

INQUA Commission on Glaciation

Report for the inter-congress period 1999-2003

The goal of the Commission on Glaciation was to explore and develop scientific co-operation for the study of past glaciation and present glacier processes. It came into existence in the Summer of 1995 at the International Quaternary Congress in Berlin and it is a follow-up of the previous Commission on Formation and Properties of Glacial Deposits, which had some similar research fields.

I. Structure

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Topical Working Groups:

- **Glacier Dynamics**
Leaders: D.J.A. Evans (UK; devans@geog.gla.ac.uk) and J. Hart (UK; j.k.hart@soton.ac.uk)
To provide enhanced study and interpretation of subglacial processes including glaciotectionic features at all scales. In particular, to investigate ice movement mechanisms with special reference to the deformation of subglacial material.
- **Geospatial Analysis of Glaciated Environments (GAGE)**
Leaders: J. Aber (USA; aberjame@esumail.emporia.edu), A. Ber (Poland; aber@pgi.waw.pl)
To pursue GIS and remote-sensing techniques for all manner of mapping, analysis, display and interpretation of glaciated terrain, as well as for modelling of glaciers and ice sheets.

- **Sedimentology of Glaciogenic Deposits**
Leaders: A. Russell (UK; gga31@cc.keele.ac.uk), D. Krzyszkowski (Poland)
To investigate problems of the interpretation of the Quaternary sedimentary record, including examination of time scales in sediment sequences.
- **Extent and Chronology of Glaciations**
Leaders: J. Ehlers (Germany; jehlersqua@aol.com), P. Gibbard (UK; plgl@cus.cam.ac.uk)
To assemble glacial chronologies from around the world to better understand ice sheet volumes and extents at various times, and to compile a GIS supported database for past ice sheet extents.

Regional Working Groups:

- **The Peribaltic Group**
Leader: L. Marks (Poland; lmars@pqi.waw.pl), Secretary: J.A. Piotrowski (Denmark; jan.piotrowski@geo.au.dk)
To investigate Quaternary history and palaeogeomorphology around the Baltic Sea with special focus on glacial processes, stratigraphy and chronology during the Weichselian Glaciation
- **Glacial Deposits and Environments in Asia**
Leader: Li Jijun (China; lijj@lzu.edu.cn)
To reconstruct glacial history of monsoon Asia with special reference to the problem of the Tibetan Plateau glaciation, its extent, timing and the sedimentary record.

Working Group Leaders:

- Topical Working Groups

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II. Commission symposia, workshops and other meetings

1. Modern & Ancient Ice-Marginal Landsystems

April 29-31, 2000; Keele, UK

Convenors: A. Russell and M. Edge (Keele University) and D.J.A. Evans (Glasgow University).

A joint meeting of Work Group 'Sedimentology of Glacial Deposits' and the 'Glacial Landsystems Working Group' (GLWG)

29 papers, 12 posters

Abstract Volume, Excursion Guide, Proceedings in Special Issue of Sedimentary Geology (see below)

This symposium provided a specialised forum for the presentation and discussion of the latest research on both Modern and Ancient Glacier-marginal Landsystems and attracted participants from 6 nationalities. Over a two day period 29 talks and 12 posters were presented on ice-marginal processes at modern glaciers and the models accounting for the formation of distinctive landforms and deposits within former glacier marginal settings. Specific topics included: processes of moraine formation, esker genesis, glacier 'plumbing', glaciolacustrine sedimentation, and the impact of glacier fluctuations, including glacier surging. On May 1st Philip Marren led a party of 20 on a field excursion to the mid-Cheshire ridge and the Wirral.

2. International Symposium and Field Workshop on Quaternary Glaciation in Monsoonal Asia

June 5-18, 2000; Chengdu, China

Convenors: Shi Yafeng (Chinese Academy of Sciences), Nat Rutter (University of Alberta), Zhou Shangzhe (Lanzhou University) and Liu Shijian (Chinese Academy of Sciences)

Organizing Committee Members: Li Jijun, Dave Mickelson, Cui Zhijiu, JimTeller, Edward Derbyshire, Rein Vaikmae, Yug Ono, Zhenbenxing, M. Kuhle, Yao Tandong, Fang Xiaomin, Frank Lehmkuhl

A joint meeting of Work Group Glacial Deposits and Environments in Asia, IGCP Project 415, National Natural Science Foundation of China, Department of Education of China, Chinese Academy of Sciences, Lanzhou University.

35 participants from 6 countries

Abstract Volume, Excursion Guide, Proceedings in Special Issue of Quaternary International (see below)

The symposium was held in Chengdu, China, June 6 and 7, 2000. It was followed by a 7-day field trip to the Tibetan Plateau. About 35 scientists from 6 countries attended the symposium. The focus of the conference was on the extent, sequence, and timing of Quaternary Glaciations in Monsoonal Asia. A major focus of debate was the presence or absence of a large ice sheet over the Tibetan Plateau at the last glacial maximum. There appears to be good agreement that there was extensive alpine glaciation and several ice caps in the eastern Tibetan Plateau. Evidence of an extensive ice sheet is more difficult to find, and that was the focus of debate, especially on the field trip. The field workshop was held mainly in Southeastern Tibetan Plateau, where we enjoyed beautiful and varied glacial terrain left by mountain glaciers and small ice sheets during different times of the Quaternary. The excursion went west from Chengdu through Kangding, Yajiang, Litang, Daocheng. North of Daocheng we examined glacial landforms and sediments of a late glacial maximum ice cap with having an area of about 3000 km². A book of abstracts was available at the Symposium. Copies can be requested from: Professor Zhou Shangzhe by E-mail (zhshz@lzu.edu.cn).

3. International Symposium on Quaternary Geology of Denmark

August 29-September 3, 2000; Århus, Denmark

Convenors: J.A. Piotrowski and M. Houmark-Nielsen

The Peribaltic Group

31 participants from 9 countries

20 papers, 7 posters

Abstract Volume (58 pp) and Excursion Guide (32 pp)

The symposium of the Peribaltic Group was held at the westernmost fringe of the Baltic Sea basin to give the participants a synopsis of Quaternary geology in an area far away from Estonia, where the Group has met last in May 1999. The symposium consisted of one paper/poster session day and four days of field excursion. At the paper session, 20 presentations were given including keynote addresses of K.L. Knudsen, M.S. Seidenkrantz and an overview presentation of M. Houmark-Nielsen. Seven posters were displayed. Accommodation was at the field station of the Department of Earth Sciences in northern Jutland and at the conference centre of the University of Aarhus in Sandbjerg, southern Jutland.

The field trip took us to some classical as well as entirely new sites in Jutland and the islands of Mors, Langeland, Møn and Fyn. On day one we visited the newly discovered cliff section at Knud Strand where Elsterian through Weichselian sediments are exposed in one section including Holsteinian and Eemian (terrestrial and marine) sediments, the cliff section at Kås Hoved with the possibly longest exposed Holsteinian marine section in Europe, and the spectacular cross-section through the Main Stationary Line at Bovbjerg at the west coast of Jutland. On the second day we looked at the Weichselian (glaciotectonised) and Holocene sediment sequence at Lønstrup Klint, and at the Skærbæk cliff on Mors exhibiting large-scale glaciotectonic deformations (also of the Tertiary substratum) in a Weichselian end moraine complex. While driving to southern Jutland on day three we looked at the morphology of the Main Stationary Line and discussed the controversial origin of numerous deep channels interpreted by some as subglacial tunnel valleys. In the afternoon we examined Saalian, Eemian and Weichselian (early Weichselian till??) succession at Emmerlev cliff on the west coast close to the German border and the Stensingmose cliff on the north shore of the Flensburg Fjord with Saalian, Eemian (marine *Cyprina* clay and Tapes sand) and Weichselian deposits, partly disturbed due to the glaciotectonics. On the last day we looked at the classical section of Ristinge cliff where a spectacular glaciotectonic setting with over 30 thrust slices including the Eemian deposits are exposed.

4. Field conference of GAGE-Working Group (I)

September 24-30, 2000; Slovakia and Poland

Convenor: J. Janocko

Geospatial Analysis of Glaciated Environments (GAGE); Project on the Glaciotectonic GIS Database and Map of Central and Eastern Europe co-ordinated by A. Ber

25 oral presentations, posters

Abstract Volume, Excursion Guide, Proceedings in Slovak Geological Magazine (see below)

The Members and National Leaders of the project are Andrzej Ber (Poland), Albertas Bitinas (Lithuania), Peter Roll Jensen (Denmark), Volli Kalm (Estonia), Alexander Karabanov (Belarus), Andrei V. Matoshko (Ukraine), Daniel Nyvlt (Czechia), Vitalij Zagorodnikh (Russia), Hans-Jurgen Stephan (Germany), Vitalijs Zelcs (Latvia), Waldemar Gogolek (Poland), James S. Aber (USA; science consulting) and Jan A. Piotrowski (Denmark; science consulting).

The topic of this meeting was glaciation of the Carpathian Mountain system of central Europe. The conference venue, Spišská Stará Ves, Slovakia, is a small town located at the boundary between two national parks, the Pieniny National Park and High Tatra National Park. Juraj Janocko was assisted during field excursions in the Slovakian Tatras by Rudolf Halouzka and in the Polish Tatras by Wojciech Raczkowski. Participants included professional scientists and science students from the Czech Republic, Estonia, Poland, Slovakia, the United Kingdom, and the United States. The conference included

excursion to examine glacial/periglacial landforms and sediments in the Slovakian Tatras and on the Polish side of Tatras.

5. International Workshop Global Ice Sheets and Sea Level during the Last Glacial Maximum

October 1-5, 2000; Timberline Lodge, Mt. Hood, Oregon, USA

EPILOG project; partly sponsored by the Commission

Convenors: E. Bard, P.U. Clark and A.D. Mix

60 participants from 9 countries

Abstract Volume, Proceedings in Special Issue of Quaternary Science Reviews (see below)

What was the extent and volume of ice during the Last Glacial Maximum (LGM) around 21,000 years ago? These ice sheets influenced global climate by affecting the planetary albedo, atmospheric and ocean circulation, and the hydrological cycle. Growth and decay of ice sheets and concomitant changes of sea-level caused global isostatic adjustments that continue today, thousands of years following the termination of the last ice age. Most of the excess ice of the LGM was locked up in large Northern Hemisphere ice sheets where today only the Greenland Ice Sheet remains. Resolving the three-dimensional distribution of this ice, as well as the volume of excess ice in the Antarctic Ice Sheet and smaller glacial centers, remains a critical but unrealized objective in understanding the dynamics of glacial cycles.

The meeting was the second in a series of planned workshops on the Last Glacial Maximum under the auspices of EPILOG (Environmental Processes of the Ice Age: Land, Oceans, Glaciers) program. EPILOG's goal is a comprehensive reconstruction of the state of the earth during (and the transitions into and out of) a full glacial state, and understanding the processes involved in those changes (Mix et al., 2001). EPILOG is revisiting the landmark CLIMAP study of the LGM earth, which created maps of sea-surface temperatures, glacial ice, and albedo (CLIMAP Project Members, 1981), as a test of our understanding of climate processes and models that predict future climate changes. This attention, and particularly the mismatches between an evolving array of data and model predictions, yields insight into the sensitivity of Earth systems to change, the role of external forcing relative to internal feedback in driving natural change, and linkages between various climate subsystems. The conference gave a synopsis of the current state-of-the-art on ice distribution, sea levels and interaction mechanisms during the Last Glacial Maximum.

6. Workshop of GAGE-Working Group (II)

November 24-26, 2000; Warsaw, Poland

Convenor: A. Ber

Geospatial Analysis of Glaciated Environments (GAGE); Project on the Glaciotectonic GIS Database and Map of Central and Eastern Europe co-ordinated by A. Ber

15 participants from Europe and North America

At the meeting, the progress in production of national glaciotectonic maps and the strategies of compiling the data mosaic into a common map at the scale of 1:1,750,000 were discussed. Software techniques were introduced to facilitate efficient data transformation into GIS. Compatibility of different working systems was considered one key factor in streamlining the final map production.

7. ICE FLOW project workshop (I)

November 23-25, 2000; Warsaw, Poland

Project Leader: L. Marks

National co-ordinators: Albertas Bitinas/Rimante Guobyte (Geological Survey of Lithuania), Volli Kalm (University of Tartu), Irina Pavlovskaya (National Academy of Sciences of Belarus), Vitalijs Zelcs (University of Latvia), Hans-Jürgen Stephan (Geological Survey Schleswig-Holstein)

The main objective of the project was focused on ice movement directions in the Peribaltic area during the Weichselian Glaciation. All the directional data, particularly derived from till fabric analyses, glaciotectonic measurements, petrographic indicators and streamlined glacial landforms were collected. The national maps (scale 1 : 500,000) will be combined into a common map of the whole Peribaltic area (scale 1 : 1,000,000), presenting ice movement directions during the Weichselian Glaciation. At the first workshop data from participating countries were presented by the national representatives and map legend proposal and timetable of further activities were fixed.

8. VI International Drumlin Symposium

June 17-23, 2001; Torun, Poland

Convenors: W. Wysota and J.A. Piotrowski

36 participants from 11 countries

Abstract Volume (56 pp), published book including the Excursion Guide (see below)

The 6th international drumlin symposium sponsored by the INQUA Commission on Glaciation in northern Poland from June 17-23, was attended by 36 participants from 11 countries, and organized by Wojciech Wysota and Jan Piotrowski. The symposium began with a day of oral and poster presentations followed by a short discussion. The discussion focused on the morphological description of a drumlin, and moved to whether drumlins could be created in the lab. Ring shear devices were discussed and it was also pointed out that drumlins have been created in flumes. Additional discussion centered on preservation of the subglacial landscape and it was unanimously agreed upon that the origin of drumlins is still uncertain! Although drumlin genesis will likely remain elusive, our knowledge of subglacial processes is advancing.

The first two days of the field excursion were led by Antoni Olszewski and Wojciech Wysota of Nicholas Copernicus University to examine drumlins, which for the most part, are restricted to tunnel channels incised into the Dobrzyn Lakeland upland. The tunnel channel and drumlins terminate at either a series of end moraines composed of bedded sand and gravel with minor amounts of till and glaciolacustrine sediment, or at an extensive kame and dead ice landscape. Hummock forms and long parallel ridges, many of which are crescent shape, characterized the drumlin morphology. Drumlin sediment was variable and included tills, glaciolacustrine and glaciofluvial sediment, which in many cases was folded with the axial fold parallel to the drumlin's length. This structural relationship which was also viewed in drumlins on the Elblag uplands in NE Poland and the Stargard drumlin field in NW Poland elicited a variety of possible origins. These ranged from glacial erosion of a glaciotectonic landscape, meltwater erosional remnants of the glaciotectonic landscape, and ice-pressing of the sediment into a large drumlin shaped cavity at the base of the ice sheet. Interestingly, the sediment within the folds was well preserved, with only minor faulting and not pervasively deformed. Low angle thrust faults indicating compression outwards from the center of a drumlin in the Obory channel, coincided with laminated sands that appear to have been drawn upwards. Because the drumlins were in most cases restricted to channels a few kilometers wide and the channels ended in large deposits of sand and gravel, a subglacial meltwater origin for the drumlins was seriously considered.

On the third day of the field trip we visited the drumlins on the Elblag glaciotectonic uplands. The one exposure we visited in these poorly studied drumlins had a similar deformed core as seen in the previous two days. From the Elblag drumlins we headed west, across the Vistula delta plain to near Gniew where we saw remarkably well exposed glaciolacustrine rhythmites in a clay pit. These sediments are spatially restricted to a small glacial lake dammed by stagnant ice in the Vistula valley. Of particular interest was a bed of ripple formsets within the clays that was explained by jökulhlaup flooding. Accommodation that night was in the Gniew castle where we were treated to a medieval feast.

The fourth day of the field trip included some regional stratigraphy of voluminous sand and gravel deposits between tills, morphology and sedimentology of drumlins and some interesting basal till contacts with glaciofluvial sediment in NW Poland. At the drumlinoid form near Mosty, the possibility of a deformation till was discussed, where the lower part of the till contained portions of the underlying sand

and laminated mud. Various aspects of deforming till mechanisms were discussed and it was agreed that the lower part of the till could be deformational in origin, but was not as obvious as a 0.2 m thick deformation till viewed previously on day two. A deformation origin for the drumlinoid was discussed but could not be substantiated with existing models.

On the final day of the field trip we visited the end moraine of the Parseta Lobe of the Pomeranian Phase (16.2 ka). The proximal edge of an outwash plain contained large boulders that appeared to have been dumped from a pulsed flow. Field trip participants described similar deposits from ice marginal areas of Skeidararjökull, Iceland and from within Rogen moraine. The outwash was then viewed from a more distal pit where the geometry of the predominantly sand bed was planar, in contrast with outwash that often contains bar and channel forms.

In summary, a revised overview of the glaciation of Poland was presented throughout the trip. Many of the drumlins could be linked to specific ice-marginal systems, but the stratigraphy of northern Poland is still debated, as are the origins of the drumlins.

9. International Field Symposium on Quaternary Geology in Lithuania

May 19–25, 2001

Convenors: Albertas Bitinas and Petras Sinkunas

The Peribaltic Group

44 participants from 7 countries

Abstract Volume (78 pp), Excursion Guide (41 pp)

The Peribaltic Group annual meeting in 2001 was organised in Lithuania. The main objectives of symposium were the acquaintance with Quaternary geology of the Eastern Lithuania, which is as a key region for solving problems of the stratigraphy of the oldest Quaternary deposits (the key sites of pre-Glacial and Holsteinian Interglacial deposits) and the problem of Neogene/Quaternary boundary. One full day of paper and poster session was given for participants to present their own research results – there were presented 28 oral and poster presentations including the overview presentation of Ona Kondratienė. 13 geomorphological and geological field sites were visited during 4 days of field excursion in eastern Lithuania: a group of plateau-kames near Pakalniai, conglomerates of glaciofluvial deposits in the Šventoji River valley, an esker near Vyžuonos, key site of Būtėnai (Holsteinian) Interglacial, glaciolacustrine and glaciofluvial delta deposits in the outcrops of Šventoji River, Merkinė (Eemian) interglacial deposits close to Kurkliai, Pleistocene tills in the Neogene quartzite quarry near Anykšėiai, the oldest Quaternary (preglacial) deposits in the Gyliai, Vetygala and Daumantai outcrops, the second biggest boulder of Lithuania “Puntukas”, etc.

10. International Symposium on Palaeo-Ice Streams

October 17-20, 2001; Århus, Denmark

Convenors: D.J.A. Evans, J.A. Piotrowski and Ch. D. Clark

60 participants from Europe and North America

Abstract Volume (81 pp), Excursion Guide, Proceedings published as Special Volume of Boreas (see below)

The symposium showed that Quaternary ice sheets were profoundly, and arguably catastrophically, influenced by the operation of transitory ice streaming. Ice streams are thought to have acted as regulators of Quaternary ice sheet geometry and thickness, and to have facilitated rapid ice disintegration at glacial terminations. It is imperative that we can identify palaeo-ice stream tracks, elucidate the controls on ice stream activation and functioning, and assess their mass balance effects on ice sheet dynamics and retreat. This will lead to a better appreciation of the role that ice streams play in determining and modulating ice sheet function and behaviour, and their interaction with climate.

The symposium consisted of two days of paper/poster sessions (invited speakers: H.P. Sejrup and D. Blankenship) and one day excursion to the Fyn Island (guides: F. Jørgensen, J.A. Piotrowski and G. Larsen) where geological and geomorphological signatures of the Young Baltic Ice Stream were demonstrated. Unique combinations of drumlins, eskers and tunnel valleys were shown together with sediments exposed in numerous gravel pits, all indicating fast linear flow during the ice streaming event. Ice movement was by a combination of basal sliding and subglacial sediment deformation. Fyn is one key area for studying the flow dynamics of the Baltic Ice Stream, which was an important element in the Scandinavian Ice Sheet during the late Pleistocene.

11. Final workshop of GAGE-Working Group (III)

February 2-4, 2002; Warsaw, Poland

Convenor: A. Ber

Geospatial Analysis of Glaciated Environments (GAGE); Project on the Glaciotectonic GIS Database and Map of Central and Eastern Europe co-ordinated by A. Ber

11 participants from 8 countries

Topics of this workshop were (1) presentations of national glaciotectonic maps of the participating countries, (2) establishing the common topographic base map, (3) the final legend of the common glaciotectonic map under completion, and (4) plans for presentation of the project results in Reno.

12. International Field Symposium on Quaternary Geology and Geodynamics in Belarus

May 20-25, 2002

The Peribaltic Group

Convenors: I. Pavlovskaya, L. Marks and J.A. Piotrowski

52 participants from 8 countries

Abstract Volume (78 pp), Excursion Guide (67 pp)

This symposium of the Peribaltic Group took place in western Belarus in the Grodno region and gathered 52 scientists from 8 countries, which demonstrates an increasing interest in the Peribaltic Group meetings. Many young scientists were able to attend this meeting due to the financial support of INQUA and the Fund of Scientific Investigations of Belarus. The holiday inn "Praleska" located amidst the beautiful forests was the residence place of the symposium.

17 oral presentations and 33 posters were presented. The 4 days' field excursion was an interdisciplinary trip focused on the Middle and Late Pleistocene, evolution of the Neman river valley, glaciotectonic features, as well as the maximum limit of the last Pleistocene glaciation in the Neman Lowland and the Grodno Highland. In this area, the most interesting stratigraphical and geological objects of the Belarusian Quaternary are located. During the field trip, participants visited 11 key sections with Holsteinian, Eemian, Saalian and Weichselian interglacial and interstadial sediments, as well as examined impressive glaciotectonic structures with disturbed Cenozoic and Cretaceous rocks.

Participants could see that the Quaternary sequence of the area is very complicated and the interpretation of the Middle-Late Pleistocene geological and geomorphological evidence in the Middle Neman area is a difficult task. This provoked lively discussions in the field, which sometimes became really boisterous at points concerning the geological position of demonstrated profiles, chronostratigraphy of the Middle and Late Pleistocene sequence and the maximum extent of the last Pleistocene ice sheet. Participants came to the conclusion that there is a need to establish collaborative research projects devoted to a geological correlation of the Quaternary within the adjacent areas of Belarus, Lithuania and Poland.

13. ICE FLOW project workshop (II)

November 21-24, 2002; Gdansk, Poland

Project Leader: L. Marks

National co-ordinators: Albertas Bitinas/Rimante Guobyte (Geological Survey of Lithuania), Volli Kalm (University of Tartu), Irina Pavlovskaya (National Academy of Sciences of Belarus), Vitalijs Zelcs (University of Latvia), Hans-Jürgen Stephan (Geological Survey Schleswig-Holstein)

During the second workshop of the project drafts of national maps were presented by the representatives of the participating countries, the common map legend was verified and timetable for 2003 established with focus on the presentation at the INQUA Congress in Reno.

14. Field Symposium on Human Impact and Geological Heritage

scheduled for May 12-17, 2003; Tallinn, Estonia

The Peribaltic Group

Friends of the Baltic Quaternary

Convenor: A. Raukas

Application for INQUA support submitted

This will be the last symposium of the Peribaltic Group in its present organisational framework. The symposium is dedicated to the hundredth birth anniversary of professor Karl Orviku (1903-1981), Member of the Estonian Academy of Sciences, doctor of geology-mineralogy, 1954–1968 Director of the Institute of Geology of the Estonian Academy of Sciences, 1961-1964 Member of the Executive Committee of the International Union of Quaternary Research.

The main objective of the Symposium is to provide a forum for presentation and discussion of recent results on stratigraphy, glacial processes and palaeogeography of the Quaternary and human impact in the Peribaltic area. Colleagues are invited to participate and to present papers on related topics. Abstracts will be published before the symposium and should not exceed 2 pages including figures and references. The Organising Committee provides one day for paper session and 3 days for field excursion. The excursion will focus on the geological heritage of glacial features (e.g., glacial erratics and rafts, end moraines) and human impact features (lakes and bogs, former military areas, etc.).

The symposium will start and end in Tallinn, which is easily reached by planes, ferries, busses and trains. Most of participating countries are visa free. Official invitations needed to obtain a visa (e.g. Russia, Belarus, Ukraine) will be sent out on your request. The registration fee is 250 USD and it includes transportation, accommodation from May 12-17, full board, excursions and conference materials. More information will be given in the second circular, which will be distributed in February 2003 to those who have submitted preliminary registration.

III. Publications

Apart from abstract volumes, excursion guides and internal reports, Commission on Glaciation published following volumes with papers documenting its research activities:

Mickelson, D.M. & Attig, J. (eds.): Glacial Processes - Past and Present. **The Geological Society of America Special Paper** 337, 1999, 203 pp, 19 papers. Proceeding from the Paleoglaciology Symposium, GSA meeting in Madison, USA, 1997.

Janocko, J. (ed.): Geospatial Analysis of Glaciated Environments. **Slovak Geological Magazine** 7, 2001, 92 pp, 10 papers. Proceedings from the GAGE Work Group Meeting in Slovakia, 2000.

Aber, J. & Ber, A. (eds.): Geospatial Analysis of Glaciated Environments. **Geological Quarterly** 44, 2000, 39 pp, 6 papers. Proceedings from the GAGE Work Group Meeting in Warsaw, Poland, 1998.

Oven, L.A. & Shangzhe, Z. (eds.): Late Quaternary glaciation in the high mountains of Central Asia. **Quaternary International** 97-98, 2002, 175 pp, 16 papers. Proceedings from the International Symposium and Field Workshop on Quaternary Glaciation in Monsoonal Asia, 2000.

Hart, J. & Rose, J. (eds.): Glacier deforming bed processes. **Quaternary International** 86, 2001, 150 pp, 11 papers. Proceedings from the symposium on deforming beds, 1999.

Piotrowski, J.A. & Wysota, W. (eds.): Drumlins: an unsolved problem. N. Copernicus University Press, 2001, 101 pp. Published in connection with the VIth International Drumlin Symposium in Torun, Poland, 2001.

Evans, D.J.A. & Russell, A.J. (eds.): Modern and ancient ice-marginal landsystems. **Sedimentary Geology** 149(1-3), 2002, 198 pp, 12 papers. Proceedings from the symposium Modern & Ancient Ice-Marginal Landsystems, 2000.

Clark, P.U. & Mix, A. (eds.): Ice sheets and sea level of the Last Glacial Maximum. **Quaternary Science Reviews** 21(1-3), 2002, 454 pp, 31 papers. Proceedings from the International Workshop Global Ice Sheets and Sea Level during the Last Glacial Maximum, 2000 (partly sponsored by the Commission).

Clark, C., D.J.A. Evans & Piotrowski, J.A. (eds.): Palaeo-Ice Streams. **Boreas** 32(1), 2003, ca. 280 pp, 17 papers (in press). Proceedings from the Palaeo-Ice Streams Symposium, 2001.

Evans, D.J.A. (ed.): Glacial Landsystems. Arnold, 2003, 17 chapters (in press). Contents: 1. Introduction to glacial landsystems (D.J.A. Evans); 2. Ice-marginal terrestrial landsystems: active temperate glacier margins (D.J.A. Evans); 3. Ice-marginal terrestrial landsystems: sub-polar glacier margins of the Canadian and Greenland high arctic (C. Ó Cofaigh, D.J.A. Evans & J. England); 4. Ice-marginal terrestrial landsystems: svalbard polythermal glaciers (N.F. Glasser & M.J. Hambrey); 5. Ice-marginal terrestrial landsystems: polar-continental glacier margins (S.J. Fitzsimons); 6. Ice-marginal terrestrial landsystems: southern Laurentide Ice Sheet margin (P. Colgan, D.M. Mickelson & P.M. Cutler); 7. Ice-marginal terrestrial landsystems: northern Laurentide and Innuitian Ice Sheet margins (A.S. Dyke & D.J.A. Evans); 8. Ice-marginal terrestrial landsystems: southern Scandinavian Ice Sheet margin (F.M. Van der Wateren); 9. Palaeo-ice stream landsystem (C.D. Clark & C.R. Stokes); 10. Supraglacial landsystems in lowland terrain (M.D. Johnson & L. Clayton); 11. Surging glacier landsystem (D.J.A. Evans & B.R. Rea); 12. Subaquatic landsystems: continental margins (T.O. Vorren); 13. Subaquatic landsystems: fjords (R.D. Powell); 14. Subaquatic landsystems: large proglacial lakes (J.T. Teller); 15. Glaciated valley landsystems (D.I. Benn, M.P. Kirkbride, L.A. Owen & V. Brazier); 16. Plateau icefield landsystems (B.R. Rea & D.J.A. Evans); 17. Paraglacial landsystems (C.K. Ballantyne).

3-volume set of J. Ehlers and P.L. Gibbard, Work Group on Extent and Chronology of Glaciations
Extent and Chronology of Glaciations:

Ehlers, J. & Gibbard, P.L. (eds.): Quaternary Glaciations - Extent and Chronology, Part I: Europe. **Quaternary Science Reviews** , 2003a (in print).

Ehlers, J. & Gibbard, P.L. (eds.): Quaternary Glaciations - Extent and Chronology, Part II: North America. **Quaternary Science Reviews** , 2003b (in preparation).

Ehlers, J. & Gibbard, P.L. (eds.): Quaternary Glaciations - Extent and Chronology, Part III: South America, Asia, Africa, Australia, Antarctica. **Quaternary Science Reviews** , 2003c (in preparation).

Description:

At the INQUA Congress in Berlin 1995 the INQUA Commission on Glaciation decided to form a new work group entitled the Extent and Chronology of Glaciations. The idea of this 'Work Group 5' was to provide a comprehensive overview of the extent and chronology of glaciation during the Quaternary, particularly including digital maps, giving relevant key locations and type sections and the relevant literature. The first results of the group were shown and discussed in a symposium, a poster session and a workshop at the XV INQUA Congress in Durban, South Africa, and this will be followed by presentation of the final results at the XVI INQUA Congress in Reno, Nevada, U.S.A.

The project involved the contribution of over 200 scientists working in more than 60 countries and territories throughout the world. The resulting compilation has taken eight years to complete and publish, and represents the most complete survey of evidence of glaciation ever attempted.

The main purpose of the of the INQUA Commission on Glaciation Work Group was as far as possible to compile the recent knowledge of the extent and chronology of Quaternary glaciations on a global scale. This information is seen as a fundamental requirement, not only for the glacial community, who are already aware of the detail and shortcomings of the available evidence, but for the wider user-community of general Quaternary workers. In particular the need for accurate ice-front positions is a basic requirement for the rapidly-growing field of palaeoclimate model-ling. In order to provide the information for the widest-possible range of users in the most accessible form, the compilers decided that it would be most appropriate to prepare a series of maps.

It was immediately obvious that this approach required the use of digitally-based techniques which would allow maximum flexibility, both for the user and for the compilers to integrate an extremely large amount of data in a wide range of forms. It also allows the user to create their own maps and/or to compare their results with those of other researchers at a scale and projection of their own choosing. As cooperation with the Work Group was and remains open to all, alternative views are given, wherever they are available. This is most spectacularly seen in the case of High Asia, where opinions on glacial limits vary considerably, depending on the author. Most of the areas have been previously mapped, some (especially in Europe) at much larger scales, many at much smaller scales. At the 1: 1,000,000 scale a map cannot be very accurate; errors in the order of a few hundred metres are normal. More accurate mapping, however, would have required a much larger effort. Increasing the mapping scale to 1: 100,000 would have required a one hundred-fold increase in detail. However, at present even a glacial map at the 1: 1,000,000 is very difficult to produce for major parts of the world. Mountain ranges comparable in dimensions to the European Alps that were heavily glaciated in the Pleistocene, such as the Werchojansk Mountains, have hardly been mapped at all. Inevitably, therefore the choice of scale must be a compromise for a project of this size.

The glacial limits were mapped in ArcView, the Geographical Information System (GIS) used by the work group. The 'Digital Chart of the World' at a scale of 1:1,000,000 was used as a base map. Of the various 'layers' of information available, only rivers, lakes, glaciers, settlements, contours (in feet), roads and railway lines were chosen in order to keep the base map as simple as possible.

The following information on former glaciations was added to the maps:

1. Glacial limits.
2. Morphologically expressed end moraines.
3. Ice-dammed lakes.
4. Glacier-induced drainage diversions.
5. Location of key sections through which the glacial limits are defined and dated.

An effort was made to map four principal 'glacial limits' for all areas:

1. The maximum limit of Pleistocene glaciation
2. The Late Weichselian/Wisconsinan Glacial Maximum (LGM)
3. The Early (or Middle) Weichselian glacial maximum
4. The maximum limit about 10-11 ka, i.e. corresponding to the glacial maximum during the European Younger Dryas Chron(ozone).

The evidence from each region is discussed in an accompanying text, to be published in the form of three volumes 'Europe', 'North America' and 'South America, Asia, Africa, Australia, Antarctica' (Ehlers & Gibbard, 2003 a, b, c), each of which contain a series of maps in digital format accompanied by an explanatory text which includes discussion of the type and quality of data used. All references to the supporting basic publications are included. Where controversial interpretations are possible e.g. in Siberia or Tibet, this is indicated. As a result, all information on Quaternary glaciations worldwide is presented for the first time in a uniform format, including the mountain glaciations of regions such as Costa Rica, Ethiopia, Greece or Taiwan. These glaciers have been very limited in extent but provide important information on the Pleistocene climatic change.

IV. Summary of the results

In the inter-congress period 1999-2003 Commission on Glaciation has organised 14 international conferences, symposia and workshops attended by over 600 scientists from all over the world. The results of research carried out within the framework of INQUA-funded projects, projects carried out under the Commission umbrella without its direct financial sponsorship and other projects for which the Commission has served as a common platform for disseminating scientific information have been published in 11 special volumes of journals and 2 books. Besides its scientific input into better understanding the Quaternary glaciations, the commission has contributed to integrating research from less known and accessible regions of the world, especially central and eastern Europe into the international scientific community.

More detailed information about past and present activities of the Commission including lists of papers/posters and abstracts given at our meetings is available at our homepage www.inqua.au.dk.

V. Future plans

After the INQUA Congress in Reno at which the Commission will be represented with two paper and six poster sessions, we intend to continue on the Top Unit level. This is justified by the fact that glaciations are the most distinct element of the Quaternary. The Commission would be reduced to few topical working groups focussing on integrated studies of extent, timing, and sedimentary/geomorphological record of Quaternary glaciations seen in the context of Global Change. Close co-operation with Palaeoclimate and Stratigraphy/Chronology units will be given a high priority implemented through joint projects aiming at complex reconstruction of the glaciated Quaternary environments. The follow-up of the present Commission will continue to serve as a common denominator for research on past and modern glaciations carried out within different international and national programmes. Detailed activity plans will be worked out as soon as the decisions regarding the INQUA structure after Reno are known, which will secure smooth fitting of our interests into the new framework.

Jan A. Piotrowski
President, Commission on Glaciation

Århus, February 23, 2003