T. Demir, İ. Yeşilnacar & R. Westaway .

River terraces of the Vltava and Labe (Elbe) system in the Bohemian Massif, Czech Republic
J. Tyracek, R. Westaway & D.R. Bridgland

Quaternary fluvial sediments; structure, distribution and genetic conditions in the Russian Arctic and Subarctic
M.N. Alekseev, V.A. Drouchits .

Middle and Late Peistocene fluvial systems in central Poland
L. Marks

Structure and evolution of the Kolyma river valley: from upper reaches to continental shelf
N.G.Patyk-Kara & G.A.Postolenko

Lete Cenozoic fluvial archives in the central and southern part of the East European Plain (a review)
Andrei V. Matoshko, Piotr F. Gozhikb &, Gusel Danukalova. .

Fluvial sedimentation in a semiarid region: the fan and interfan system of the middle Souss Valley, Morocco
N. Bhiry & S. Occhietti

Mammalian biostratigraphy of Pleistocene fluvial deposits in northern Uruguay, South America
M. Ubilla .

This will now appear as a collection of papers spread across two 2004 issues of this journal

IGCP 449: Global Correlation of Late Cenozoic Fluvial Deposits

Minutes

Scientific Business Meeting 6

1 p.m., Tuesday, 10 June 2003. Hilton Hotel, Belém, Pará state, Brazil. (the venue for the 3rd Latin American Congress of Sedimentology)

Scientific Business Meeting 6a

7.30 p.m., Tuesday, 17 June 2003. Hotel Imperador Galvez, Rio Branco, Acre state, Brazil. (the base for the IGCP 449 / GLOCOPH field excursion on the Neogene Palaeogeography, Palaeohydrology and Palaeoecology of Southwestern Amazonia)

Rob Westaway, The Open University, UK.

To avoid repetition, the minutes of both meetings (attended by about 50 participants in total) have been combined.

Apologies were offered for the absence of all three co-leaders and the International Secretary of IGCP 449:
Dr David Bridgland (Durham University, UK) [represented by Rob Westaway],
Professor Sampat Tandon (New Delhi, India) [represented by Rajiv Sinha],
Dr Liping Zhou (Beijing, China), and
Dr Darrel Maddy (University of Newcastle-upon-Tyne, UK).

In their absence, these meetings were convened by Professor Edgardo Latrubesse (Federal University of Goiás, Goiânia, Goiás state, Brazil), Professor Rajiv Sinha (Indian Institute of Technology, Kanpur, India), and Dr Rob Westaway.

1. Summary of outcomes of previous meetings and project activity

This is the mid-point of the fourth of the five years of the project. It was noted that business meetings had been held at each of the previous conferences sponsored by IGCP 449, to summarise progress and plan future activities. The emphasis on involvement of people from developing countries has been maintained throughout the project, and is considered a major factor responsible for the rating of the project by IGCP as excellent during each previous review and the consequent award of maximum funding, thereby ensuring continued maximum participation of people from developing countries. A series of special issues of journals, reporting the scientific contributions to these meetings, was in progress. These were summarised as follows:

International Meeting for 2000 (Prague, Czech Republic, April 2001). A special issue of Proceedings of the Geologists' Association, edited by David Bridgland, Sampat Tandon, and Rob Westaway. Processing of most material for this by the guest editors is now complete, and is now

with the Editor-in-Chief of the journal. It is hoped that publication might be expedited so that the original intention that this issue would appear in 2003 can still be maintained.

International Meeting for 2001 (Kanpur, India, December 2001). A special issue of Current Science, edited by Sampat Tandon and Rajiv Sinha. This was published in April 2003; copies were distributed at both business meetings. Electronic versions of the papers are available for download from **http://tejas.serc.iitc.ernet.in/currsci/** or **http://www.ias.ac.in/currsci/contents.htm**.

International Meeting for 2002 (Agadir, Morocco, December 2002). A special issue of Géologie Physique et Quaternaire, edited by Serge Occhietti, Ali Ait Hssaine, and David Bridgland. Manuscripts for this are currently being received from authors.
The possibility of a special issue for the Belem conference was discussed. Initially independently of IGCP 449, Carina Hoorn is editing a volume for contributions on the Late Cenozoic evolution of the Amazon Basin. In principle, and with agreement of the editor, with minor modifications this could be made into an IGCP 449 publication. Other suggestions were discussed, including the possibility of a more general volume, possibly edited by Edgardo Latrubesse and Rob Westaway.

Forthcoming IGCP 449 activities include a session at INQUA (Reno, USA, July 2003) and one at the 2004 IGC (Florence, Italy, May 2004). A concluding meeting for the project (London, UK, December 2004 or January 2005) is also planned, and agreement has been reached for contributions to it to be published in a special issue of Quaternary Science Reviews. A provisional list of contributions has also been prepared.

1a. Database and Web site

An initial aim of IGCP 449 was to prepare a global database of Late Cenozoic fluvial archives. At Kanpur (December 2001) it was agreed that this aim was too ambitious. It was instead agreed to begin work on a pilot database covering part of northern India, which would help to design suitable data structures for storing this type of data more globally in future. Rajiv Sinha summarised progress on this to date. It was also agreed at Kanpur that a fluvial archive web site, developed in parallel, would meet many of the initial objectives of the original global database. This will be hosted by Durham University, and will be prepared by David Bridgland and Rob Westaway. A prototype version of a partial global web site went online in 2002. Following this, considerable feedback has been received, which has led to the incorporation of significant improvements in the final version. Notably, these will enable the web site to be fully navigable while preserving the original intention that users can view and print web pages but not download the images embedded in them for potential re-use, thus avoiding potential difficulties over plagiarism. Rob Westaway explained that much of the material for the final version of this web site has now been prepared, but it is not yet operational, largely due to the insistence to date by Durham University that only a particular member of their technical support staff is authorised to post material on their web server.

1b. Identification of Data Providers

As stated in item 1a, much of the data for the IGCP 449 web site has already been received. A number of regional specialists have made material available for this, a notable example being the data set of field photographs and maps for the major rivers in Iraq (the Tigris and Euphrates) assembled by Jaroslav Tyracek in the 1970s.

Many participants agreed to make available their material on river systems in South America, or drew attention to other suitable material that could be used. As a result, the South American part of the web site can now be developed.

1c. Important Submission Dates

The intention is that contributions to the special issue of Quaternary Science Reviews that will form the final outcome of the project (item 1) will go out for review directly after the end-of-project

meeting, in early 2005. As a result, the contributors that have been identified should begin manuscript preparation now so their manuscripts are ready in time.

1d. Annual Report Requirements and Deadlines

It was explained that entries for the 2003 Annual Report of IGCP 449, for instance, the national report for each participating country, should be received by David Bridgland (**d.r.bridgland@dur.ac.uk**) by September 2003. It was emphasised that a thorough Annual Report is key to maintaining maximum funding for the final year of IGCP 449.

2. Targets for Years 4 and 5

2a. Database completion

The intention has been for the project web site to be developed in three phases, covering, altogether, rivers in NW Europe, eastern and southern Europe, Asia, North Africa, North America, Australasia, and South America. With the exception of North and South America, work on each of these is well in hand (see item 1a). As a result of contacts made at this meeting, the South American part can now proceed (see item 1b). It was hoped that the involvement of IGCP 449 at INQUA (Reno, July 2003) would be beneficial to coverage for North America.

3. Final Project Outcomes

The main project outcomes were identified as the series of special issues (item 1), the fluvial archives web site (item 1a) and the pilot database (item 1a). In addition, many individual publications have appeared that acknowledge IGCP 449. All participants were asked to mention IGCP 449 in any relevant publications, and to provide reference details to David Bridgland for inclusion in project reports.

4. Follow-on Project

The view was unanimously expressed that an application should be made for a follow-up project, given that IGCP 449 has been so successful at forging international links – especially with developing countries – and in disseminating new scientific ideas in a subject area that had previously been under-researched. Several participants suggested that the same project should continue for five more years, but it was explained that the IGCP rules do not permit this. As a result, much time was spent discussing possible alternative project titles. One suggestion was that the follow-on project should focus on shorter timescales, concentrating on the Late Pleistocene or Holocene. However, it was generally thought that this time scale is already well covered by other projects, such as FLAG and GLOCOPH. Another suggestion was that the time-scale should be restricted from the Late Cenozoic (i.e., Miocene, Pliocene, and Quaternary) adopted for IGCP 449 to just the Quaternary. However, it was felt that this restriction would exclude many workers and topics. A contrary suggestion was to expand the time scale to the whole Cenozoic, as some regions (notably Australia) have very long-time-scale fluvial records. However, other regions do not, and for them any new project on this basis would end up being essentially the same as IGCP 449. Other suggestions involved geographic restrictions, such as to cover fluvial sequences in the southern hemisphere, in the tropics, or at low latitudes in general. However, as with restrictions in time scale, it was felt that any geographical restriction would exclude many potential workers and topics. Some participants suggested that the title should specify a precise research topic, such as “Comparison between Late Pliocene and modern rivers” or “Relationships between crustal deformation and the evolution of fluvial systems”. However, the problem remained of excluding many potential participants.

On balance it was thought most appropriate to aim for a general overall title, such as “Fluvial response to climate change”, and to identify within that a number of specific themes to be investigated, such as biostratigraphy, archaeology / human evolution, and relationships between crustal deformation and climate. Possibly, the emphasis could be shifted relative to IGCP 449 to allow for more involvement of specialists on the climate system in general, or “Earth System Science”, as well as fluvial specialists. Processes considered should range from those operating over long time-scales to much shorter-term processes, such as Heinrich events in the North

Atlantic region. The project definition should encompass the whole Cenozoic, while indicating that where records exist for only part of this time-scale they can be incorporated.

No specific potential project leaders were discussed, but it was felt that there should be a team of co-leaders from both western and developing countries. The aim of significant involvement of people from developing countries should remain a priority, as for IGCP 449. Whoever leads the project should uphold this objective and support the suggested scientific scope.

5. Any other Business

None. The meetings were adjourned.

FLAG / IGCP 449 Poster Session
16th INQUA Congress
Reno USA, July 24 2003

SEISMIC STRATIGRAPHY AND PALAEOENVIRONMENTS OF QUATERNARY INCISED-VALLEY SYSTEMS IN THE EASTERN ENGLISH CHANNEL

WRIGHT, Matthew R.[1], BALSON, Peter S.[2], BRIDGLAND, David R.[1], LONG, Antony J.[1], and SELBY, Ian[3], (1) Department of Geography, University of Durham, Science Laboratories, South road, Durham, DH1 3LE, United Kingdom, M.R.Wright@durham.ac.uk, (2) British Geological Survey, Kingsley Dunham Centre, Keyworth, Nottingham, NG12 5GG, United Kingdom, (3) Hanson Aggregates Marine Limited, Burnley Wharf, Marine Parade, Southampton, SO14 5JP, United Kingdom

RIVER RHINE AND CHANNEL RIVER RESPONSE TO LATE QUATERNARY ALLOGENIC FORCING: THE IMPORTANCE OF TECTONIC SETTING

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THE LATE CENOZOIC DEVELOPMENT OF THE GEDIZ RIVER, TURKEY

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A MID-DEVENSIAN WOOLLY RHINOCEROS SKELETON FROM TERRACE GRAVELS AT THE TRENT-TAME CONFLUENCE, WHITEMOOR HAYE, STAFFORDSHIRE, UK

SCHREVE, Danielle C., Department of Geography, Royal Holloway, Univ of London, Egham, Surrey, TW20 0EX, United Kingdom, Danielle.Schreve@rhul.ac.uk, HOWARD, Andrew J., School of Geography, Politics & Sociology, Univ of Newcastle-upon-Tyne, Newcastle-upon-Tyne, NE1 7RU, United Kingdom, and CURRANT, Andrew P., Department of Palaeontology, Nat History Museum, Cromwell Road, London, SW7 5BD, United Kingdom

FLUVIAL STYLE CHANGES DURING THE LAST 35,000 YEARS IN THE TISZA VALLEY (HUNGARY)

VANDENBERGHE, Jef[1], KASSE, Kees[1], GABRIS, Gyula[2], BOHNCKE, Sjoerd[1], and VAN HUISSTEDEN, Ko[1], (1) Institute of Earth Sciences, Vrije Universiteit, De Boelelaan 1085, Amsterdam, 1081 HV, Netherlands, Jef.Vandenberghe@geo.falw.vu.nl, (2) Department of Physical Geography, Eötvös Lorand Univ, Ludovika tér 2, Budapest, H-1083, Hungary

PROCESSES AND EVOLUTION OF FLUVIAL SYSTEM DURING THE LATE QUATERNARY IN THE CENTRAL KERALA REGION, INDIA

NARAYANA, A.C., Department of Marine Geology & Geophysics, Cochin Univ of Sci & Technology, Cochin 682016 India, a_c_narayana@yahoo.com.

INTERFLUVES OF THE SOUTHERN GANGA PLAINS, INDIA: ATTACHED AND DETACHED FLOODPLAINS IN THE LATE QUATERNARY

GIBLING, M.R., Earth Sciences, Dalhousie Univ, Halifax, NS B3H 3J5, Canada, mgibling@dal.ca, TANDON, S.K., Geology, Delhi Univ, Delhi, 110007, India, SINHA, R., Engineering Geosciences Group, Department of Civil Engineering, Indian Institute of Technology Kanpur, Kanpur, 208016, India, and JAIN, M., Risoe National Lab, P.O. Box 49, Roskilde, DK-4000, Denmark

LAKE MONROE, POSSIBLE FLUVIAL RESPONSE OF THE OUACHITA RIVER TO PLEISTOCENE ARKANSAS RIVER AGGRADATION

FITZGERALD, Danny, Deparment 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 SAPAROEA, Aart-Peter[2], and POSTMA, George[2], (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 FLUVIAL DYNAMICS IN THE RIO GRANDE DE NAZCA CATCHMENT, SOUTHERN PERU

BAADE, Jussi, Department of Geography, Univ of Jena, Loebdergraben 32, Jena 07743 Germany, cub@uni-jena.de.

RECONSTRUCTION OF DEBRIS FLOW FREQUENCY USING LAKE SEDIMENTS OF LAGO DI BRAIES/N-ITALY AND THE INFLUENCE OF VEGETATION AND CLIMATE

MÄUSBACHER, Roland[1], IRMLER, Ralf[1], DAUT, Gerhart[1], SCHNEIDER, Heike[1], and VAN DER BORG, Klaas[2], (1) Department of Geography, Univ of Jena, Löbdergraben 32, Jena, 07743, Germany, crm@uni-jena.de, (2) Robert J. Van de Graaff Laboratory, Utrecht Univ, P.O. Box 80000, 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, Univ of New Mexico, Albuquerque, NM 87131, atillery@unm.edu, (2) Desert Botanical Garden, 1201 N. Galvin Pkway, Phoenix, 85008

IGCP449 Business Meeting 7
Reno, July 2003

Present: Dr David Bridgland (DRB), Dr Darrel Maddy (DM), Prof Jef Vandenberghe (JV), Prof Mauro Coltorti (MC), Prof Ashok Singhvi (AS) A. Bosch, Aldino Bondesan, Dr Fahu Chen, Dr Tuncer Demir, Dr Martin Gibling, Dr Vanessa Heyvaert, Dr Wim Hoek, Prof. David Keen, Dr Frank Lehmkuhl, Dr Simon Lewis, Dr Xiaoze Li, Prof. Leszek Marks, Prof Roland Mausbacher, Paolo Mozzi, Dr Annamaria Nador, Dr David Passmore, Irina Pavlovskaya, Prof Jim Rose, Dr Danielle Schreve, Dr Anzhi Sheng, Dr Rajiv Sinha (RS), Prof Sampat Tandon, Prof. Torbjorn Tornqvist, Dr Liping Zhou

- DRB Summarized of Outcomes from Previous meetings(s) & project activity
  - Business meeting 6, Belem, June 2003. Thanks to Edguardo Latrubesse for organizing the meeting. DRB commented target for 2004: IGC in Florence and FLAG meeting in Siena. Possible end-of-project meeting in London. China meeting is desirable but difficult, especially given SARS.
  - DRB asked Mauro Coltorti about IGC session: No 449 Session had been arranged but 449 contributions would form part of other sessions.
  - Question concerning Canadian meeting: Yukon Trip was still being organized (subsequently confirmed as withdrawn).
  - AS commented on an Asian AGU in Singapore – suggesting a possible session
  - November Meeting in Kenya? Global Change agenda was also suggested

- Database & Web site (identification of data providers)
  - RS gave information concerning a new web-based Indian database. DRB suggested posters could also be added to website.
  - DRB gave info concerning Durham-based website.

- Annual Report requirements and deadlines.
  - September deadline. DRB outlined necessity for increased regional reports. The 2002 report was circulated for general consideration.

- Targets for Year 4
  - Phases 1-3 database completion
    - NW Europe : comprehensive coverage
    - Eastern and Southern Europe: comprehensive coverage
    - Asia: patchy data; mostly from India
    - North Africa: Little data, except for Morocco
    - North America: Information patchy and selective. More input needed.
    - Australiasia: Comprehensive Australian coverage but information elsewhere still required
    - South America: Some information but more needed. Belem meeting may provide

- Final project outcomes
    - QSR final project output. This has been agreed in principle and will stem from the final meeting.
    - Final project report
    - Completion of internet database (Durham)

- Current Publications i*n press* or planned.
    - PGA papers from Czech meeting still *in press*. Publication expected now in 2004.
    - Current Science. Papers from India meeting now published. RS will supply website link.
    - Géographie Physique et Quaternaire: Possible collection of papers arising from Morocco (2002) meeting to be published here.
    - Belem output also planned (South American edited volume).

- Follow-up project
    - Belem: 2 ideas
        - Concentrate on a shorter timescale/human impact
        - Comparison of database with modern
    - Global fluvial response to climate change. Perhaps Cenozoic.

    - Should follow on project be thematic or remain regional? JV suggested thematic programmes are covered elsewhere in FLAG agenda. A topic is required that is globally inclusive, that would not exclude areas where much work has already been achieved, and yet would still encourage the filling of data gaps.

    - Follow-up project will be discussed further via email and by the present leaders.

- Any Other Business

    DRB indicated that some project money still available to support attendance at this meeting.

    Darrel Maddy
    July 24th 2003

IGCP 449 activity in Argentina, 2003

C.G. Ramonell
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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.

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 sedimentologic sections will be provided by Argentinian researchers to the IGCP 449 internet data base.

IGCP 449 2003 Activity in Australia

Gerald Nanson

News of meetings or 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**" (see Report for 2002).

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.

News of research project completions

This year has been significant in seeing the completion of several major research projects. Tim Cohen has completed a study of late Holocene river and floodplain processes on the north coast of New South Wales

Gerald Nanson *et al*. (2003) have 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.

Publications:

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.

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.

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.

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.

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 2003 Activity in Bulgaria

Ivan Zagorchev
Bulgarian Acadamy of Science, Sofia

The Bulgarian group has again been active in 2003. Following the visit to Bulgaria by R. Westaway in 2001, analysis of the sequences of the Struma and Mesta Rivers continues, with a view to determining the regional uplift history, with a view to comparison with neighbouring regions. Preliminary results were presented at the FLAG 2002 meeting.

At the 2004 International Geological Congress, based in Florence, the Bulgarian group will be 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 will provide 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. Controversial problems related to exhumation will be especially stressed.

On Bulgarian territory, we shall demonstrate the attitude of Neogene and Quaternary planation surfaces from the Danube plain (Moesian platform) to the Strouma valley; the Neogene - Quaternary fluvial systems of the Danube, Maritsa and Strouma/Strymon and the fault control in their evolution; parts of the older (Egerian = Chattian - Aquitanian) fluviolacustrine system; relics from the Late Eocene - Early Oligocene marine, lake and fluvial deposits.

A new regional guidebook will be prepared.

Publications:

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).

Yaneva, M., Berov, B., Frangov, G. 2002. Evolution of Sofia Basin during Neogene. – Geol. Balc. (in press)

Yaneva, M., Ognjanova, N., Nikolov, G. 2002. Palaeoecological evolution of Gotse Delchev Basin during the Neogene, SW Bulgaria. – In: International Science Conference in Memory of Prof. Jaranov, Varna, 8-11 Sept., 2, 36-46.

Zagorchev, I. 2002. Neogene fluviolacustrine systems in the northern Peri-Aegean Region. Geologica Carpathica, Special issue (CD), 53.

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

Zagorchev, I. 2002. Neogene fluviolacustrine systems in the northern Peri-Aegean Region. - Geologica Balcanica, 32. 2-4.

IGCP 449 activity in Brazil, 2003

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

The year of 2003 was particularly active for Brazilian researchers in IGCP 449. Between June 8-11 an IGCP 449 Symposium was organized in Belem do Pará, Brazil, as part of the 3rd Latinamerican Congress of Sedimentology. This meeting was chaired by Edgardo Latrubesse (Federal University of Goias-Brazil) and Gerald Nanson (University of Wollongong, Australia). Participation in this meeting 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 (19) contributions were published in the Annals of the Latinamerican 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 (UFG, Brazil) and José Stevaux (UEM-Brazil). A total of 35 participants from 10 countries (Argentina, Australia, Brazil, Germany, India, Italy, Japan, Spain, UK, USA) took part 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 m^3/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 m^3/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 trivbutaries). 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 filed excursion (Latrubese 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 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.

Publications:

Latrubesse, E.M. 2002. Evidence of Quaternary palaeohydrological changes in Middle Amazonia: the Aripuaña-Roosvelt and Jiparaná “fans”. *Zeitschrift fur Geomorphologie* 129, 61-72.

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Latrubesse, E.M. & Kalicki, T. 2002. Late Quaternary palaeohydrological changes in the upper Purus basin, southwestern Amazonia. *Zeitschrift fur Geomorphologie* 129, 41-59.

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IGCP 449 2003 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

Ashmore, P. 2002 The response of river morphology to climatic change - mechanisms and time scales. GAC/MAC Annual Meeting, Saskatoon, Saskatchewan, Program and Abstracts Volume

Baines, D., Smith, D.G., Froese, D.G., Baumann, P., and G. Nimeck 2002. Electrical Resistivity Ground Imaging (ERGI): A New Tool to Map Lithology and Geometry of Channel and Valley-Fills, Sedimentology, 49, 441-449..

Froese, D.G., R.J. Enkin, and D.G. Smith 2001. Placer depositional settings and their ages along Dominion Creek, Klondike area, Yukon. In: Yukon Exploration and Geology 2000, D.S. Emond, and L.H. Weston (eds), Exploration and Geological Services Division, Yukon, Indian and Northern Affairs Canada, p. 159-169.

Froese, D.G., Matheus, P., and J. Rasic (2003) Beringian environments and heritage of the Upper Yukon River: A field workshop from Dawson City, Yukon through Yukon Charley Rivers National Preserve, Alaska, May 30-June 3, 2003, 62p.

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

Froese, D.G. and Smith, D.G. 2002. North Atlantic climate events in eastern Beringia (13000-8000 cal yr BP): coupled fluvial-eolian response of the middle Yukon River, central Alaska. FLAG/IGCP 449 meeting Clermont-Ferrand France, September 9-11, 2002.

Froese, D.G., Westgate, J.A., Schweger, C.E., Preece, S.J., and J. White 2002. The Klondike Goldfields: A 4 million year archive of environmental change in eastern Beringia. FLAG/IGCP 449 meeting Clermont-Ferrand France, September 9-11, 2002.

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 .

Froese, D. G., and Zazula, G. D. (2003). "3rd International Mammoth Conference Fieldguide to Quaternary Research in the Klondike goldfields, Yukon Territory." Yukon Paleontology Program. Occasional Papers in Earth Science No. 6, 72 p.

Jackson, L.E., Froese, D.G., Telka, A., Westgate, J.A., Preece, S.J., Storer, J., and C. Huscroft (2002) Late Cenozoic Geology Ancient Pacific Margin NATMAP project, Report 5: Paleoecology sampling and paleoclimate records, south Klondike placer district, Yukon Territory. Geological Survey of Canada Current Research 2002-A2, 16p.

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.

Occhietti, S., Clet, M., and Richard, P.J.H. 2002. Stratigraphic style of the Quaternary units in the St. Lawrence Valley and estuary: A Review. GAC/MAC Annual Meeting, Saskatoon, Saskatchewan, Program and Abstracts Volume.

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.

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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 a follow-up project to IGCP 449; it is anticipated that an application will be made for such a project 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 luminescenece: selection of equivalent doses for age calculation. *Quaternary Science Reviews* 22, 1123-1129.

IGCP 449 2003 Activity in the Czech Republic

Jaroslav Tyráček & Pavel Havlíček
Czech Geological Survey, Prague

1) Regional correlations

The Moravian main terrace and the Alpine Hochterrasse correlation - a short review of preliminary results

Two main Quaternary climatostratigraphic systems are used in Europe. One of them is derived from the well-known Alpine stages, based on mountain glaciations, the other is based on the continental glaciations centred on Scandinavia. The former quadriglacialistic (fourfold) subdivision (later enriched by additional stages) saw world-wide application (being used in such exotic regions like the Far East in totally diverse environments) and was also adopted on the North American continent. The latter is practically confined to the continental Europe only, including the British Isles and partly the Asian Siberia.

The correlation of both systems is, since the beginning, theoretical, the Alpine Mindel being correlated with the Elsterian, Riss with Saalian and Würm with Weichselian. Any fixed proved link connecting directly both systems was never established, though two favourable regions exist in Europe. The first is represented by the Rhine River, which originates in the ”Rheingletscher region” with well expressed sediments of four Alpine glaciations and flows due north into the realm of the Scandinavian ice sheets. The second region occupies Northern Moravia, with the Odra River basin and the Moravian Gate, where the glacial sediments are in direct contact with the fluvial terraces of both the Odra River and, due south (beyond the main European water divide), with the left-bank Danube tributaries. Whereas in the Rhine valley correlation by means of fluvial terraces proved to be, due to neotectonic movements, unfeasible, the other route through Moravia appears more promising. The main terrace there, inserted between the sediments of the Elsterian and Saalian glaciations, is developed practically along all larger valleys in the Ostrava Basin or more precisely along all larger tributaries to the local master stream, the Odra River. The terrace sandy gravel rests unconformably upon the pre-Quaternary bedrock or more frequently upon the glaciofluvials and tills of the Elsterian glaciation, which can reach up to 100 m in thickness. In turn, the main terrace body is mostly overlain by Saalian till, varved clay or glaciofluvial sand and gravel, except for sectors, in which the covering sediments were subsequently denuded leaving thus the terrace exposed. In the overdeepend, nowadays abandoned N - S trending valley of the Poruba Gate, the main terrace gravel reaches over the main European water divide (between the Baltic and Black Sea) and enters the Bečva River valley, already in the Danube drainage area (Tyráček 1963). The overlying Saalian glaciofluvial sediments attain more than 25 m in thickness at the watershed. Toward the southern mouth of the Poruba Gate the Saalian sediments die out and the terrace gravel occurs to the surface or is covered by younger loess. From the Poruba Gate downstream the main terrace can be traced along Bečva, Morava and Dyje rivers as far as the Danube valley. Thus this gravel body represents a virtual connecting link between the two mentioned glaciated areas as well as a key chronohorizon for intended correlation of both stratigraphic systems.

However, a better understanding of the geological structure and more precise dating of the main terrace is essential for correlation. In the Ostrava Basin the main terrace is usually double, being built up by two separate aggradations (Macoun, Šibrava 1961, Šibrava 1964). The lower gravel represents the retreat phase (kataglacial, warming arm of the climate cycle) of the Elsterian glacial or of the inter-Holsteinian cold phase. Its formation concluded by the end of the glacial and the subsequent break in deposition is evidenced by a paleosol of an interglacial type developed on top of it. The younger upper aggradation corresponds to the successive advance phase (anaglacial, cooling arm) of the older Saalian (Drenthe) glacial. Its dating is evidenced by its relation to the glacial sediments. In the Ostrava Basin the upper terrace contact is transitional, the gravel passing upward into the Saalian glaciofluvial sand. An expressive horizontal facies change is also documented. The upper gravel passes laterally, basinward into the glaciofluvial sand of the basal beds of the Saalian advance phase and interfingers with it.

Because the Saalian glaciation in N.Moravia is correlated with the older, Drenthe glacial, two interglacials Treene and Eem should be theoretically present in the overburden. This postulate was confirmed by occurrences of two interglacial paleosols within the loess covering the sediments of the Saalian glaciation (Macoun et al 1965). Both interglacials overlie the Drenthe glaciofluvial, which is always stratigraphically inserted between the upper aggradation of the main terrace and the sediments of the Warthe age. The Warthe (Warta) glacier stopped in Central Poland (Mojski 1995) and did not enter our territory. Therefore, the sediments of the Warthe stadial are represented by other genetic types, like fluvial, or slope deposits and primarily by loess. The interglacials are represented by paleosols, usually developed within loess blankets. Analogous geological structure exists at the opposite, southern end of the track. The ”Hochterrasse” in the Alpine foreland, particularly in the Riss valley and in the ”Rheingletscher area” (Ellwanger et al. 1995,1996, Miara 1995) is also overlain by two interglacial paleosols. However, in detail the situation differs from the northern part. The older paleosol, for many investigative years unrecognized, is developed directly on the top of the gravels while the younger one occurs within the cover deposits. This means that the equivalents of the peak of Saalian glaciation are missing or did not develop at all. The ”Hochterrasse” gravel was accumulated by glacial melt-waters, indicating a retreat phase. This fact, together with missing cold sediments that should theoretically intervene between the underlying gravel and overlying interglacial paleosol, may be taken as an evidence of kataglacial (warming arm) origin.

Therefore, it can be preliminary confirmed that the Saalian glaciation in the north correlates with the Alpine Riss, as many times stated in previous literature. Both terraces belong to the same climatostratigraphic cycle i.e. either to Riss or Saale which are comparable, however, in detail they differ. The Moravian ”main terrace gravel” was aggraded during the anaglacial phase (cooling arm) of Saalian while the alpine ”Hochterrasse” gravel corresponds to the kataglacial phase (warming arm) of the same glaciation.

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2) Publications

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Břízová E., Havlíček P. & Vachek M.(2003): The protected locality Čejčské jezero – palynological, palaeopedological and geological research .- Geoscience Research Reports for 2002, 61-65, CGS Praha.

Havlíček P.(2003): Quaternary-geological investigations in the Podyji National Park in 2001-2002.-Geoscience Research Reports for 2002, 71-73, CGC Praha.

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Havlíček P. & Smolíková L. (2003): Neolithic rondel in Mašovice, southern Moravia: Quaternary geological and paleopedogical investigations.- *Thayensia* (Znojmo),5: 3-9, Znojmo.

Hlaváč J. & Havlíček P. (2003): Molluscan thanatocoenoses in the over bank deposits of the Radějovka River between Radějov and Petrov Villages.- Geoscience Research Reports for 2002, 78 – 82, CGS Praha.

3) Lectures and Posters

Břízová, E. & Havlíček, P. Palynology and stratigraphy of organic sediments in both Bohemian Massif and West Carpathians

Nývlt, D. Fluvial terrace system in formerly glaciated areas of Northern Bohemia
Participation in the workshop “Quaternary 2003” Masaryk University, Brno.
Late Cenozoic fluvial sediments in West Carpathians – II.

IGCP 449 2003 Activity in France

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Activity in France during the past year has concentrated on the following projects :

- Saint-Acheul, river Somme (Northern France)
A paper will be 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. *Quaternaire,* (accepted).

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, Macrogastra 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, Macrogastra ventricosa, Perforatella bidentata, P. incarnata, Belgrandia marginata, Hygromia limbata*) allow to correlate the Saint-Acheul assemblage with malacofaunas recovered in other stage 11 tufa deposits from the Somme and the Seine valleys. This chronological allocation is reinforced at Saint-Acheul by stratigraphy and ESR quartz age of the underlying fluvial deposits (403 ± 73 kyrs BP). Besides, taxonomical reassessment of the *R. (Lyrodiscus)* species shows that *R. (Lyrodiscus) skertchlyi* Kerney, 1976 is a junior synonym of *Retinella (Lyrodiscus) elephantium* (Bourguignat, 1869). Reappraisal of the French malacological lists improves their similarity with British malacofaunas of Hoxnian age. These new results strenghtened the originality and biostratigraphical value of the "*Lyrodiscus* assemblage".

- La Celle-sur-Seine, river Seine (Northern France)
This site is well-known in the litterature 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 planed 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.

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ANTOINE P, MUNAUT A.V. LIMONDIN-LOZOUET N., PONEL P., et FAGNART J.P. 2002 - Réponse des milieux de fond de vallée aux variations climatiques (Tardiglaciaire et début Holocène), d'après les données du bassin de la Selle (Nord de la France). Processus et bilans sédimentaires. In: J.P. Bravard et M. Magny (dir.) *Les Fleuves ont une histoire, Paléoenvironnement des rivières et des lacs Français depuis 15 000*, Errance, Paris, 15-27.

ANTOINE P., MUNAUT A.V., LIMONDIN-LOZOUET N., PONEL. P. & DUPÉRON J.& DUPÉRON M. 2003 -Modification of fluvial systems in relation to climatic modifications during the Lateglacial and Early Holocene in the Somme Basin (Northern France). *Quaternary Science Review*. 22, 2061-2076.

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LIMONDIN-LOZOUET N**.**, BRIDAULT A., LEROYER C., PONEL P., ANTOINE P., CHAUSSE C., MUNAUT A.V., PASTRE J.F., 2002. Evolution des écosystèmes de fond de vallée en France septentrionale au cours du Tardiglaciaire : l'apport des indicateurs biologiques. In J.P. Bravard et M. Magny (dir), *Les Fleuves ont une histoire, Paléoenvironnement des rivières et des lacs Français depuis 15 000*, Errance, Paris, 45-62.

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IGCP 449 2002 Activity in Germany

Raimo Becker-Haumann

The 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 Illerglacier 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 Illerglacier 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, that 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 glacigenic sediments.

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IGCP 449 Activity in Hungary, 2003

compiled by Annamaria Nador

Like in the previous years, research has been focused on the thick Pleistocene fluvial succession in the central and eastern part of the Pannonian Basin. Results achieved in 2003 include the recognition and analysis of 400 ky sedimentary cycles and a sequence stratigraphic analysis of the basin fill complex, as well as neotectonic study of the basin margin areas. Our results have been presented at the IGCP Annual Meeting in Agadir in December 2002 (A. Nador's participation was sponsored by the project), at the INQUA Congress in Reno (July 2003), and at the 22th IAS Regional Meeting in Opatija (September 2003).

Large-scale cyclicity and sequence strtaigraphy

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 depoits 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 depoits 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 Milankovitc 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 paralell „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 deceted. Both affected the present day surface. Riedel faults can be seen as renewed small valleys opening since the last decade untill 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.

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Juhász Gy. (in press). A Körös-medence pleisztocén képződményeinek fáciesvizsgálata és őskörnyezeti rekonstrukciója. (Facies analysis and paleogeography of the Pleistocene formations int he Körös Basin) – Földtani Közlöny 133/4 *(in Hungarian with English abstract)*

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Juhász Gy., Müller P., Tóth-Makk Á. (in press). Alluvial architecture and fluvial cycles of Quaternary deposits in a continental interior basin, E Hungary. – Geologia Croatica

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IGCP 449 2003 Activity in India

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 (Chuaria 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±10% of the total contribution from the Ganges tributaries comes from the High Himalaya and 20±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 hman 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 constitutes 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 proposed SSS 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 metres to a few tens of metre. 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. Specific institution where these drill core nodal centres are to be developed will be worked out once the projects get started.

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 interfluve (Kanpur-Kalpi region)
2. Yamuna-Betwa interfluve (Kalpi-Kotra region)
3. Ganga-Ramganga intrfluve (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 interfluve. 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, 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.

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, 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)

Recent Publications by IGCP 449 participants:

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2. Jain V. & Sinha, R. (2003) Hyperavulsive-anabranching Baghmati river system, north Bihar plains, eastern India, Zeitschrift für Geomorphologie (Annals of Geomorphology), 47/1, p. 101-116.
3. 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.
4. Jain, V. & Sinha, R. (2003 online) Fluvial dynamics of an anabranching river system in Himalayan foreland basin, north Bihar plains, India, Geomorphology.
5. Goodbred, S.L. (2003) response of the Ganges dispersal system to climate change: a source-to-sink view since the last interstade. Sedimentary Geology, 162, 83-104.
6. Chamyal, L. S., D. M. Maurya and Rachna Raj (2003). Fluvial systems of dry lands of western India: A synthesis of Late Quaternary palaeoenvironmental and tectonic changes. Quaternary International, 104, pp. 69-86.
7. Maurya, D. M., S. Bhandari, M. G. Thakkar and L. S. Chamyal (2003) Late Quaternary fluvial sequences of southern Mainland Kachchh, western India. Current Science, 84, pp.1056-1064.
8. Maurya, D. M., M. G. Thakkar and L. S. Chamyal (2003). Quaternary geology of the arid zone of Kachchh : Terra incognita. Proc. Ind. Nat. Sci. Acad., 69, pp. 123-135.
9. Maurya, D.M. M.G.Thakkar and L. S. Chamyal (2003). Implications of transverse fault system on Tectonic evolution of Mainland Kachchh, Western India. Current Science, 85, 661-667.
10. Rachna Raj, N. Mulchandani, S. Bhandari, D.M. Maurya, and L. S. Chamyal (2003). Evidence of Mid Holocene seismic event from Dhadhar River basin, Gujarat Alluvial Plain, Western India. Current Science, 85, 812-815.

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12. Westaway, R., Bridgland, D. and Mishra, S. (2003). Rheological differences between Archaean and younger crust can determine rates of Quaternary vertical motions revealed by fluvial geomorphology. Terra Nova, v.15, pp.287-298.
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15. Jain, M. and Tandon, S. K. (2003). Quaternary alluvial stratigraphy and palaeoclimatic reconstruction at the Thar margin (vol 84, pg 1048, 2003). Current Science, v.84, pp.1369-1369.
16. Kumar, R., Ghosh, S. K., Mazari, R. K. and Sangode, S. J. (2003). Tectonic impact on the fluvial deposits of Plio-Pleistocene Himalayan foreland basin, India. Sedimentary Geology, v.158, pp.209-234.
17. Bateman, M. D., Frederick, C. D., Jaiswal, M. K. and Singhvi, A. K. (2003). Investigations into the potential effects of pedoturbation on luminescence dating. Quaternary Science Reviews, v.22, pp.1169-1176.
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20. Sangode, S. J. and Kumar, R. (2003). Magnetostratigraphic correlation of the Late Cenozoic fluvial sequences from NW Himalaya, India. Current Science, v.84, pp.1014-1024.
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28. Jain V. & Sinha, R. (in press) Evaluation of geomorphic control on flood hazard through GIUH. Current Science.

29. Sinha, R., Gibling, M.R., Tandon, S.K., Jain, V. & Dasgupta, A. S. (in press) Quaternary stratigraphy and sedimentology of the Kotra section on the Betwa river, Southern Gangetic plains, Uttar Pradesh.

IGCP 449 2003 Activity in Lithuania

Petras Sinkunas

Investigation team 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).

In 2003 investigations within the IGCP 449 project were continued focusing 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 glacigenic 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.

Relevant publications

Simniskyte A., Stancikaite M., Kisieliene D., Girininkas A., Daugnora L., Guobyte R. Juodonys: gyventojai ir gamta. Lietuvos archeologija. 26, 2003 (in print).

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Stancikaite M., Milkevicius M. and Kisieliene D. Palaeoenvironmental changes in the environs of Zadeikiai Bog, NW Lithuania, during the Late Glacial and the Holocene According to palaeobotanical and C14 data. Geologija. Vilnius, 2003. No. 43. 47-60.

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Kondratiene O. and Seiriene V., Vegetation and climate of the Butenai (Holstein) Interglacial in Lithuania. Geological Quarterly, 47(2), 2003. 139-148, ISSN 1641-7291.

O. Kondratiene, A. Bitinas, V. Seiriene. Interglacial lake sediments in the section Kintai-19 (Maritme lowland, West Lithuania). Geologija (in print).

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Stancikaite M., Baltrunas V., Kisieliene D., Guobyte R., Ostrauskas T. Gamtine aplinka ir gyventoju ukine veikla Birzulio ezero apylinkese holocene // Vilniaus Dailes Akademijos darbai. 2003 (in print).

Abstract of presentation

Stancikaite M. Late-Glacial palaeoenvironment and climate in Lithuania. 2nd International NCCR Climate Summer School “Climate Change: Impacts on Terrestrial Ecosystems". Grindevald, Switzerland, 2003, 30 August – 6 September.

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 planed to investigate the change of the palaeohydrological pattern during the Quaternary.

Field investigations in outcrops are planed 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.

IGCP 449 2003 Activity in Morocco

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L'année 2002/2003 est caractérisée par plusieurs activités scientifiques et culturelles. L'activité la plus marquante est l'organisation à Agadir du 3 ème colloque international d'IGCP 449, du 13 au 17 décembre 2002. Le thème de ce colloque était sur: Oscillation du niveau marin, tectonique et changements climatiques au cours du Cénozoique dans les régions d'Agadir et de Taroudant, Maroc. Ce colloque, auquel ont participé plusieurs chercheurs venant de différents pays a compris une journée de communication à Agadir et 4 jours d'excursion comprenant les régions d'Agadir, Taroudant, le Haut Atlas et Marrakech. La première journée interesse Agadir et son piémont qui présentent des étages marins quaternaire associés à la néotectonique et leur relation avec les remblaiements continentaux. La deuxième journée concerne la retombée sud du Haut Atlas et Taroudant. Dans le 1er arrêt, une discussion riche s'est déclenchée à propos des terrasses alluviales mio-pliocènes haut perchées et tectonisées de l'oued Issen à Dkhila , surmontées par des dépôts de pente pliocènes, affectés eux aussi par la néotectonique. Dans la plaine, à Taroudant (2ème arrêt principal), des dépôts lacustres tectonisés et des dépôts de sables ont fait l'objet d'une autre discussion. La troisième journée est consacrée à la traversée du Haut Atlas ou nous avons vu d'autres systèmes de terasses, en relation avec les glacis d'érosion, des explications sur l'orogenèse du Haut Atlas et l'évolution des systèmes alluviaux ont été données. D'autres arrêts dans différents endroits ont marqué cette traversée, citons par exemple les empreintes des pattes des Dinosaures sur le Crétacé ou plusieurs géologues ont participé à la discussion. La genèse du piémont nord atlasique a fait aussi l'objet de ce troisième jour. A Marrakech, la quatrième journée s'est focalisée sur les vallées de l'Ourika et de Tahannaoute (Haute montagne) et la comparaison avec le versant sud atlasique. Cette excursion a été encadrée par moi même et le géologue Chellai de l'université de Marrakech. Le guide de l'excursion a été préparé par Serge Occhietti (Canada), Weisrock (France) et moi même. La fin de l'année 2002 est caractérisée aussi par la participation au colloque du FLAG tenu à Clermont-Ferrand, en France.

L'année 2003 connaît aussi des activités intenses. Les plus importantes sont l'élaboration d'un projet de recherche interuniversitaire d'une durée de 4 ans sur le patrimoine et le développement durable dans le Souss en partenariat avec l'Université de Nancy 2, France dont je suis responsable de la partie marocaine. Préparation d'un colloque qui aura lieu les 8et 9 décembre 2003 à Agadir sur les carrières (étude d'impacct sur l'environnement) dans le cadre du projet PROTARS (Faculté des Sciences) (membre de la commission scientifique et d'organisation et participant avec une communication). Ce colloque comprend une journée de communication et une journée d'excursion.

Participation au festival de géographie à Saint-Dié des vosges, France qui a eu lieu du 3 au 5 octobre 2003 pour représenter l'IGCP 449.
Membre d'un groupe de recherche pluridisciplinaire présentant un projet de recherche de cartographie (SIG).

Participation à la soutenance et à l'encadrement des doctorats en France et au Maroc au cours de l'année 2003.

Encadrement des chercheurs allemands le 25 septembre 2003 de l'université de Frankfort dans la région de Taroudant sur les badlands et possibilité du développement d'un projet dans l'avenir.

Encadrement et direction de 6 mémoires de fin d'étude (Maîtrise) portant sur l'environnement et l'eau (année 2003 / 2004). Directeur du département de géographie pour le mandat 2004/2007. Participation et membre d'une sous commission de l'Agenda 21 (PNUD) sur l'environnement urbain d'Agadir.

Publications:

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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 atlantiqua de l'Aanti-Atlas (Oued ASSAKA, S-O marocain). *Quaternaire*, 14, 179-192

IGCP 449 2003 Activity in the Netherlands

Meindert van den Berg

Main report awaited

Publications 2002-3

Tebbens, L.A. Veldkamp, A. & Kroonenberg, S.B. In press. Natural compositional variation of the River Meuse (Maas) suspended load: a 13-ka bulk geochemical record from the upper Kreftenheye and Betuwe Formations in northern Limburg. *Geologie en Mijnbouw/Netherlands Journal of Geosciences*.

Veldkamp, A., van den Berg, M.W., van Dijke, J.J. & van den Berg van Sapororea, R.M. 2002. Reconstructing Late Quaternary fluvial process controls in the Upper Aller valley (North Germany) by means of numerical modelling. *Geologie en Mijnbouw/Netherlands Journal of Geoscience*, 81, 375-388.

IGCP 449 2003 ACTIVITY IN POLAND

Leszek Marks

Scientific achievements:

- Basing 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;
- Two project-related papers were accepted to publication in 2003 and should be published next year.

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.

References:

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.

IGCP 449 2003 Activity in Russia

Valentina Drouchits

A significant outcome from the investigation of Late Cenozoic fluvial deposits in Russia is the special issue of the series «Stratigraphy of oil and gas basins of Siberia» devoted to the Cenozoic of Western Siberia (editor V.S. Volkova, reviewers: Yu. Gladenkov, M.N. Alekseev, V.I. Krasnov) (Novosibirsk: Publishing House of the Siberian Branch of the Russian Academy of Sciences, Department "GEO", 2003, 246pp. Correlation of marine and fluvial interglacial deposits for the Middle and Late Pleistocene has been carried out using geological, palaeontological and radiometric data.

The Tobolian horizon consists of the marine Ob and Turukhanian Suites and their continental analogues, the fluvial Tobolian and Chembakchinskian Suites. This Tobolian horizon is of regional significance throughout the West Siberian plain, and is also observed in the northern part of Russia and in the Arctic islands. The TL-age of this key horizon changes from 390 $\pm$ 65 up to 260 $\pm$ 56 ka; it is thought to correspond with OIS 9.

The Shirtinsk interglacial horizon also includes marine, fluvial and lacustrine deposits. According to TL and ESR data its age is 180 –190 ka.

Continental analogues of the Kazantsevian marine horizon are the Yabylnisk Suite and its analogues in the palaeovalleys of the Ob, Yenisey and Irtysh.

Deposits of the maximum Kazantsevian transgression have an age of 134.8 ka according to ESR data. The Yabylnisk suite, according to TL data, is 130$\pm$25 ka. These suites also correspond to the Blake geomagnetic excursion.

The Marine Karginian deposits have an average age of 52.27 ka, their bottom boundary has an age of 56.72 ka and the top boundary of 47.83 ka. The stratigraphical equivalent of the marine Lower Karginian deposits is the Zolotomysskie fluvial layers with peat lenses. The age of this peat is from 38-40 to 45 ka by ^{14}C.

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 Russian group is planning a local meeting in 2004 (date to be finalized), with an indoor programme in Perm, followed by an excursion to examine the terraces of the Kama river. The organizer will be Valentina Drouchits, Moscow.

IGCP 449 2003 Activity in Spain

Juan I. Santisteban Navarro

During 2003 the following meeting took place:
"*XI Reunión Nacional sobre el Cuaternario*". Oviedo University. 2th-4th July, 2003.

Research Projects:
Active research projects during this year were:

- *"Analysis of recent evolution of the sediments, waters and biome on the Las Tablas de Daimiel National Park"*. DGCYT Project: REN2002-4433-C02-01. 2002-2005. 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. 2002-2005. Subproject leader: Dr. Mª 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: Mª 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: Mª del Carmen Llasat Botija (U. Barcelona).
- "*Procesos hidrologicos en areas seminaturales mediterraneas. Estudio de las variaciones espacio-temporales en sistemas adehesados*". DGCYT Project REN2001-2268-C02-02. 2001-2004. Subproject Leader: Susanne Cecilia Schnabel (Universidad de Extremadura).
- "*Procesos hidrologicos en areas semi-naturales mediterráneas*". DGCYT Project REN2001-2268-C02-01. 2001-2004.Subproject Leader: Francesc Gallart Gallego (C.S.I.C.).
- "*Incorporacion de datos de paleocrecidas e inundaciones historicas al calculo de la avenida de proyecto de presas*". DGCYT Project REN2001-1633. 2001-2004. Project Leader: Gerardo Benito Ferrández (C.S.I.C.).
- *"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.

In addition, two proposals to be coordinated by Spanish teams have been submitted for international research programs:

6th Framework Program of the European Union: *Multicriteria design of paleoclimatic proxies: validation and new approaches for the climatic data of the last millennium on the terrestrial environment* (MULTICLIM1000).

European Science Foundation, EuroCLIMATE/EUROCORES: *Reliability of palaeoclimate proxies: are they the ultimate tool?* (RELCLIM).

Publications:

One of the most remarkable publications during 2003 is the publication of the book:

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.

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.

Other papers published in international journals are:

- 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., Sánchez-Moya Y. & Sopeña A., 2003. Sedimentology of high-stage flood deposits of the Tagus River, Central Spain. *Sedimentary Geology*, 157, 107-132.
- 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.
- Jiménez-Espinosa R. & Jiménez-Millán J. 2003. Calcrete development in Mediterranean colluvial carbonate systems from SE Spain. *Journal of Arid Environments*, 53, 479-489.
- 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.

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

In addition to all this information, there is a lot of work done (and published) about paleontology (mainly palynology and human paleontology) in Spain. All Spanish groups are not reflected here (as a fault of mine and lack of time availability), active groups are working now in the Ebro Basin (mainly people from the Zaragoza, CSIC –Spanish Research Council- and Barcelona Universities), Duero Basin (groups from the Spanish Geological Survey and University Complutense of Madrid), Tagus Basin (CSIC, Spanish Geological Survey and University Complutense de Madrid) and Guadalquivir Basin (Sevilla University). Small basins are also being studied.

Present work focuses mainly in processes and dating.

IGCP 449 activity in Syria, 2003

Maryam Bshesh, Ma'amoun Abdelkareem, Graham Philip, Andrew Shaw, David Bridgland, Rob Westaway & Nico Galiatsatos

River Orontes: Homs Regional Survey

Further work was carried out in 2003 on the Pleistocene sequence in the Upper Orontes valley (continuing work since 2000 as part of the Homs Archaeological Survey), funded by the Council for British Research in the Levant. Previously, and during the recent fieldwork, a series of terrace gravels of the Orontes was 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. The Lower and Middle Palaeolithic artefacts were 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.

One problem arising from the initial work in the area was that Satellite images from the 1960s show a radiating pattern of features extending across the area from the south-east, seemingly emanating from the upper part of the Wadi ar-Rabaya, a right-bank Orontes tributary that drains the Anti Lebanon Mountains. It was therefore possible that the mapped gravels were associated with these features rather than forming terraces of the Orontes. In order to address this problem, clast analysis (stone-counts) of the various gravels were undertaken during this season's work, in order to differentiate Orontes gravels from tributary gravels. A total of 13 counts, each with a minimum of 250 clasts, were carried out. This has shown that the Orontes gravels are 25-65% chert/flint (at 16-32 mm size), whereas the tributary gravels are mostly limestone, with less than 15% chert/flint. A significant portion of the fieldwork was devoted to this technique, since it seemed likely to resolve the issue, as can now be confirmed.

Ground-truthing of the GIS data (Donoghue *et al*., 2002), also undertaken during the recent fieldwork has established that the radiating features are shallow dry valleys, now somewhat modified by agriculture, which explains why they are less visible on more recent GIS images. They may represent an erosional fan (possibly an avulsion fan) originating from the Wadi ar-Rabaya catchment, probably dating from the last wet episode in the Quaternary history of the Homs area. Our work this year has shown that these shallow valleys cut across the calcreted gravels, which in places are exposed in their sides.

As previously postulated, the gravels mapped during our fieldwork do belong to the River Orontes. Indeed, as a result of this year's work, several additional Orontes terraces have been identified, taking the number to at least fifteen. Andrew Shaw (University of Southampton) and Keith Challis (York Archaeological Trust) will be participants.

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. During the 2003 fieldwork attempts were made to recover artefacts directly from the conglomerates, and the first in situ artefact(s) were discovered, at Al Hussainiyeh [BU 90236 27562]. It is believed that decalcification of the upper surface of the conglomerates, as observed in exposures, has liberated artefacts (along with other gravel clasts) into the surface soils, which will account for at least some of the material collected in the field surveys.

River Euphrates

Further reconnaissance was undertaken in the Syrian portion of this important Middle Eastern river valley, based around Rakka and Deir ez-Zor, in collaboration with Turkish colleagues. Sections in which terrace gravels are overlain by basalt were observed during the 2003 visit. A formal application to research this part of the valley will be submitted to the Syrian authorities; funding will be sought to support this work in 2004.

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.

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

IGCP 449 2003 Activities in Turkey

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

The following fieldwork was carried out during 2003 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, fieldwork was carried out 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. During the 2003 field season Palaeolithic artefacts (hand-axes) were recovered from Euphrates gravels at Biracik and Karababa.

Demir, T., Westaway, R., Seyrek, A., Bridgland, D. Fluvial landforms indicative of Quaternary surface uplift: the Euphrates (Fırat, Al Furat) terrace staircase in eastern Turkey and northern Syria. *Géologie Physique et Quaternaire* (Montreal), 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, submitted.

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 cost 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 ocurred 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. Some of the results obtained were published during 2003 and others are in press. Dating of the large number of basalt samples collected in 2001 is currently under way, and when complete it will be possible to reconstruct the incision history of this river sysem in some detail.

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., Pliocene and Quaternary regional uplift in western Turkey: The Gediz river terrace staircase and the volcanism at Kula. Tectonophysics, in press.

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 in August-September 2003 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 2004.

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, will be prepared during 2004.

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 during 2004. 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 2003 Activity in the UK

Simon Lewis

UK participation in IGCP 449 has continued through a range of activities; the focal point of which was the IGCP 449 session at INQUA XVI in Reno, Nevada. In addition to this UK scientists have contributed to the project through fieldwork in the UK and further afield, sample and data analysis, participation in workshops, meeting and conferences and through a range of publications.

UK participation in project meetings, 2002-2003

The 2003 Annual Meeting in Belem, Brazil, was a difficult one for UK participation, since it clashed with our main university examinations period. Rob Westaway (Open University) was able to attend and has reported the meeting, including a published report in *Quaternary Newsletter*. Tony Brown also represented the UK community in Belem. Several UK participants attended the alternative 2003 venue, the 16th INQUA Congress in Reno, Nevada. These included David Bridgland (U of Durham & co-leader IGCP449, Simon Lewis (Queen Mary, U of London & UK national correspondent), David Keen (Current President of the UK Quaternary Research Association as well as co-leader of the IGCP 449 Biostratigraphy subgroup), Danielle Schreve (Royal Holloway U of L, another co-leader of the IGCP 449 Biostratigraphy subgroup), Philip Gibbard and Jim Rose.

The 2002 Annual Meeting in Morocco (this December meeting occurred after the Annual Report for 2002) attracted a useful level of UK participation, with David Bridgland and Rob Westaway (see above), together with Anne Mather and Martin Stokes (Plymouth), who provided a joint report for *Quaternary Newsletter*. Gill Thomas (Cheltenham) also attended from the UK.

Progress with relevant UK projects

Aggregates Levy Sustainability Fund (ALSF):

A number of UK participants in IGCP 449 are actively involved in projects funded through the ALSF. Since Quaternary fluvial deposits are a major source of commercial aggregate, it is 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 significantly overlap with the objectives of IGCP 449 and will generate data that will contribute to the project. These include:

Sussex/Hampshire Coastal Corridor
(Martin Bates and Francis Wenban-Smith)

This project includes a reappraisal of 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, including Selsey (see below) and the application of dating methods (OSL, amino acid geochronology).

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 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'), which has been designated for concentrated housing development in the near future.

The Shotton Project
(Simon Butteo, David Keen & Alex Lang)

This project, which seeks to assess and raise awareness of the Quaternary archaeological record from the English Midlands, has involved new investigations at a number of fluvial sites. IGCP 449 participants are heavily involved, notably David Keen and Danielle Schreve. Of particular interest has been a rhinocerous found at Whitemoor Haye, Staffordshire. This discovery from a fluvial context represents one of the best-preserved remains of *Coelodonta antiquitatis* in the UK (see also Appendix Iii).

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 looks 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. The project is largely geoarchaeological.

Till-Tweed Project
(Dave Passmore, Tim Van der Shriek)

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

Ancient Human Occupation of Britain (AHOB):

This Leverhulme-funded project continues to provide 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 is being collected, which is contributing to the work of IGCP 449. There is a significant overlap with the archaeological objectives of IGCP 449 (see Appendix Ii). Examples of the work of AHOB undertaken during 2003 that is contributing to IGCP 449 include:

Marks Tey, Essex
(Danielle Screve, David Bridgland and Mark White)

Following on from a reconnaissance investigation in 2002, 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 though, 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 been looking at 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);
- 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. New research was discussed at the meeting and this included results of work that is contributing to IGCP 449. Participants included Simon Lewis, Danielle Schreve, David Keen, Jim Rose and Mark White.

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.

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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.

IGCP 449 2003 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 - *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;

Main directions of study within the scope of the Project

- 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.

The results of these studies are reflected in publications and presentations (see below).

Publications concerning the Project aims

- 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.
- 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.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.

Presentations concerning Project aims

- *Fluvial archives group. FLAG biennial meeting. Clermont-Ferrand, France. Maison de la Recherche. September 9-11th 2002.*

Matoshko, A., Popova L.

The titles of presentations correspond to the titles of abstracts (see above).

Prospects for 2003 activity

- Review and correlation of alluvial archives and fluvial events of the main rivers of the East European plain: Volga, Don, Dnieper, Dniester (in collaboration with Russian Academy of Sciences);
- Recognition of the main features of the modern fluvial relief evolution within different climatic zones and geomorphologic regions of the Ukraine territory.
- Palaeontological studies of micromammal fauna from the Late Pleistocene – Holocene alluvial suites of the Middle Dnieper area.

It is expected to prepare papers according to these tasks.

A.V.Matoshko
Institute of Geography, National Academy of Sciences of Ukraine, Kiev;

IGCP 449 2002 Activity in Uruguay

Martín Ubilla

Research projects:

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

Publications:

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.

Ubilla, M. 2004. Mammalian biostratigraphy of Pleistocene fluvial deposits in northern Uruguay, South America. Proceedings of the Geologists' Association (in press). Due early 2004.

Tambussi, C., Ubilla, M., Acosta, C. & D. Perea. In press. Record of magellan goose and seriema from the late Pleistocene of Uruguay and its palaeonvironmental implications. Studies on neotropical fauna and environment. This paper is being revised.

Scherer, C., Da Rosa, A., Ubilla, M., Witeck, L. & A. Porcela. in revision. Contribuicao ao estudo da megafauna pleistocénica (Xenarthra, Litopterna, Notoungulata, Proboscidea, Perissodactyla) do Municipio de Pantano Grande no estado de Rio Grande do Sul. *Rev. Bras. Paleont*. This paper is being revised.

Papers in progress:

Ubilla, M. & Veroslavsky. A chronological and paleoambiental reassessment of early to middle Pleistocene fluvial deposits (Salto Formation) in western Uruguay.

Ubilla, M., Goso, C & N. Lorenzo. Middle to Late TL/OSL dating on fluvial sequences in northern Uruguay: biogeographic connotations on mammalian associations.

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.

IGCP 449 2003 Activity in the United States

Mike Blum, University of Nebraska-Lincoln

16TH INQUA CONGRESS, RENO, NEVADA, July 2003

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, Deparment 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 SAPAROEA, Aart-Peter[2], and POSTMA, George[2], (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, Univ of New Mexico, Albuquerque, NM 87131, atillery@unm.edu, (2) Desert Botanical Garden, 1201 N. Galvin Pkway, Phoenix, 85008

Rich Modola ran a pre-conference field trip to Boulder that looked at a piedmont terrace staircase dating back to 2Ma (with dating evidence).

RECENT, NEW, AND CONTINUING RESEARCH

Research relevant to IGCP 449 in the United States during 2002-2003, 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 Antartarctic 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. Tornqvist'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”.

Report of the Subgroup on Archaeology from fluvial sequences
2002-2003

Sheila Mishra & Mark White

Britain:

In addition to the work on UK fluvial archaeological resources occurring as part of the Leverhulme-funded project AHOB (Ancient Human Occupation of Britain), 2003 has seen 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 are contributing to IGCP 449, and in particular to this subtheme of the project. First-round projects under this scheme finish in March 2004. An announcement about a second round is eagerly anticipated (expected 10th December 2003). A number of draft project designs are already in preparation for the expected 2nd round, including follow-on projects building on those described here.

Regional and thematic projects (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.

Site specific activities during 2002-3:

Marks Tey, Essex
(Danielle Screve, David Bridgland and Mark White)

Following on from the 2002 investigation (see 2002 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 though, 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.

Boxgrove, West Sussex
(Mark Roberts)

Although a marine rather than a fluvial site, Boxgrove is of huge importance to the British Lower Palaeolthic. 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.

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.

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)

Analysis of the sediments exposed in the 2002 investigation here continues. The preliminary interpretation suggests that fluvial deposits are included. Dating indicates that the oldest part of the sequence dates back to OIS 12.

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 has 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 mired animals in a cut-ff 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.

Welton-le-Wold, Lincolnshire (unknown river)
(Joanna Hambly)

An ALSF project has been re-examining this site during 2003. The site is of particiular interest in that is might include rare evidence of a Saalian-equivalent glaciation in Britain. The project will include a reassessment of archaeological collections from the site, as well as a new borehole survey. Results are eagerly anticipated.

France:

Saint-Acheul, River Somme (Northern France)

Following the new work and discoveries at this important Lower Palaeolithic type locality in recent years (see 2002 report), a paper will be 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’. A summary is reproduced here:

> Recently a new cleaned profile at Saint-Acheul in the Somme valley, the type locality of 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 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.

India:

As reported in the last two years, work is ongoing 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. 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.

In the last year 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 peninuslar rivers Godavari, Bhima and Narmada. The results of the 2003 season are still being assessed.

South Africa:

River Vaal/Orange
(Peter Beaumont & John McNabb)

The results of the 2002 research are still being assessed. 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 Windsorton 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.

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 borer 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. It is intended to undertake fieldwork in the Ar Raqqa reach of the Euphrates during 2004, in order to map the terrace deposits, prospect for archaeology and obtain dating samples both of gravel matrix (luminescence) and overlying basalts (potassium-argon). An application for support has been submitted for a research programme during the autumn of 2004.

River Orontes: Homs area
(G. Philip, M. Abdelkareem, M. Bshesh, D.R. Bridgland, A. Shaw, R. Westaway & M.J. White)

Fieldwork in 2003 was aimed at clarifying the results of a pilot study previously carried out as part of the Homs Archaeological Survey (led by G. Philip), which revealed that Lower and Middle Palaeolithic artefacts occur as field debris on the gentle eastern valley-side of the Upper Orontes, south of Homs (Bridgland *et al*., 2003). A series of terrace gravels of the Orontes was 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. The Lower and Middle Palaeolithic artefacts were 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.

One problem arising from the initial work in the area was that Satellite images from the 1960s show a radiating pattern of features extending across the area from the south-east, seemingly emanating from the upper part of the Wadi ar-Rabaya, a right-bank Orontes tributary that drains the Anti Lebanon Mountains. It was therefore possible that the mapped gravels were associated with these features rather than forming terraces of the Orontes. In order to address this problem, clast analysis (stone-counts) of the various gravels were undertaken during this season's work, in order to differentiate Orontes gravels from tributary gravels. A total of 13 counts, each with a minimum of 250 clasts, were carried out. This has shown that the Orontes gravels are 25-65% chert/flint (at 16-32 mm size), whereas the tributary

gravels are mostly limestone, with less than 15% chert/flint. A significant portion of the fieldwork was devoted to this technique, since it seemed likely to resolve the issue, as can now be confirmed.

Ground-truthing of the GIS data, also undertaken during the recent fieldwork has established that the radiating features are shallow dry valleys, now somewhat modified by agriculture, which explains why they are less visible on more recent GIS images. They may represent an erosional fan (possibly an avulsion fan) originating from the Wadi ar-Rabaya catchment, probably dating from the last wet episode in the Quaternary history of the Homs area. Our work this year has shown that these shallow valleys cut across the calcreted gravels, which in places are exposed in their sides.

As previously postulated, the gravels mapped during our fieldwork do belong to the River Orontes. Indeed, as a result of this year's work, several additional Orontes terraces have been identified, taking the number to at least fifteen.

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. During the 2003 fieldwork attempts were made to recover artefacts directly from the conglomerates, and the first in situ artefact(s) were discovered, at Al Hussainiyeh [BU 90236 27562]. It is believed that decalcification of the upper surface of the conglomerates, as observed in exposures, has liberated artefacts (along with other gravel clasts) into the surface soils, which will account for at least some of the material collected in the field surveys.

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.

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

Work on this NERC-funded project continued during 2003, with its anticipated end-date in Spring 2004. Attention in 2003 was focussed 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.

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 depocentre, 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.

United Arab Emirates:

Wadi Bih/Wadi Dhaid

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

Work is continuing on the geoarchaeology of these sytems. 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.

Malaya came on stream. This railway ceased commercial operations in 1931 but was maintained as a social service before conversion to the present road in 1972.

Fig. 7. Madeira-Mamore Railway Company locomotive no. 20 (built by Baldwin Locomotive Works, Philadelphia, Pennsylvania, in 1909; works no. 34004) on display on a short length of preserved track outside Guajara-Mirim station, which is now the town's natural history museum.

Fig. 8. Part of the northern escarpment of the Pacaas Novas Mountains, northeast of Guajara-Mirim. The flat surface in the foreground, cleared of forest vegetation for cattle ranching, is a pediment developed on the chemically-weathered upper surface of Early Proterozoic granite that forms the crystalline basement in this region. Some corestones are visible; elsewhere tors are also observed. The ~260 m high escarpment in the background is formed of Late Proterozoic conglomerate, deposited in a graben within the granite. Subsequent chemical weathering has lowered the land surface in the granite but not in the conglomerate, creating a topographic inversion.

The main reasons for visiting this area were to briefly examine some of the extensive gold mining operations in placer deposits within fluvial deposits of the Madeira and Mamore - the gold being fluvially transported from the Guapore shield - and to inspect the Pacaas Novas Mountains (Fig. 1). Unlike the River Acre, already observed, which only drains the Amazon lowlands, the Madeira system also drains part of the Andes Mountains (Fig. 1). As a result of higher rainfall, erosion of the flanks of the Andes is rapid and this river system therefore carries a vastly greater sediment load than any of the purely lowland Amazon tributaries. The ~150 km long Pacaas Novas mountain range (Fig. 8) is formed of Late Proterozoic conglomerate, deposited as the fill in a graben in the crystalline basement of the shield. However, because this siliceous conglomerate does not weather chemically whereas the feldspar-dominated basement does, a topographic inversion has developed. Most field trip participants considered this quite an interesting place, but it was generally agreed that its connection with Late Cenozoic fluvial deposits was somewhat tenuous.

Having returned to Rio Branco late on 14 June, we left again the following morning, as the fourth and fifth days (15 and 16 June) involved a second excursion, this time with an overnight stop farther north at Boca do Acre (Fig. 1), at the confluence of the Acre and Purus rivers. Although this destination was only ~150 km from Rio Branco, much slower speeds were necessary on this dirt road. The main function of the town of Boco do Acre is to accommodate travellers arriving or departing on river boats from or to other settlements on the Purus, to which the nearest alternative road access is ~150 km upstream at Sena Madureira, and ~350 km downstream at Labrea. For instance, we observed a boat arriving from the town of Pauini, ~100 km downstream, a journey of a day and a half. River boat trips on the afternoon of 15 August and the morning of 16 August enabled close observation of the channel of the Purus upstream and downstream of Boca do Acre. This lowland river has a similar appearance to the Acre (Fig. 4), but is larger, being also flanked by abandoned Holocene channels.

Day 6 (17 June) involved a traverse along highway BR-364 for ~150 km westward from Rio Branco to Sena Madureira and back, providing the first clear sight of the sediments of the Solimoes Group, which pre-date the establishment of the west-east drainage by the modern Amazon system into the Atlantic (Fig. 9). It seemed obvious to all participants that these Miocene sediments represent a combination of fluvial and lacustrine environments, suggesting deposition in a vast wetland where rivers discharged into lakes. The mineralogy of the fluvial sediments suggests derivation direct from the Andes, in contrast with this region’s modern rivers that drain only the Amazon lowlands.

Although some participants had to leave on 17 June to avoid being stranded as a result of airline problems, the field trip ended after the morning of 18 June (day 7), following a final boat trip to investigate the Solimoes Group sediment exposed along the Acre river channel upstream of Rio Branco. Although most of the length of this river channel is incised into earlier Holocene sediments, the Miocene sediment is exposed in a few places, mainly on the outsides of incised meanders (Fig. 10). Like elsewhere, the tidal interpretation previously proposed for these sediments does not appear to be plausible.

On the afternoon of 18 June, after the organised field trip had ended, I arranged a visit to the Palaeontology Museum at the Federal University of Acre outside Rio Branco. This museum possesses a remarkable collection of vertebrate fossils from the Solimoes Group, including river turtles, rodents, and notungulates (South American endemic herbivorous mammals). The most spectacular exhibits were of the giant Miocene crocodile *Purussaurus brasiliensis* (Fig. 11).

Fig. 9. A typical roadside exposure of the Solimoes Group: in a road cut on the south side of highway BR-364, east of Sena Madureira. This exposure looks like a fluvial channel incised into mud and then filled with sand, with some lateral accretion. No field trip participant could think of any explanation in terms of tidal processes.

On the evening of 18 June I caught a flight from Rio Branco to Manaus. This connected with a flight to Rio de Janeiro departing just after midnight and arriving early in the morning of 19 June. Because I had no confidence, in advance, that either of these domestic flights would operate as scheduled, I arranged an extra day in Brazil before my return flight to Heathrow, to reduce the risk of being stranded and so missing this international flight (as British Airways would be unlikely to have any sympathy for any passenger delayed because VARIG were a shambles, and would almost certainly refuse to rebook my ticket to a later flight). I used the time in Rio de Janeiro to investigate the coastal geomorphology (Figs. 12, 13).

Fig. 10. Exposure of Solimoes Group sediment on the outside of a meander loop in the left bank of the River Acre, just upstream of Rio Branco. This exposure consists of a rhythmic pattern of many sand-mud interbeds, each bed being typically several tens of centimetres thick. This outcrop and others in the region have previously been interpreted as a result of tidal deposition, in part because the measured thicknesses of beds show a cyclicity that has been interpreted as a result of the fortnightly spring-neap tidal cycle. However, these sediments look very similar to alternations between flood (sand) and slack water (mud) deposits observed elsewhere (for instance around Boca do Acre) and can thus be explained instead as a result of repeated seasonal flooding. A major difficulty with the tidal interpretation is that it would require a sedimentation rate of many metres per year, requiring the whole ~1 km thickness of sediment to have accumulated in just a few hundred thousand years. No field trip participant considered a tidal interpretation plausible.

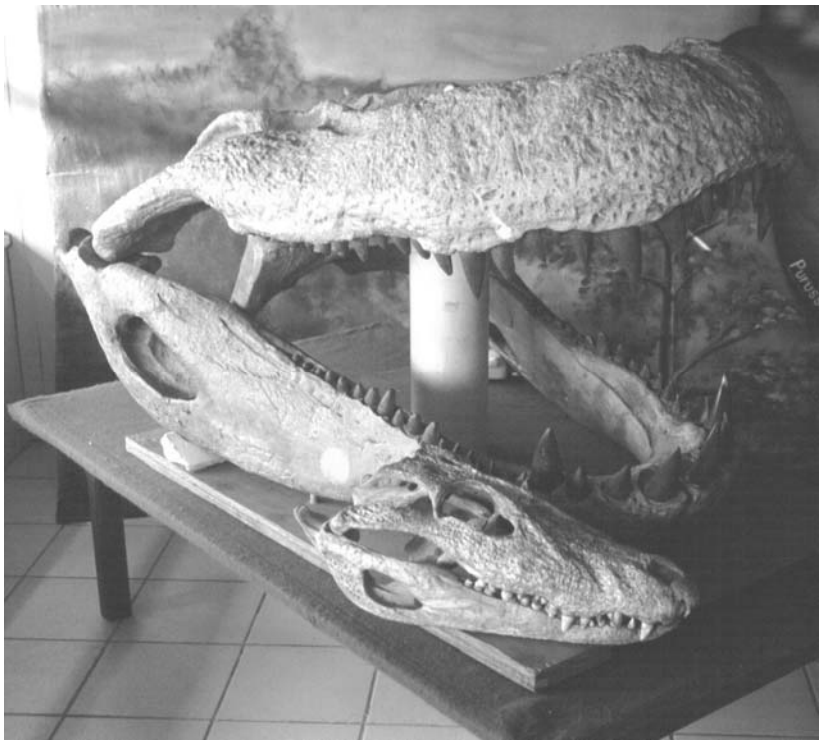

Fig. 11. Skull of the giant Miocene crocodile *Purussaurus brasiliensis* from the Solimoes Group, on display in the Palaeontology Museum at the Federal University of Acre. Its jaw is 1.8 m wide between hinges, and the living animal is estimated to have had a length of ~15 m. In the foreground for comparison is a skull of the largest modern Amazonian crocodile species, *Melanosuchus niger*, the black caiman or jacaré açu, which grows to a length of ~5 m.

Fig. 12. Coastal geomorphology of Rio de Janeiro. View SW from the cable car station at the summit of Morro do Pão de Açucar (Sugar Loaf Hill) to Morro do Leme hill, with the curve of Copacabana beach and Copacabana point in the distance (Fig. 13).

The landscape of Rio de Janeiro is well-known to consist of many rounded hills formed of Precambrian granite or granitic gneiss (Figs. 12, 13), which have intruded into very ancient (Archaean /Early Proterozoic) crustal basement. In regions of younger crust, one typically observes in granite coastlines fossil marine clifflines and associated wavecut platforms above present-day sea-level. Examples include west Cornwall in SW England, at ~130 m above sea-level, and in the Anti-Atlas Mountains of Morocco (visited in December 2002 with Royal Society support) at ~45 m above sea-level. However, these regions are in younger crust (Palaeozoic crust in Cornwall; latest Proterozoic crust in the Anti-Atlas), in which the surface uplift that is revealed by these geomorphological features can be explained as a result of net inflow of mobile lower crust induced by processes such as erosion and cyclic loading of the continental shelf by seawater. In contrast, it is evident that no such features are observed at Rio de Janeiro, suggesting much greater crustal stability, possibly because the thick and cold Archaean lithosphere lacks any mobile lower-crustal layer. A manuscript pointing out these observations and this simple interpretation will shortly be submitted for publication.

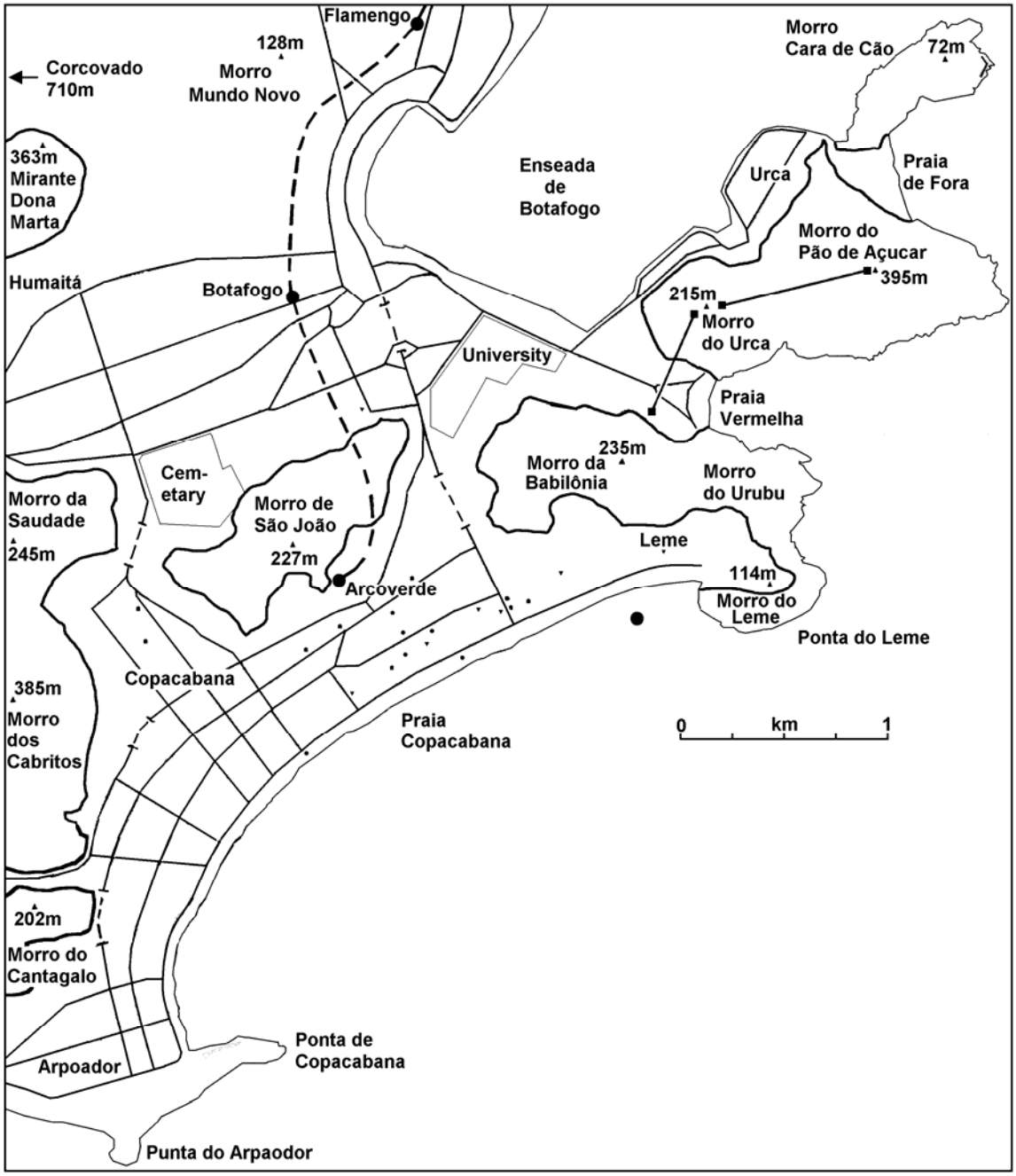

Fig. 13. Map of part of the Atlantic coastline of Rio de Janeiro. Distinctive symbols indicate roads (with tunnels), the metro, and the Pão de Açucar cable car route. Thick lines enclose areas of exposed granite or granitic gneiss that have not been built over.

Finally, on the morning of 20 June I flew from Rio de Janeiro to São Paulo, then waited for the overnight flight back to Heathrow. After another long wait there a connecting flight returned me to Newcastle Airport in the early afternoon of 21 June.

Report of the Subgroup on Biostratigraphy from fluvial sequences 2002-2003

Danielle C. Schreve, David H. Keen, Nicole Limondin-Lozouet & Martin Ubilla

Britain:

GIS data base for the Midlands Rivers - Severn and Worcestershire/Warwickshire Avon

(Shotton Project participants)

A trial programme of portraying fluvial sediments and find sites of Palaeolithic archaeology and Quaternary palaeontology within a GIS system is being put together by the Shotton Project of the University of Birmingham (Professor D.H. Keen and Mr A. Lang) with the collaboration of Worcestershire Archaeology. This project is funded by the Aggregates Levy Sustainability Fund (ALSF). The system is being built in November 2003 on a base of the British Geological Survey Drift Geology map and with all find sites superimposed on the Quaternary geology. Links in the system will lead to publications on the sites mapped. It is hoped that this pilot project for Worcestershire and Warwickshire will be placed on the web as a research source. It is hoped to extend the mapping to other catchments in 2004.

Funtham's Lane (King's Dyke), Cambridgeshire (Fenland Basin)

Research continues into the complex series of fluvial deposits in channels cut into Oxford Clay bedrock at this site. Bulk samples were taken for microvertebrate analysis from Channel D and Section G by Danielle Schreve, which were part analysed by Liz Hahessy (Royal Holloway Quaternary M.Sc student) during 2003. In addition, surface finds of large vertebrates have also been recorded, although the possibility of conducting a controlled area excavation has not been available to date. In terms of surface finds, Channel D has yielded well-preserved partial vertebrae and a right unciform and 3rd metapodial of *Coelodonta antiquitatis*, seven associated upper molars of *Equus ferus*, a left upper deciduous M4 of *Mammuthus primigenius* and three elephant rib midshaft fragments and a lower molar of a large bovid. The large vertebrate remains indicate a predominantly open environment with rich grazing. The bulk samples have yielded a small number of fish remains, including complete scales and fin spines of *Perca fluviatilis*, implying the presence of a slow- to moderately-flowing water body and a gentle depositional environment. On the basis of the vertebrate remains, Channel D can currently be assigned a broad late Middle, or most probably, Late Pleistocene (MIS 3) age. This age attribution is in keeping with the evidence from the Mollusca, although the fauna is not a large one. It is hoped that collection of new material and evidence from the microvertebrates will resolve the age of the deposits.

Section G has yielded a rich microvertebrate assemblage, including *Sorex araneus*, *Arvicola terrestris cantiana*, *Apodemus sylvaticus* and *Microtus* sp, bones of frog or toad, spines of *Gasterosteus aculeatus*, pharyngeal teeth of Cyprinidae and other fish remains. The small mammal remains, in particular the morphology of the *Arvicola* molars, support a late Middle Pleistocene age but are not otherwise age-

diagnostic. The vertebrates indicate a temperate environment with a source of still or slowly-flowing water, bordered by dense riparian vegetation and grassland.

The Funtham's Lane sites were visited as part of a Quaternary Research Association Short Field Meeting in September 2003, organised by Dr Harry Langford.

Latton (near Cirencester), Upper Thames
Kate Scott, Simon Lewis & Darrel Maddy

A working gravel pit here has yielded mammalian remains belonging to the Sandy Lane MAZ, including the distinctive small interglacoial form of *M. primigenious* (mammoth). The assemblage is therefore ascribed to the MIS 7 interglacial, deposits of which survive beneath the later gravels. The finds, which include Palaeolithic artefacts, have generally come from basal contexts either below, or reworked into the gravel.

Lynford, Norfolk - River Wissey
(Danielle Schreve)

Over 2000 individual vertebrate finds have now been identified by Danielle Schreve. All bulk samples from the site have been processed for small vertebrate remains and spit residues have also been sorted for bones and teeth. These are awaiting identification. Of the larger faunal remains, *Mammuthus primigenius* is most commonly represented at the site (at least 75% of the material seen so far), followed by *Rangifer tarandus*, *Coelodonta antiquitatis* and *Equus ferus*. Carnivores, including *Ursus arctos*, *Canis lupus*, *Vulpes vulpes* or *Alopex lagopus* and *Crocuta crocuta* are more rarely encountered, although gnawing on bones from the last-mentioned species in relatively frequent. Detailed examination of the vertebrate material has so far failed to uncover a single unequivocal record of cut marked material, although several fragments of reindeer long bone show green bone fractures and occasional impact marks that are consistent with bone marrow extraction. Additionally, molars of woolly rhinoceros and horse show breakage patterns that imply deliberate fracturing of the mandible to obtain marrow. The paucity of mammoth long bones is arguably the most persuasive evidence of hominin intervention, since there appears to be no taphonomic reason for their absence at the site. However, the most striking aspect of the vertebrate assemblage is the enormous variety of preservational conditions encountered, ranging from very fresh to extremely weathered. The assemblage is also characterised by an overwhelming majority of small bone fragments, generally less than 6cm in diameter, the small size thought to be the result of trampling. Carnivore gnawing is also prevalent. The likelihood that this deposit represents a palimpsest of different assemblages accumulating via diverse processes over an extended period is therefore being explored. Evidence from Mollusca (D.H. Keen) and beetles (G.R. Coope) suggest a palaeoenvironment which is 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, Linford 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 report on the site is due to be submitted for publication at the end of March 2004.

Marks Tey, near Colchester, Essex - Old course of River Thames
(Danielle Schreve)

Following on from initial surveying and coring in 2002, a five day excavation was undertaken by Danielle Schreve, Mark White and David Bridgland in April 2003 to establish the limits of the margins of the Hoxnian lake basin at Marks Tey. As anticipated, the edge of the basin is located in a field adjacent to the main clay extraction site and a series of trial trenches proved gravels overlying till, overlain by clays and black silty organic deposits. A small number of *in situ* worked flakes, together with a cervid phalanx, were recovered from the gravels, and preliminary processing of the clay has yielded remains of fish, very comminuted shells, seeds and a molar of *Apodemus* sp. Other flakes, including later prehistoric material, were recovered during field walking. Much of the bone and shell was badly degraded by weathering such that the most abundant remains were of the calcite opercula of the gastropod *Bithynia tentaculata*. The aragonite shells of the species were reduced to fragments. The fish remains were mostly of tooth fragments. Work continues on processing the sediments collected in April.

Welton-le-Wold, Lincolnshire (unknown river)
(Joanna Hambly)

An ALSF site-specific project is re-examining this enigmatic site, of particiular interest in that is might include rare evidence of a Saalian-equivalent glaciation in Britain. As part of the project the fossil material will be reassessed. There will also be a borehole survey. Results are eagerly anticipated.

Whitemoor Haye, Barton-under-Needwood, Staffordshire and Coleshill, Warwickshire - River Tame

Danielle Schreve and Andy Currant have continued research on the Middle Devensian mammalian assemblage from Whitemoor Haye, near Alrewas in south Staffordshire, which includes the spectacular anterior skeleton of a woolly rhinoceros, *Coelodonta antiquitatis* (Blumenbach, 1807), discovered in September 2002. Although quarrying continues apace at the pit, only a few additional vertebrate remains have been found this year.

Thirty-three separate elements have now been identified from the partial rhinoceros skeleton, representing an adult individual. These include the cranium and lower jaw, some of the vertebrae and ribs, a single shoulder blade and the major parts of the anterior limbs. Although the pelvis and hind limbs were not found, two elements of the posterior skeleton were recovered in the same area as the front part, namely the last lumbar vertebra and the last rib on the right side. The absence of the remainder of the skeleton would suggest that the posterior part had been exposed by fluvial activity and dispersed in antiquity, whereas the anterior part remained undisturbed. Several features of the partial skeleton all point to the very rapid burial of a (probably frozen) carcass. These include the excellent preservation of the bone surface, the presence of the fragile stylohyoid bones, the occurrence of dental calculus (normally removed by transport) and the preservation of plant remains in the fossae of the upper dentition. The animal may have perished during spring snow melts or as a result of becoming mired at the edge of the channel. The periglacial nature of the climate suggests that any skeletons deposited on the floodplain would have been

quickly frozen and buried beneath sandy sediments, whereas freezing may have helped preserved some of the material in a semi-articulated form.

On account of the excellent preservation, samples of bone and tooth enamel from the woolly rhino skeleton have been subjected to various biomolecular analyses, including mitochondrial DNA (Prof. Alan Cooper, University of Oxford), osteocalcin sequencing (Dr Christina Neilsen-Marsh, University of Newcastle) and collagen stable isotope analysis (Dr Mike Richards, University of Bradford). These will provide important information on the palaeodiet of the animal, the prevailing palaeotemperature and the evolutionary relationship of the Whitemoor Haye specimen both to extant African and Asian species of rhinoceros and to other European *Coelodonta*, including permafrost-preserved specimens. The possibility also exists for the genetics of the plant material present in the teeth of the Whitemoor Haye specimen, as well as the dental calculus on the teeth, to be studied.

A poster on the woolly rhinoceros and its geological context was presented at INQUA 2004 in Reno (Schreve, et al., 2003).

The same terrace of the Tame has recently (November 2003) yielded organic muds at Barton-under-Needwood about 5 km downstream of Whitemoor Haye. These muds are being analysed for pollen and plant macro remains (Dr T.M. Mighall, Coventry and Ms A. Vaughan-Williams, Royal Holloway) and insects by Dr S. Elias (Royal Holloway).

Organic sediments which may also be the same age from Coleshill, upstream of the two above sites, give the opportunity to refine a ^{14}C chronology obtained by Coope and Sands in the 1960s from channel fills in adjacent pits now quarried away. A discovery of a channel infill within the terrace gravels was sampled by D.H. Keen and A. Lang (Birmingham), and T.M. Mighall (Coventry) in November 2003. Palaeobotanical analyses by Mighall and insect analyses by Coope (Birmingham) will be followed by a ^{14}C dating programme to determine the age of the terrace.

Selsey and West Wittering, Sussex; Stone Point, Hampshire - Solent River

These fossiliferous sites in the estuarine reaches of the former Solent River have been 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 detrmine 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 which will be followed up by boreholes and trenching in 2004. 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.

France:

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

Mammalian remains were also recovered, including aurochs (identified by P. Auguste). Ur/Th dating is in progress (by J.J. Bahain) and coring of the deposit is planned for October 2003.

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 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) has increased the faunal list from the 40 taxa previously reported to 77 species. Preliminary results show that, despite tjhe 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 further tested by an additional study of this material based on new field work, 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.

Saint-Acheul, River Somme (Northern France)
P. Antoine & N. Limondin-Lozouet

The recent reappraisal of this site, and the discovery of a tufa there containing a molluscan assemblage belonging to the "*Lyrodiscus* biome" (ANTOINE &, LIMONDIN-LOZOUET, in press). 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 filograna, Clausilia pumila, Macrogastra 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" 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 strenghtened the originality and biostratigraphical value of the '*Lyrodiscus* assemblage'.

Germany:

River Neckar

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 Neckar valley (Van Kolfschoten, 2000). 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 Wipper (Mania, 1996) is possible.

Syria:

River Orontes

(M. Abdelkareem, D.R. Bridgland, A. Shaw, R. Westaway & M.J. White)

A study of the upper catchment of this river has been undertaken in the past three years 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*., 2003). Although the area has calcareous ground water, thanks to Micene 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. 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:

Rivers Sakarya and Mudurnu

(Tuncer Demir & Rob Westaway)

During 2003 sites in these rivers that have yielded mammalian faunas and palaeobotanical material were visited. 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 biostratgraphical details into a regional synthesis.

Uruguay:

Sopas Formation

(Martin Ubilla, Daniel Perea, César Goso Aguilar & Nora Lorenzo)

Publication of recent work on the biostratigraphical value of the vertebrate assemblage from this Upper Pleistocene fluvial deposit in northern Uruguay is

imminent. A paper under the above authorship is in press in Quaternary International, destined for the first issue in 2004 but already available with full pagination on the internet (Ubilla *et al*., 2004). Its role as a contribution to IGCP 449 appears in the acknowledgements. A second publication will appear in the IGCP 449 special issue of Proceedings of the Geologists' Association during 2004, based on Martin Ubilla's participation inn the Inaugural Project Meeting in Prague (Ubilla, in press).

The 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 outcrop along riversides in various tributaries of the Uruguay River system.

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Report of IGCP 449 Subgroup on Crustal Deformation & Uplift Modelling

Rob Westaway & Andrei Matoshko

November 2003

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. Last 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. These latter two papers were published too late for the full references to be cited in last year's report by this group.

The pace of this research has 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 is beginning on modelling the uplift histories revealed by these records, and a further synthesis of evidence (Bridgland and Westaway, 2004a), has been prepared.

Second, probably the most important point to emerge this year is 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., 2003) 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 has begun 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, 2004b). 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, 2004b).

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 has concentrated in volcanic regions of Europe and the eastern Mediterranean region, studies to date including Westaway et al. (2003b, 2004a,b), Bridgland et al., (2003), Demir et al. (2003, 2004), and Westaway (2004a).

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Géographie Physique et Quaternaire
IGCP 449 Special issue

(Arising from 2002 Annual Meeting in Morocco)

Ali Ait Hssaine – QUATERNARY OF MOROCCO (in French)

D.R. Bridgland & R.W.C.Westaway DIFFERING PATTERNS OF LATE CENOZOIC FLUVIAL ARCHIVES: EMERGING RESULTS FROM IGCP 449.

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.

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

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

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This will now appear as a collection of papers spread across two 2004 issues of this journal

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3. Geomorphology and Sedimentology of Piedmont Zone, Ganga Plain, India (U.K. Shukla & D.S. Bora)
4. Quaternary alluvial stratigraphy and paleoclimatic reconstruction at the Thar margin (M. Jain and S.K. Tandon)
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FLAG 2004

Siena, September 7-11, 2004

FLUVIAL ARCHITECTURE AND DYNAMICS IN RISING MOUNTAIN CHAIN AND RELATED BASINS: TECTONICS, CLIMATIC INFLUENCE AND HUMAN IMPACT

SCIENTIFIC COMMETTEE: David Bridgland, Mauro Coltorti, Mauro Marchetti, Darrel Maddy, Frank Pazzaglia, Pierluigi Pieruccini, Jef Vandenberghe.

ORGANIZING COMMETTE: Mauro Coltorti, Piero Farabollini, Darrel Maddy, Pierluigi Pieruccini

Many parts of the world are affected by tectonic movements that have played an important role in the fluvial pattern and its evolution during the Pliocene and the Quaternary. Climatic changes that are able to affect the vegetational cover, affect the relationship between discharge and sediment flux leading to important changes in the fluvial architecture. Human impact is usually able to act on the vegetation on a very short time span creating effects, also at a regional scale, that are similar to those induced by climatic changes. This conference will be devoted to investigate the relationship between all these factors.

The Field trip will lead the participants across the Italian Peninsula, a rising mountain chain, with a western Tyrrhenian side affected by extentional tectonics and the eastern Adriatic side affected by an intense uplift. Part of the trip will be devoted to illustratrating some of the changes in the fluvial architecture induced by human impact during the Late Holocene. The Papers presented during the Meeting will be published in an International Review.

The Excursion will give participants the opportunity to visit some of the very well preserved Italian Medieval towns (Siena, Spoleto, Fabriano) and to discuss fluvial deposits and dynamics in front of very tasty regional food and wine.

The Conference will be held in Siena, Department of Earth Science.

The Excursion will start in Siena the morning of 9th and will be end in Ancona the evening of the 11th. The bus will return to Siena late in the evening.

Siena has no Airport but can be reached by train from Rome, Florence or Pisa. Ancona has an Airport with many connections to Rome or Milano and minor Internatioonal flights. Details on how to reach Siena and to leave from Ancona will be given in the Second Circular.

7 and 8 September 2004: Conference in Siena: Oral and Poster Presentation, FLAG Meeting

9-11 September 2004 Field Trip across the rising Apennine Chain. From the extensional Tyrrhenian side to the rising Adriatic side: tectonic, climate and human impact.

FIELD TRIP
THE FLUVIAL SYSTEMS RESPONSE TO THE UPLIFT OF THE ITALIAN PENINSULA: TECTONICS, CLIMATE AND HUMAN IMPACT. A TRANSECT ACROSS THE APENNINE: THE PLIO-QUATERNARY FLUVIAL SEQUENCES.

3) THE WESTERN SIDE OF THE PENINSULA: **FROM PLIOCENE SYNFORM BASINS TO PLEISTOCENE EXTENSIONAL BASINS.**

a. **WEST AND EAST TIBER BASIN** (Umbria Region, Tyrrhenian side) - **1st day**
The beginning of the uplift of the Italian Peninsula: The planation surface in the Apennines;
The fluvial architecture in the Lower Pliocene: fine grained sequences with lignites (fossil forest of Dunarobba with still standing stumps of Taxodium forest).
The fluvial architecture in the Middle Pliocene-Lower Pleistocene: from fine grained alluvial plain to coarse-grained alluvial fans (S.Gemini, Spoleto-Montefalco Basin).
The onset of extensional tectonics and Late Quaternary climatic changes: alluvial fans, fluvial terraces, debris slopes, travertines, paleosoils and fault escarpments (Acquasparta, Massa Martana, Spoleto-Foligno basin).
b. **GUALDO TADINO BASIN** (Umbria Region, Tyrrhenian side) - **2nd day**
The evidence of Early-Middle Pleistocene eastward shifting watershed: wind gap and former drainage to the east (Adriatic side). Captures and reverse drainage to the west (Tyrrhenian side). Late Pleistocene alluvial fan and large scale (catastrophic ?) gravitational movements. Fault escarpments

4) THE UNCERTAIN DRAINAGE IN THE APENNINE RIDGE

a. COLFIORITO BASIN AND THE AREA OF THE 1997 EARTHQUAKE
The planation surface, Wind Gaps, Fault activity, Early-Middle Pleistocene alluvial plain, paleosoils, River captures.

3) THE EASTERN SIDE OF THE PENINSULA: FROM THE RISING APENNINE RIDGE TO THE RISING EARLY-MIDDLE PLEISTOCENE FOREDEEP

a. UPPER ESINO VALLEY – 3rd day
Fluvial terraces and their relationships with Middle-Upper Pleistocene climatic changes and uplift. Alluvial facies, paleosoils, archaeology.
Late Pleistocene fluvial architecture and slope dynamics.
b.POTENZA RIVER VALLEY
Changing dynamics during the Holocene. Human impact vs. climate changes.

Anticipated IGCP 449 special issue *Quaternary Science Reviews* 2005

Global Correlation of Late Cenozoic fluvial deposits

Results of IGCP 449

Contributions anticipated (some/all will be papers given at end-of-project meeting, winter 2004/5):

Regional syntheses:

UK - S.G. Lewis et al.

France - P. Antoine, J-F Pastre, N. Limondin-Louzouet

Germany - R. Becker-Haumann, M. Frechen

Italy - M. Coltorti

Iberia - J.I.S. Navarro

Eastern Europe - J. Tyracek et al.

Russia (south & north-flowing drainage compared?) - A. Matoshko, V. Drouchits, N. Patyk-Kara

India - Rajiv Sinha, S.K. Tandon et al.

North Africa - Rafat Zaki, A. Ait Hssaine, A. Weisrock

Southern Africa - P. Beaumont et al.

China – Mo Duanon, Yang Liankang, Liping Zhou

Australasia - G. Nanson (et al.)

South America - E. Latrubesse, J. Stevaux

USA - M. Blum, F. Pazzaglia

Canada – S. Occhietti (St Lawrence) & D. Froese (Yukon)

Middle East & Turkey - T. Demir et al.

Thematic syntheses:

Mammals - D. Schreve et al.

Molluscs – D. Keen et al.

Archaeology - S. Mishra, M.J. White et al.

Relation of fluvial sequences to crustal rheology – R. Westaway

Overall synthesis (patterns, correlations) – D.R. Bridgland et al.