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INTERNATIONAL EVALUATION OF QUATERNARY GEOLOGY, 2005

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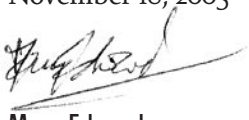
To the Swedish Research Council

A panel of international experts was appointed in September 2005 by the Scientific Council for Natural and Engineering Sciences and was given the task of carrying out the evaluation of Quaternary Geology in Sweden. The evaluation took place in Stockholm during November 14 – November 18, 2005. During these days, the grant holders under review presented their research activities to the Expert Panel. The Panel also interviewed the grant holders during that time.

The present document reports the findings and recommendations of the Expert Panel, which considers its task fulfilled. In accordance with the terms of reference of the Expert Panel, its international members take full responsibility for this report.

November 18, 2005



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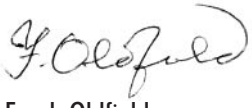
Vera Markgraf



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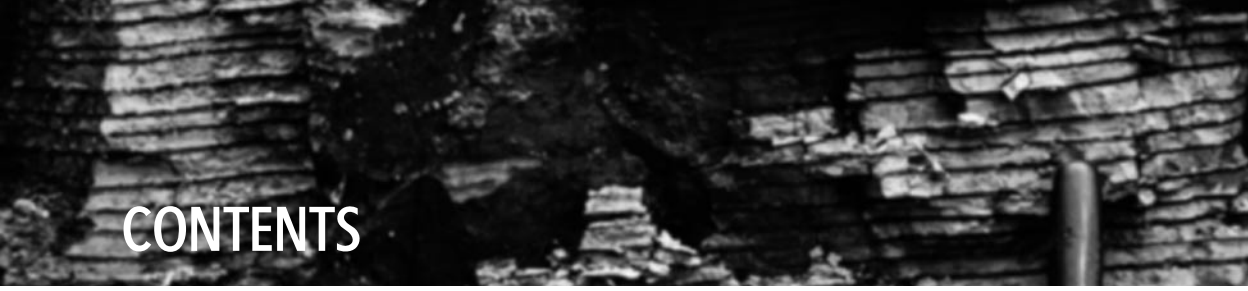

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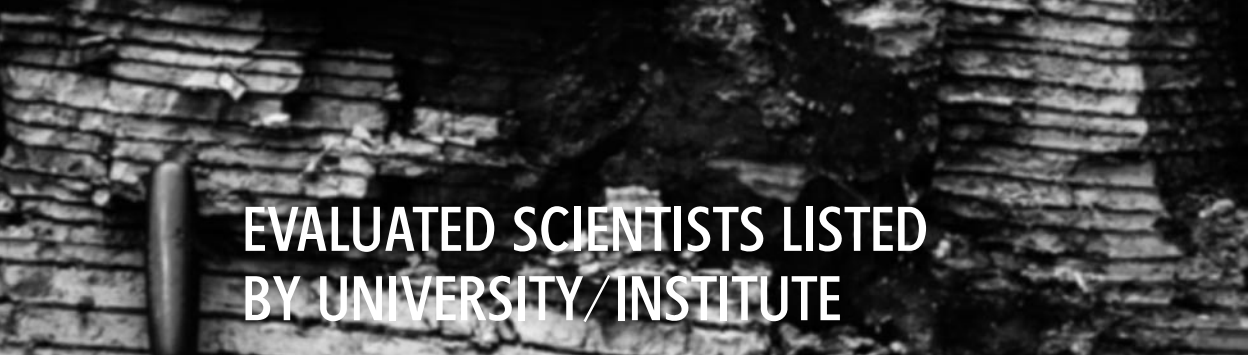


EVALUATED SCIENTISTS LISTED BY UNIVERSITY/INSTITUTE

Geological Survey of Sweden

Johan Nyberg

Göteborg University

Kjell Nordberg

Lund University

Svante Björck
Dan Hammarlund
Mats Rundgren
Per Sandgren
Ian Snowball

Stockholm University

Thomas Andrén
Eve Arnold
Jan Backman
Karin Holmgren
Gunhild Rosqvist
Stefan Wastegård
Barbara Wohlfarth

Umeå University

Leif Kullman
Ingemar Renberg

University of Kalmar

Marie-José Gaillard-Lemdahl
Geoffrey Lemdahl

Uppsala University

Keith Bennett
Göran Possnert

ASPECTS OF RESEARCH IN SWEDEN AND GENERAL RECOMMENDATIONS

Introductory Remarks

Quaternary Geology represents a broad subset of the studies funded by the Swedish Research Council's Geology and Geophysics Committee, ranging from stratigraphy and geochronology to palaeoclimatology and palaeoecology, and including aspects of carbon cycle dynamics and palaeo-oceanography. In all, 20 researchers were evaluated, having received Swedish Research Council grants during the period of 2000 – 2005. Seven of these researchers were based at different departments at Stockholm University, five at Lund University, two each at the universities of Uppsala, Umeå, and Kalmar, one at Göteborg University, and one at the Geological Survey of Sweden. The Expert Panel notes that many Swedish scientists currently working in the field have not received financial support from the Swedish Research Council during the past five years.

The field is relatively small and the Panel members recognised many of the researchers being reviewed; there were no conflicts of interest, however. Prior to the Expert Panel meeting, reports were submitted by each researcher and presented to the Panel. The reports included detailed information on level of support, progress, publications, students and postdocs trained, interactions, dissemination, and future plans; the researchers were also asked to comment on the general state of the field and its future. Each researcher gave a brief presentation to the Panel on progress, key results, and vision for the future, which was followed by a question-and-answer session.

The researchers were given ample opportunity to raise their own points of concern and to provide general comments to the Panel. Prof. Keith Bennett of Uppsala University could not participate in this meeting, as he had previously organised fieldwork in the Southern Hemisphere; he was, however, evaluated on his submitted report only. Dr. Johan Nyberg, employed by the Geological Survey of Sweden, was also reviewed for his Swedish Research Council-funded research, but because he is currently working outside of academia it was decided not to rank his overall performance.

The Panel reviewed senior, mid-career, and junior scientists. Evaluations were based on the performance of scientists within their peer group. To some extent, the amount of time available for research was taken into

account when formulating evaluations. This was particularly the case for several senior scientists, who carried extremely heavy administrative loads during all or part of the evaluated period. The situation of younger scientists with new families was also noted; in particular, a decrease in the productivity of women scientists in such circumstances was taken into account in evaluations. In the main, the Expert Panel was impressed with the quality of research topics of Quaternary Geology in Sweden, and by the scientific achievements of the individual scientists.

Employment Structure and Research Funding

It rapidly became apparent, from submitted reports and from conversations, that all is not well at Swedish universities in terms of funding research. A major funding crisis, precipitated largely by an expansion of institutions without a concomitant increase in funding from central government, has led to the prominent, research-intensive universities retrenching and the newer universities established, but virtually unable to provide any research support to their staff. Senior and junior researchers alike expressed the concern that a generation of good researchers could be driven from the field by a lack of permanent positions at the mid-career level. Ironically, funding for Ph.D. places is still relatively high, and a healthy number of postdocs are working in Sweden on overseas funding, despite cuts in domestic funding for postdocs. Thus, good people are brought forward, only to be cut out of the system after investing ten or more years of their life in science.

Considering the financial situation, there is a risk that earlier investments in laboratories may be wasted if facilities are forced to close because of a lack of technicians. Further, poor staffing levels compromise the effectiveness of currently active laboratories.

Overall, these problems, mentioned in several recent evaluation reports for the Swedish Research Council, bode ill not only for science, but for the future competitiveness of the universities. This crisis clearly cannot be resolved by actions of the Swedish Research Council alone; a concerted effort to solve the problem must involve the universities and the government. However, the Swedish Research Council might consider redirecting some resources to maintain promising mid-career scientists until this crisis is resolved.

Status and Future of Quaternary Geology in Sweden

It is the panel's view – and this is supported by virtually all researchers interviewed – that the boundaries of Quaternary Geology have been expanding for some years. Today, some of the most important contributions are in palaeoclimate reconstruction, Earth system science, long-term ocean dynamics, environmental pollution, human impact on the environment, and human – climate interactions; these are key areas of science addressing internationally important issues as well as issues at the national level.

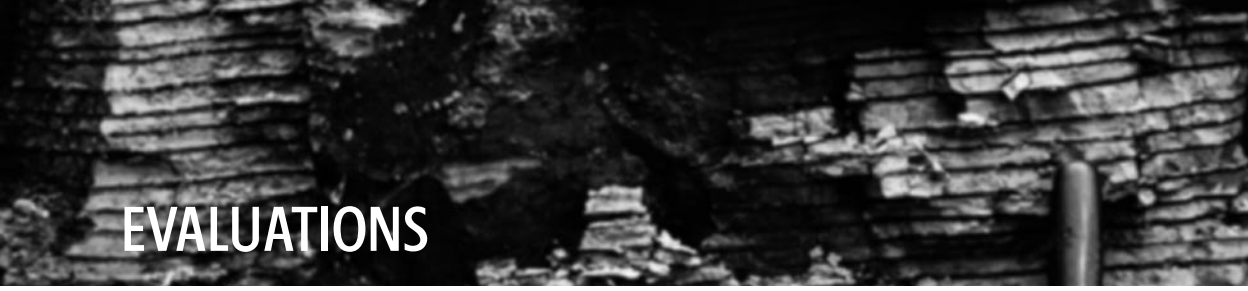
Several researchers raised the point that the term "Quaternary Geology" was becoming obsolete, or at least misleading, as practitioners were expanding the boundaries of the field and becoming more interdisciplinary in their approaches to problems. However, while research foci may change, the principles of stratigraphy that underlie proxy-based reconstructions from sediment archives are fundamental to good science. There is some concern that with an explosion of new subfields there will soon be no room for the teaching or practice of traditional disciplines of glacial geology, geomorphology, and stratigraphy. This would be a disservice to the field.

A structural response to these changes is seen in the fact that several universities have reorganised departments, combining disciplines such as physical geography and environmental science with geology. There was almost unanimous acceptance and support of these changes amongst researchers. The Swedish Research Council may wish to consider at some stage the renaming of this funding area in recognition of the rapid evolution of Quaternary science, but the main thing, of course, is that it continues to fund the range of topics perceived as important by the national and international scientific communities.

Given restricted funds, the possible establishment of centres of excellence in Quaternary science and the focusing of research and research infrastructure in a few universities should benefit the field, provided facilities and training opportunities are made available to the whole community. The Expert Panel was impressed by the degree of collaboration within Sweden and between Swedish and overseas groups. It is clear that scientists appreciate that expensive equipment should not be unnecessarily duplicated, and they are for the most part willing to use facilities in other institutions. The maintenance and running of complex equipment is extremely expensive and must be carefully justified. A case that fully justifies support is the accelerator facility at Uppsala, which provides a world-class essential service as well as being the focus for cutting-edge research.

This is an era of big-project science, but several researchers noted that the most productive science is often done in smaller, focused groups. While some large projects are essential, for example, ocean drilling campaigns and large-scale syntheses, the panel agrees that a mixture of project sizes is the best situation. It is perhaps telling that several of the most prominent and productive scientists interviewed expressed a preference for working in smaller groups and maintaining flexible collaborations. It is important that creative and productive individuals are not eclipsed by the rise of "mega-projects". A related trend in science across much of Europe is the increased "steer" from governments to science programmes. This trend was criticised by interviewees as being counter-productive. The best science is usually initiated from the bottom up, not the top down. It is to be hoped that in the future the Swedish Research Council can continue to recognise and reward individually initiated projects of the highest quality.

Several researchers mentioned cross-disciplinary collaboration with social scientists. Climatic and environmental change is intimately linked with human actions and societal responses: vulnerability and adaptation to environmental change are critical issues that require natural and social scientists to tackle problems together. Natural scientists with the capacity and inclination for productive dialogue with social scientists are rare, and they should be encouraged to pursue cross-disciplinary projects when the outcomes promise to be fruitful. Funding institutions will have to consider innovative ways to fund such research. There should not be a lack of support merely because the work is perceived to fall between disciplinary/methodological/philosophical boundaries; good work of this kind builds essential bridges.



EVALUATIONS

Thomas Andrén
Department of Geology and Geochemistry, Stockholm University

The Drainage Events of the Baltic Ice Lake and the Possible Consequences for the Climate Development in the North Atlantic Region

Abstract (the submitted version)

By this application, we wish to address two specific questions raised by the results from our new data. 1. Exactly how large is the error in the Swedish varve chronology? 2. Was the final drainage of the Baltic Ice Lake (BIL) a two-step event and what were the consequences on the circulation in the North Atlantic?

Marine sampling in the Western Baltic Proper will enable us to include a well dated, regional time-synchronous marker horizon in the Swedish varve chronology, the Laacher See tephra. We propose that high-resolution shoreline displacement studies be performed in the high area in central Östergötland together with a coring in the area west of Billingen included, in order to verify if there were two freshwater outbursts during the final drainage of BIL. We will also be able to evaluate to what extent the drainage of BIL affected the climate development in the North Atlantic region. Applied methods include measurements of clay-varves, grain size, magnetic properties, TOC, stable isotopes and analyses of calcareous fossils, pollen, and diatoms. Precision levelling of shorelines and lake isolation levels will be carried out.

Past Performance

Methodology

Andrén's strength is in lithostratigraphical methods, namely varved clays studies. In collaboration with specialists, he has also effectively utilised biostratigraphical methods, primarily diatom analysis.

Position within the area

Andrén is known for his studies on the Late Weichselian and Holocene history of the Baltic water body. He has published 13 peer-reviewed articles on this subject since 1996, and he is first author of five of them. Andrén participated actively in the EU-funded BASYS (Baltic Sea System Studies) Programme and he is first author of the project reports, which were published in 1996 and 1998. A conference volume, edited by Andrén, entitled *Baltic Sea Science Congress 2001*, was published in 2005.

Particular achievements

The main results of the project are convincing, including the verification of the nearly 800 years of error in the Swedish varve chronology and, further, that the sudden drainage of the Baltic Ice Lake (ca 10 000 km^3 of water) had only little effect on the North Atlantic thermohaline circulation.

Future

Project plans

Andrén is co-ordinating an international project proposal for Integrated Ocean Drilling Programme, IODP. It was well received by the preliminary Evaluation Panel, and the actual project proposal awaits writing.

Balance between resources and goal

Andrén has no research financing, and his position as a part-time university teacher does not support his activities in the IODP Programme. In the case of a positive proposal outcome, funds would not be available earlier than 2009.

Comment on the Area

Position within Quaternary Geology

Andrén's work on the history of the Baltic Sea represents a rather conventional but at the same time essential field of Quaternary Geology in the sphere of the Baltic Basin.

Importance and future potential of the area

The role of changing climate versus anthropogenic impact on the ecosystem of the Baltic is a most crucial research area, which Andrén emphasises as a topic of his future research activities.

General Judgement

Thomas Andrén's main topics have been connected to the history of the Baltic Sea water body including the project funded by the Swedish Research Council on the drainage events of the Baltic Ice Lake, etc. Since 2002, Andrén has published only one paper (co-authored) in a peer-reviewed journal despite his four-year junior research position (forskarassistent), which terminated in 2004. The Expert Panel regards his work as *good*.

Eve Arnold
Department of Geology and Geochemistry, Stockholm University

Asian Monsoon Variability

Abstract (the submitted version)

This proposal requests funding to perform research on two projects, which are both related to the study of the evolution of the Asian monsoon. Specifically, funding is requested to generate clay mineralogy records from a continental site on the loess plateau of China and from Ocean Drilling Programme (ODP) cores to be collected on Leg 184 in the South China Sea. The objectives of this research are to provide a high resolution palaeoclimatic proxy for continental weathering, which can be used to test the following hypotheses: 1. The evolution of the Asian monsoon circulation is related to the uplift of the Tibetan Plateau; 2. The onset of the Asian monsoon resulted in changes in the weathering regime over large regions of Asia; 3. The changes in the weathering regime in Asia provided an internal feedback to the Earth's climate dynamics, which led to the onset of Northern Hemisphere glaciation.

Past Performance

Methodology

Since her Ph.D. in 1996, Arnold's research focused on mineralogical analysis of marine sediments, with the goal to understand source area and transport mechanisms of mineral aerosols and their implication on past climatic conditions. The Swedish Research Council-funded research is a comparison of marine sediments in the South China Sea with terrestrial loess sequences in China, in order to reconstruct the last seven million years of monsoon variability and the effects of tectonism (Tibetan Plateau uplift) on climate.

Position within the area

Following her Ph.D. in 1996, a total of six publications are listed, two of which as first author; the publications are moderately cited. The research grant, starting in 1999, supports a Ph.D. dissertation. One paper on results of this project has been submitted. Although her scientific approach and data presented are of high quality, her publication record does not yet reflect this. In order to fulfil her promise as a strong researcher in this field, she must ensure that publications emerge that fully reflect the quality of the research; otherwise there is a danger that she will loose the opportunity to continue with funded research.

Particular achievements

Arnold is playing an important role in national and international co-ordination efforts for the Integrated Ocean Drilling Programme. As director of the department's sedimentology laboratory, she also provides a valuable service to education in Quaternary Geology.

Future

Project plans

There are no future research plans presented, given that teaching seems to be Arnold's principal occupation. She hopes to stay involved in research through collaboration only. Her presentation included reference to collaborative research, both on loess and related North Pacific marine sequences that would be of considerable interest to the Quaternary research community.

Balance between resources and goal

For the present, Arnold has limited her goals to the minimal time resources available to her for research.

Comments on the Area

Position within Quaternary Geology

Studies focusing on comparison of palaeoenvironmental records from marine and terrestrial sediments have provided important insights into global change issues on long timescales. In China, this research has a long tradition and has resulted in outstanding research results presented by Chinese scientists (e.g., on the relation between past climate cycles and

human evolution). Arnold's research may add another facet to the question on tectonic changes and their effects on climate.

Importance and future potential of the area

This research of integration between terrestrial and marine records will remain an important focus in the future research in Quaternary Science.

General Judgement

Eve Arnold's research focuses on reconstruction of the last seven million years of monsoon behaviour analysing marine and terrestrial sediment sections from China. Because of high teaching and administrative loads, Arnold's research project is essentially a Ph.D. dissertation under her supervision. Arnold enjoys teaching and public outreach and thus does not foresee to be involved with other research projects except through potential collaboration with colleagues. The Expert Panel regards her work as *good*.

Jan Backman
Department of Geology and Geochemistry, Stockholm University

High Resolution Holocene Climatic and Environmental Variability in the Skagerrak

Abstract (the submitted version)

In this project, the following was planned: To identify, quantify, and evaluate palaeoclimate proxies down-core in the Skagerrak core MD 992286, in order to characterise the NAO-index; To compare the Skagerrak sedimentary high resolution Holocene palaeoclimate record with instrumental climate data, and to investigate possible couplings of the ongoing warming trend with the natural fluctuations of NAO; To document Holocene Skagerrak circulation variability pattern and amplitude on decennial, centennial, and millennial timescales and compare with atmospheric climate records from Greenland ice cores by creating long time series, at a resolution close to one or a few years; and to outline the temperature, current, wind and precipitation changes using the Skagerrak sedimentary high resolution Holocene palaeoclimate record.

The cyclonic circulation of water masses in the Skagerrak is mainly governed by the inflow of high-saline Atlantic water from the North Sea. This inflow has a known interannual variability, likely linked to large-scale North Atlantic variations such as the North Atlantic Oscillation (NAO). Present sedimentation rates in the Skagerrak may reach 5 – 7 mm/year, and the Holocene is in some areas represented by over 70 m of sediments, thus containing an archive of biological, physical, and chemical properties of the depositional environment, including NAO-driven variability.

Past Performance

Methodology

Backman is a specialist in marine geoscience. His main focus has been on reconstructing the palaeo-oceanography and palaeoenvironment of the Cenozoic. In particular, he has devoted his work to analysis of sediment cores. In his earlier works, his main method was nannofossil analysis. Later he has, together with colleagues, expanded the methods to, e.g., geochemical and lithological techniques, and also high resolution acoustic analysis. During the last decade or so, he has been instrumental in the planning and execution of the marine geological activities using Swedish icebreakers in the Arctic Ocean.

Position within the area

Backman lists 20 peer-reviewed articles since 1996. An additional seven articles are in press. He is first author on two of these articles. The articles are moderately to poorly cited. Backman holds a key position in Swedish marine geology, and he has supervised seven Ph.D. students. He has been, and still is, frequently used as the Swedish representative in international marine geological organisations. Backman has been instrumental in establishing marine geoscience as a new Ph.D. programme at Stockholm University.

Particular achievements

One of Backman's articles, published in *Nature* with N. J. Shackleton as senior author, brought the study of the Late Cenozoic palaeo-oceanography and palaeoclimate a huge step forward. The article, "Oxygen isotope calibration of the onset of ice rafting and history of glaciation in the North Atlantic region", has been cited 444 times.

Backman is an international authority on the marine geology of northern high latitude seas. The Arctic coring expedition (ACEX project) is well known in the geologic community and has received international media

coverage. It has revealed that deep-sea drilling is possible in waters covered with drifting sea ice, and that there is a higher potential for core recovery than previously thought.

Future

Project plans

Backman and his group plan to proceed with a joint Swedish – UK – Danish IPY (International Polar Year) programme to the Lomonosov Ridge in the Arctic Ocean using Swedish icebreakers. They are also involved in an IODP proposal "Cenozoic Pacific Equatorial Age Transect – Following the Equator".

Balance between resources and goal

The present resources indicate that the group needs additional resources to continue with both of these plans. If forced to choose, it would probably be wise to give priority to the work in the Arctic Ocean, given Sweden's experience within this area.

Comments on the Area

Position within Quaternary Geology

Although Backman does not characterise himself as a Quaternary geologist, he has participated in very important work related to reconstructing the Quaternary palaeoenvironment. He is certainly well known for his marine geological works in the North Atlantic and in the Arctic Ocean.

Importance and future potential of the area

Backman has received financial support from the Swedish Research Council for several projects in the period of 2000 – 2005. The research topics addressed are important for several key palaeo-oceanographic issues related to Quaternary Geology. The area attracts a considerable interest, *inter alia*, due to the need for predicting the future climate evolution.

General Judgement

In view of the very heavy administrative load, Jan Backman's work in recent years is considered *excellent* by the Expert Panel. The evaluated Skagerrak-project was well organised and well performed. Most of the interesting results are already published or in press.

Keith Bennett
Department of Earth Sciences, Uppsala University

Quaternary Ecology

Abstract (the submitted version)

My over-riding research interests are in the area of the response of organisms to climate change on timescales of thousands to hundreds of thousands of years. These responses take the form of (i) distribution and abundance change; (ii) extinction, locally and totally; and (iii) speciation (evolution). The challenge is to understand the relative importance of the three (since all occur), and at which timescales. In practice, this interest takes the form of several distinct lines of research activity:

1. Palaeoenvironmental reconstruction, principally by means of pollen analysis, and centred on questions related to the distribution of woodland and individual tree species (including projects funded by the Swedish Research Council);
2. Numerical analysis of Quaternary stratigraphical data, with a view to improved understanding of data, and uncertainties associated with data. Of particular interest have been methods for the zonation of stratigraphical sequences, and age-depth modelling;
3. The use of fossil DNA (aDNA) as a means of complementing molecular phylogenies based on living organisms (project funded by the Swedish Research Council);
4. The relationship between macroevolution (speciation) and environmental change: causal or otherwise.

I thus attempt to maintain interests at a research level that span the whole range from primary data collection (with recent projects in Sweden, Chile, and in Kamchatka) to analysis of that data, and synthesis of that data with other work; as part of our overall understanding of how organisms respond to climate change.

Past Performance

Methodology

Bennett is a palynologist focusing on the ecological aspects of past changes in vegetation composition and structure as well as on extinction and

speciation during the late Quaternary with examples from Sweden, southern South America, and, most recently, from Kamchatka. An additional strength of his research is the critical approach to basic data handling and numerical data analysis, for which he has developed computer programmes.

Position within the area

Bennett is among the few palynologists with a primarily ecological focus in the interpretation of palaeoecological data, such as identifying the responses of plant taxa to environmental change. Along these lines, he has published seminal papers, a book, and book chapters, which are widely cited. During 1996 to 2005 he lists 22 papers; 11 of which as first author, one book, one field guide, and three book chapters. In addition, he has developed computer software for analysing and plotting pollen data and performing age *vs*. depth modelling. The most frequently cited paper during the 1996 – 2005 interval is on a biostratigraphic zonation technique, which he has developed. Bennett has supervised 13 Ph.D. students since 1990.

Particular achievements

Bennett's book on "Evolution and Ecology" (1997), widely quoted, reflects his true calling and interests. His most recent research project on extraction of fossil DNA from Holocene pollen has a great potential in the quest to determine the rate of speciation (molecular clock) versus environmental change.

Future

Project plans

Apart from continuing ongoing palaeoecological research projects in southern South America and in Kamchatka, the fossil DNA research seems to be the most innovative line of Bennett's present research. There are presently several other research projects within the Scandinavian Quaternary community focusing on DNA research, which hopefully lead to future collaboration. The substantial effort on further improvement of numerical techniques for pollen analytical research and helping other researchers with the application of these techniques is a service to the community.

Balance between resources and goal

Bennett considers his funding level adequate, stating that his most cited publications were not part of funded projects, but from the development of ideas. He is an individual player in the field, following his own interests.

Comments on the Area

Position within Quaternary Geology

The field of palaeoecology is well established within Quaternary Science and will certainly continue to play an important role. Bennett is well positioned to play a key role within the Scandinavian community, although he seems to rather work on his own terms than in teams.

Importance and future potential of the area

Much palaeoecological research, using palynology, has still to be done, in Scandinavia and elsewhere.

General Judgement

Keith Bennett is an internationally acclaimed palynologist with an ecological bent, focusing on the responses of ecosystems to environmental change rather than the reconstruction of palaeoclimate changes. His palaeoenvironmental research projects in southern South America have produced very interesting data in a still poorly known region, which probably also will be the case with the new project on Kamchatka. His collaboration with other research projects is mostly linked to his interest in numerical data analysis and development of computer software. The Expert Panel regards his work as *excellent*.

Svante Björck
Department of Geology, Lund University

Late Quaternary Palaeoclimate, Sea Levels and Chronologic Problems around the Atlantic

Abstract (the submitted version)

The Atlantic and bordering regions play a key role in global climate. Our palaeoclimatic investigations along an inter-hemispheric Atlantic island transect aim to analyse leads and lags and inter-hemispheric couplings during rapid climate change of deglacial – interglacial scenarios. We work with sea level changes and modelling of the Greenland Ice Sheet and lacustrine/peat records, and glacial geology (when present) on Greenland, Iceland, Faroe

Islands, Azores, Tristan da Cunha and Isla de los Estados, and islands off the Antarctic Peninsula as well as on the European North Atlantic Sea Board. We also work with tree-ring records in Europe and on Isla de los Estados.

The sediment records are analysed with a set of conventional techniques, including some new ones – eolian particles in peat bogs (proxy for storminess/ winter conditions) and "lake IRD" records (winter conditions) – to obtain proxy records for different palaeoclimatic parameters. A main methodological thread for the project is chronology. We invest much effort into creating secure chronologies; the new AMS ^{14}C facility in Lund increases dating quality; good communication with dating staff, and possibilities for tests and alternative sample preparations. This has resulted in well-dated records; a prerequisite for detailed correlations. No synthesis has so far been written up, but two subsyntheses (Denmark Strait, Greenland – Iceland – Faroe Islands) imply fairly large temporal and spatial variability and weak evidence for a distinct 8.2 event. Examples of other results: warm Younger Dryas summers in Greenland, hydrologic variations in Azores are in pace with Bond cycles; a clear 8.2 event is, for the first time, found in the Southern Hemisphere.

Past Performance

Methodology

Björck is a truly holistic Quaternary geologist. From the onset, his research focused on a multi-disciplinary understanding of Quaternary environmental changes, using conventional (pollen, sedimentology, stratigraphy) as well as more modern techniques (aeolian and ice-rafting indicators) in terrestrial as well as marine sediments. One of the key aspects in the context of these studies dealt with establishing and improving the chronologies of past changes, applying whatever technique the specific data set required (varve counting, radiocarbon and uranium series dating, tephrochronology, etc.).

Position within the area

Björck is one of the major players in the Scandinavian and European field of Quaternary Science, having involved a wide range of collaborators and thus produced a remarkably high number of wide-ranging research publications. At present, he spearheads a large project, ATLANTIS; an interhemispheric palaeoclimate project comparing Holocene sediments from islands in the Atlantic Ocean, with the goal to determine the role of the thermohaline circulation on environments from pole to pole. Since 1996, Björck lists 59 publications and ten book chapters, 18 as first author. Many of his publications are widely cited.

Particular achievements

Björck is a leader in the Swedish – Scandinavian Quaternary palaeoclimate community, with an exemplary record of productivity and success in forging collaboration. His 1996 *Science* publication on terrestrial – atmospheric deglacial records around the North Atlantic has been a most widely cited article.

Future

Project plans

Björck's future goals involve finalising the ATLANTIS project, specifically retrieval and analysis of sediments from both ends of the transect; from Staten Island and Iceland. In addition to the wealth of data emerging from this project, he should be encouraged at this stage in his career to write synthesis papers, given his overview and long-term expertise on a wide range of palaeoclimatic topics.

Balance between resources and goal

Given that resources are unlikely to increase dramatically, it seems even more important to focus on specific goals that relate to the researcher's expertise, such as writing synthesis papers on the large-scale aspects of research results; such as the very successful 1996 *Science* publication. With the potential for Lund to receive a Linnaeus Grant for carbon cycle studies, Björck should be encouraged to assure that the other fields of Quaternary Science remain viable in Lund, especially the excellent state-of-the art laboratories.

Comments on the Area

Position within Quaternary Geology

Quaternary Science at Lund University is exemplary for its performance and productivity, in large measure the result of Björck's efforts and his enthusiasm. Especially those fields with up-to-date laboratories should by all means be continued.

Importance and future potential of the area

For Quaternary Science to remain viable nationally and internationally, it is essential for interdisciplinary groups as strong as the Lund Quaternary pro-gramme to remain funded at the needed level.

General Judgement

Svante Björck has done an excellent job in building upon and further enhancing the Quaternary Science programme in Lund with his enthusiasm for the broad range of Quaternary Science and his scientific excellence. He stands as an example for the whole Swedish and Scandinavian Quaternary research community, educating and promoting young scientists in this interdisciplinary field and fostering a collaborative research community. The Expert Panel regards his work as *outstanding*.

Marie-José Gaillard-Lemdahl
Department of Biology and Environmental Science, University of Kalmar

Human Impact on Terrestrial Ecosystems in Southern Sweden during the Holocene — with an Emphasis on Quantitative Reconstruction of Past Land Cover Inferred from Fossil Pollen Data (SWEHITE)

Abstract (the submitted version)

Despite a century of palaeoenvironmental research that has utilised pollen records, the issue of translating pollen data to quantitative estimations of vegetation or land cover over a known area has remained a major challenge. In this project, good progress in quantitative landscape/vegetation reconstruction has been achieved with the development of the "Landscape Reconstruction Algorithm" (LRA). LRA takes advantage of the development of mechanistic models of pollen – vegetation relationships. The project aimed at validating the approach in Southern Sweden. The output from the LRA will then be displayed as maps for selected time windows of the last 3 000 years BP, using additional information (geology, geography, history, and archaeology) via a GIS-system with associated probability models. Based on the LRA approach, it is now possible to produce land cover maps at two distinct spatial scales, i.e., at the detailed, local scale and at the regional/subcontinental scale. The former will be invaluable in integrated palaeoecological studies of lake – catchment relationships, as vegetation has a primary influence on these systems. Moreover, provided that the LRA (and models

involved) is validated for other regions than Southern Sweden, it will be possible to use the approach for large-scale reconstructions of past land cover that will be useful for testing climate – vegetation models and hypotheses on the inter-relationship between climate, land-cover, and human impact (such as the much disputed Vera's, Ruddiman's, and van Geel's hypotheses).

Past Performance

Methodology

Gaillard-Lemdahl's area of expertise is palaeoecology with emphasis on the interpretation of human impacts and cultural landscapes of the Holocene. Her main focus is pollen, but in collaborations with modellers, particularly S. Sugita, she has gone beyond conventional approaches to model-assisted reconstructions of land cover in heterogeneous landscapes.

Position within the area

Gaillard-Lemdahl has been involved in a range of collaborative projects and is internationally prominent in the field of landscape-scale reconstructions of past vegetation cover. The Swedish Research Council project is about quantifying the openness of land cover, e.g., in forested landscapes affected by human agriculture, something that has long challenged palaeoecologists, and which would have a range of applications – to better inform climate models, to aid in conservation planning, and to understand recent human impact history and its effect on ecosystems. She is one of the European leaders in this kind of research, and much good work has come out of her collaboration with S. Sugita. She has 14 publications in peer-reviewed international journals, of which she is first author on one, and which are moderately to poorly cited.

Particular achievements

The new modelling approach to heterogeneous landscapes is an excellent contribution to the field. It involves wide collaboration that extends beyond her own expertise to include modellers, but which particularly makes good use of the NorFA network to disseminate the modelling approach to many young scientists and other, more senior colleagues – importantly, this has been done as the research has been progressing; this open approach has led to successful dissemination, education, and research development well beyond the bounds of the project sponsored by the Swedish Research Council.

Future

Project plans

With the models developed, the next plans are to apply them to particular case studies and regions; and in collaboration with other groups. The new forest disturbance study is a case in point. There are potentially many interesting applications in biodiversity and conservation, informing vegetation models, and linking to archaeology.

Balance between resources and goal

Gaillard-Lemdahl moved to a professor's chair during the period of assessment. Although she now has a permanent position, with currently considerable time for research, almost all other resources for her immediate group, except perhaps funding for one to two students, come from the Swedish Research Council or other external funding. This limits the scope of the group, both in size and what it can achieve in the future. However, at the University of Kalmar, Gaillard-Lemdahl is head of a large and dynamic group in environmental sciences, which has great potential.

Comments on the Area

Position within Quaternary Geology

Gaillard-Lemdahl has provided excellent leadership to international groups on land-use and palaeoecology, and she is well established within PAGES and other Quaternary networks. The work is at the ecological end of the Quaternary Geology spectrum and relates to fields such as human impact studies, archaeology, and long-term ecological processes.

Importance and future potential of the area

Quantifying land cover patterns has various important applications, relating to Earth system modelling, carbon modelling, geomorphologic and fluvial modelling, understanding past human societies and their impact on land cover and guiding conservation strategies.

General Judgement

Marie-José Gaillard-Lemdahl holds a professorship and has had research funds from the Swedish Research Council for the past several years in support of a project to quantify pollen-based landscape reconstructions. She has

also moved twice, the last move being enforced as part of a reorganisation of the Swedish academic system. Her own productivity has suffered in part as a result; she has rather few publications in peer-reviewed journals. The Expert Panel recognises her excellent contribution in addressing the need for quantification in reconstructions of heterogeneous landscapes, in developing and supporting the international network, and in bringing together a synergistic working group to train many young palaeoecologists in the use of quantitative techniques. The energy spent on such endeavours is impressive, but Gaillard-Lemdahl should seek a better balance in the future between these activities and the essential need to publish consistently in the international literature. Her contribution is assessed as *very good* to *excellent*.

Dan Hammarlund
Department of Geology, Lund University

Holocene Climate Dynamics in Scandinavia and Related Ecosystem Responses

Abstract (the submitted version)

The main focus of my research since 2000 has been on reconstruction of centennial to millennial-scale changes in atmospheric circulation patterns across Scandinavia, primarily based on stable isotope analysis of lake sediments. Ongoing studies target the changing isotopic labelling of precipitation in response to predominant cyclonic pathways and seasonality changes as inferred from oxygen isotope analysis of aquatic cellulose in small open-basin lakes along a North-to-South transect through Sweden. Related work has been based on carbon and oxygen isotope analysis of specific carbonate components of lake sediments in different hydrologic settings.

Modern isotope hydrology data are instrumental for the palaeoclimatic interpretation of the isotopic records. Through combination of this approach with palaeoecological methods (pollen, plant macrofossils, chironomids, etc.), the local and regional ecological effects of the inferred climate changes are evaluated. Additional palaeoenvironmental information is provided by C and N elemental and isotopic records obtained on sediment organic matter (elemental analyser acquired through a Swedish Research Council grant).
One particular feature under study is the tree-limit ecotone of the Scandes Mountains, where pronounced impacts of changing circulation patterns are

evident. Another climate – ecosystem coupling is currently investigated in northernmost Sweden, where discontinuous permafrost is thawing in response to recent warming as revealed by monitoring. Detailed palaeoecological and geochemical analyses of lake sediments and peat sequences are performed for identification of possible analogous events in the past and their relations to climate and carbon cycling.

Past Performance

Methodology

Hammarlund's research involves a combination of stable isotope (O, C), with elemental (C, N) and biostratigraphic analyses of Holocene lake sediment components (pigments, cellulose, carbonates) in Fennoscandia and Northern Russia (Kola, Kamchatka). To improve on the generally accepted relation between temperature and oxygen isotopes, he has developed a modern calibration network of stable isotopes for Scandinavia in comparison with seasonal climate parameters (including moisture parameters and atmospheric circulation). Ultimately, this can then be applied to reconstruct past climate variations in Southern Sweden in a novel way. He is also pursuing stable isotope analysis in tree rings, related, e.g., with reconstruction of past tree-line fluctuations in Scandinavia.

Position within the area

In the ten years since his Ph.D., Hammarlund has developed a high profile in the field of isotopic and geochemical palaeoclimatology for Scandinavia. He has numerous collaborative research projects with scientists in Scandinavia, Russia, and in Canada (ISOMAP). He has 21 publications and two book chapters in the last ten years, eight of which as first author; and he is moderately cited.

Particular achievements

Hammarlund's focus on high-resolution, multi-proxy analysis (primarily using different stable isotopes) of lake and peat sediments as well as tree rings is particularly relevant in the field of palaeoclimatology – and is making him a potential key person for collaborative efforts in the whole field of Quaternary Science in Scandinavia.

Future

Project plans

Given Hammarlund's already well established collaboration within and

beyond Scandinavia, there is no doubt that he will continue to play a role in the field of palaeoclimatology. He has to be encouraged, however, to find a good balance between developing and pursuing his own research projects and collaboration with others, and not to accept other data uncritically.

Balance between resources and goal

Although it would be preferable to establish a modern stable isotope laboratory at Lund University, the present collaboration with Copenhagen appears to be working well, without hampering the scientific productivity. However, the key for maintaining such a laboratory would require funding for technical support.

Comments on the Area

Position within Quaternary Geology

Hammarlund's research field and his wide-ranging interests clearly enable him to play a role in Scandinavian collaboration in the field of Quaternary palaeo-climatology. Although apparently a good team player in collaborative research projects, he needs to continue to strengthen his own research programme.

Importance and future potential of the area

Globally, the field of isotopic palaeoclimatology continues to be central in Quaternary studies.

General Judgement

Hammarlund is a productive researcher in the field of stable isotope palaeoclimatology, also including elemental and biostratigraphic analyses. His project on reconstructing from lacustrine and peat records in Sweden past seasonal climate parameters, especially moisture and atmospheric circulation, is a novel approach. He is also involved in many other projects, e.g., research on tree-line fluctuations, past permafrost conditions, and carbon cycling. The Expert Panel was somewhat concerned by the degree of reliance on palaeo-environmental proxy methods developed elsewhere as well as their use, without evaluation of the uncertainties associated with their application. Dan Hammarlund's contribution is assessed as *very good* to *excellent*.

Karin Holmgren
Department of Physical Geography and Quaternary Geology, Stockholm University

Regional and Temporal Patterns in Climate

Abstract (the submitted version)

My research aims at high-resolution reconstruction of Late Quaternary climate and environmental changes. The objectives are to advance current knowledge of how and why regional and temporal patterns in climate have varied, in order to understand natural variability and to explore the interactions between climate, environment, and human societies. I seek to provide high-quality information from regions for which little data is available (Southern Africa and East Africa), using several climate proxy archives, and to complement available climate information in Sweden through contribution of high-resolution climate data, using speleothems.

Specific methods used are high-precision U-series dating, stable isotope, trace element and lamina analysis of African and Swedish speleothems; stable isotope analysis of cellulose from subtropical trees, and multi-proxy analyses of peat and lake sediments from Equatorial and Southern Africa. The information gained on climate history (specifically the last 2 ka) is integrated with information on area-relevant environmental and societal development through cross-disciplinary research co-operation with human geographers.

The results have permitted a better appreciation of past variations in temperature, precipitation, and vegetation from selected environments. This facilitates the understanding of past changes in atmospheric circulation patterns and forcing factors behind climate. The research has strengthened the role the Department of Physical Geography and Quaternary Geology, Stockholm University, has in the field of palaeoclimatic research in Southern and Eastern Africa.

Past Performance

Methodology

Holmgren's primary research focus has been on palaeoclimatic reconstruction using speleothem analysis. She has applied this approach, mainly relying on stable isotopes, to speleothems from both Southern Africa and,

more recently, Northern Sweden. Alongside this specialism, she has expanded into other archives and proxies, including subtropical tree rings, using wiggle matched ^{14}C for dating control, as well as peat and lake sediments using, e.g., pollen analysis. Latterly, she has used her skills and experience with palaeo-archives and proxies to work closely with the climate modelling community, in an effort to develop an important new perspective on Northern Hemi-sphere climate variability over the last 1 000 years.

Position within the area

Holmgren has emerged as a major leader in her research field. This reflects the high quality of her scientific data, her commitment to rigorous research in regions where palaeoenvironmental studies are thin on the ground. Her skills as an organiser and group leader and her recognition that – especially in the areas she has studied in Africa – climate, and more especially hydrological variability, is of major importance for human societies. Her position is both distinctive and highly valued. Holmgren has published widely, with recent articles in excellent international journals. She lists 27 peer-reviewed papers, of which she is first author of seven. There is a moderate level of citation.

Particular achievements

One may especially note the high resolution records of climate variability in Southern Africa, the thorough and sensitive exploration of past human – environment interactions (with M. Widgren), and the recent, highly stimulating re-evaluation of Northern Hemisphere late-Holocene climate variability (with A. Moberg).

Future

Project plans

Holmgren's project plans focus on her ongoing speleothem research both in Southern Africa and in Sweden, as well as broader concerns with multi-proxy reconstructions of regional (including Swedish) climate. These latter, like the future plans to continue with studies of human – environment interactions, depend on developing, leading, and sustaining networks of people spanning the natural and social science divide. In addition, she is closely involved in a major proposal for a Linnaeus Grant, involving meteorology and climate modelling alongside her own and her colleagues' Quaternary concerns. She also plans (should the opportunity arise) to build on her existing research networks (PLATINA and HOLIVAR) to prepare a bid for EU

Framework 7 funding that includes a major emphasis on research in Africa. Another longterm plan is to apply to the Southern Hemisphere the same kind of approach to late Holocene climate reconstruction that has been successful in the Northern Hemisphere.

All these goals are valuable. They reflect Holmgren's formidable energy, capacity for productive research, and for organising and leading networks of scholars. It is important to recognise that her value in both the networking activities and the pursuit of greater insights into human – environment inter-actions, rests in part on, and is significantly enhanced by, the high quality of her natural science research. Her plans to work on Southern Hemisphere archives of late Holocene climate variability will require her to interact with other groups with similar goals, so that any final synthesis reflects the best possible integration of the latest research.

Balance between resources and goal

The ongoing research and future plans must be seen alongside her role as head of a large, complex department for at least the next year and possibly beyond that. Against this background, it has clearly taken a huge amount of energy, enthusiasm, and dedication to achieve her current level of research productivity. Sustaining this and developing the range of plans outlined above may well require stronger institutional support for research and graduate supervision than she currently enjoys. She has successfully broadened the base of her outside research funding, and it is important that her future situation allows her the opportunities to continue to do this. Both additional time and postdoctoral support would be of great value.

Comments on the Area

Position within Quaternary Geology

Holmgren occupies a distinctive and leading position in the field. This has become well recognised internationally. She continues to make a major contribution through the supervision of Ph.D. students.

Importance and future potential of the area

The special nature of Holmgren's contribution within and beyond Quaternary Geology must be explicitly recognised and allowed to develop further. Natural scientists with the capacity and inclination for productive dialogue with social scientists, including human geographers in the field of vulnerability to environmental change and societal sustainability, are very rare. Maintaining and enhancing her role in this area, will require care on

her part to balance these wider concerns with continued research based on her skills and experience as a natural scientist. At the same time, there is a need for funding institutions to recognise the special importance of this type of inter-disciplinary research – and consider imaginative and effective ways of promoting and rewarding it when the outcomes justify financial support. Environmental variability is of human concern and is likely to be increasingly important for future societies in the countries where much of Holmgren's research is focused. The past provides our only empirical insights into many of the key issues involved. Good research in this area should not lack support merely because it falls between disciplinary or methodological boundaries.

General Judgement

Karin Holmgren has achieved a high and distinctive research profile and shows every promise of continuing to generate excellent results, both in her own areas of specialism and alongside researchers in human – environment interactions. In all these fields, she shows a high level of competence. She works with a wide range of colleagues, both to interpret her results in terms of climate variability and to explore their implications for past changes in human societies. In this latter regard, she falls into a small group of rigorous biophysical scientists, who are working closely and successfully with social scientists. In addition, she has shown a high level of skill in creating and leading networks of scholars, whose combined research interests focus both on Europe and on Sub-Saharan Africa. Her contribution is assessed by the Expert Panel as *excellent*.

Leif Kullman
Department of Ecology and Environmental Science, Umeå University

Climatic Tree Line Dynamics — Biogeographic and Historic Aspects

Abstract (the submitted version)

The project has focused on megafossil and macrofossil tree remains in North-Central Sweden. It attests to new views on postglacial forest history.

The principal tree species immigrated to nunataks during the Late-Glacial. This swift reappearance suggests that they survived the last glaciation closer to Scandinavia; than generally believed. After an early-Holocene maximum, their tree limits have descended until the late-19th century, indicative of gradual summer cooling, relating to decreased boreal summer insolation. The same force may have caused regional extinction of *Larix sibirica* and prompted the evolution of a subalpine birch forest belt after ca 7 000 years BP.

Some millennia later, *Picea abies* expanded from its late glacial to early Holocene bridgeheads. Macrofossil of thermophilous trees (*Quercus*, *Tilia*, *Ulmus*, *Alnus glutinosa*, and *Corylus*) at high elevations further support an early Holocene (10 000 – 7 000 years BP) summer thermal optimum. These species spread more rapidly and to higher latitudes and altitudes than previously inferred from pollen data. This further stresses that glacial tree refugia were quite close to Northern Scandinavia.

During the first millennia of the Holocene, the highest forest belt displayed a non-analogous species mixture with boreal (*Pinus*, *Picea*, *Betula*, and *Larix*) and thermophilous species (*Quercetum Mixtum*-type). Rapid recent glacier melting has exposed megafossil birch remains on glacier forefields, which date between 9 000 and 6 000 years BP. Continued work on this material will give new details on glacier history and accurate views on tree-line positions during the early Holocene.

Past Performance

Methodology

Kullman uses detailed field studies to find and date macrofossil remains across the tree-line ecotone to reconstruct past tree-line fluctuations as a response to climate change in the Holocene and Late Glacial.

Position within the area

It is unusual today to be afforded the resources to develop such in-depth knowledge of an ecosystem; and in the application of the megafossil approach to tree-line reconstruction, Kullman plays a unique role in Nordic and probably European science. The Swedish Mountains have yielded a rich record of megafossil wood and other remains, and it has been possible to reconstruct tree-line fluctuations in great detail. These studies have been a model for others elsewhere. Kullman has been productive: of 34 papers in peer-reviewed journals, all but two are first-authored, and most are moderately cited. He has supervised two doctoral students.

Particular achievements

Kullman has devoted a large part of his career to the understanding of tree-line dynamics in the Swedish mountains. There is no doubt that he is the foremost authority on the region in this respect. He has pioneered approaches to the study of both large and subtle tree-line shifts and documented the responses of a sensitive ecotone to climate changes of the Holocene. The in-depth understanding of his system is reflected in a large number of papers in established international journals that are consistently well cited, with others in regional journals. Most recent finds of wood dating the early Holocene and Late Glacial have challenged convention as regards the early appearance of trees in upland Scandinavia.

Future

Project plans

Stated plans are to focus more on the megafossils of the Late Glacial, this being the critical period, and to work in Norway, with Norwegian collabo-r-ators.

Balance between resources and goal

Kullman works with very few resources. His level of productivity is high, as the method he has used is field-based; and the main requirement is for ^{14}C dates. However, he is currently out of funding, so his research is at a standstill. Clearly, a source of funding is needed to make further investigations of these finds. Although maintaining a research programme is not an easy task under the present circumstances. There are, however, possibilities. In this situation, the best chances of success are if Kullman assumes the responsibility to forge collaborations that strengthen future proposals.

Comments on the Area

Position within Quaternary Geology

Tree-line fluctuations have long been studied to document climate change. The scope of such studies has grown in recent years, and they can play an important role in climate reconstruction. In Sweden, Kullman is the most productive person working in the field. He has remained focused on the tree lines of the Swedish mountains, rather than moving into new geographic or

methodological areas in a major way, and years of experience in his chosen field area mean that he is in a unique position to read the landscape and find new megafossil sites. His finds of tree remains that date not only to the early Holocene, but also to the Late Glacial, have raised important issues.

Importance and future potential of the area

More recently, a focus of the work has been on finds of megafossils dating to the early Holocene and the Late Glacial, including finds of tree species that can only be explained as being refugial, isolated populations at the very periphery of the Scandinavian ice sheet. More attention is now being paid in Quaternary studies to the existence of small, refugial populations. This has major implications for our understanding of the response of taxa to large-magnitude climate change, the ability of tree species to survive in adverse conditions, and the relative importance of migration over climatic or other environmental factors in influencing population expansions and range changes. However, the relevance of the research is diminished without a broader approach to examining the significance of the finds that date to the Late Glacial: while these finds have stimulated an important debate about glacial refugia, there is the possibility that there are some dating artifacts. It is essential to eliminate alternative hypotheses before such revolutionary conclusions can be widely accepted.

General Judgement

Kullman has done good work on Holocene tree-line fluctuations over several decades. He is productive, but also someone who works alone. The current lack of funds largely reflects the development of controversy around his latest finds of wood, dated to the Late Glacial, in high-elevation locations that were, possibly, either under ice or surrounded by ice during much of the last glacial cycle. Further funding requires an emphasis on a more holistic approach to the question: that he actively seeks to resolve the different hypotheses that have been put forward in response to his most recent finds. For example, this might be through collaborations that allow other approaches to be brought to bear on the problem. Future funding will not be well invested if it generates more of the same kind of data; rather, it should support a multi-disciplinary approach to these sites. In such an undertaking, Kullman could be the leader, or certainly a key investigator. The Expert Panel's overall assessment of Leif Kullman is that his research is *very good*.

Geoffrey Lemdahl
Department of Biology and Environmental Science, University of Kalmar

Quaternary Palaeoentomology and Palaeoclimatology

Abstract (the submitted version)

During the first three-year-period of my position (1996 – 1998), at Lund University, I mainly focused on Late Glacial and Holocene climate changes in Southern Sweden, Western Norway, and Switzerland redrawn from *Coleoptera* records. During the second period of my position (1999 – 2001), at Växjö University, I turned my interest to "Holocene forest dynamics in Southern Sweden". The idea of this research was to evaluate insects as indicators for interpreting structures and disturbance regimes in boreo-nemoral woodland ecosystems. Clearly, insects are very valuable for identifying structures such as openness, age composition of trees, and frequencies of dead wood. Insects are also good indicators for disturbances such as grazing and forest fires. These are features that by using tools as traditional pollen analysis are difficult to obtain in forest historical research.

At Kalmar University, we have built up a research group of four doctoral students and two senior researchers to reconstruct changes in woodlands during the Holocene on a West – East transect in Southern Sweden. We apply a multi-proxy approach using a combination of methods; as pollen-, plant macrofossil-, insect-, dendro- and charcoal analyses. Moreover, I have carried out palaeoentomological studies on samples from Eemian and Weichselian stadials and interstadial deposits at the site Oerel, Northwestern Germany. The climate and environmental information have been correlated with similar results from France, British Isles, and Northern Sweden.

Past Performance

Methodology

Lemdahl works primarily in palaeoentomology, the identification of fossil insect remains, and their interpretation in terms of past climate, by the application of the MCR method of palaeoclimate reconstruction, or their past ecological dynamics. It is in climate reconstructions that major contributions have been made. He has also used a range of other palaeo-ecological

techniques: macrofossils, charcoal, etc. His most recent work seeks to develop a methodology that addresses disturbances to forests, e.g., large-animal grazing and fires.

Position within the area

Palaeoentomology is a highly specialised area, and only a few people are experts. They tend to operate singly or with a small number of trainees. In Europe, Lemdahl is one of a very few experts in the field. He has collaborated widely in different groups, contributing to high-quality reconstructions of past environments that have appeared as substantive papers in good journals. In all, he has 19 international journal publications in the last ten years and is first author on five; these five are not particularly highly cited. Lemdahl's collaborations tend to be mainly in cross-disciplinary projects. Over recent years, these collaborations have tended to reflect a fairly opportunistic approach to research, Lemdahl being involved in a range of projects, by no means all under his direction. Other work has not yet been published, particularly since his move into a teaching position after the year 2000.

Particular achievements

Lemdahl has produced high quality work from a number of key sites, including some first quantitative estimates of temperature change and data that provide more details about climate gradients at key past times. His strongest body of work is in palaeoecology and palaeoclimate reconstructions of the last glacial – interglacial cycle and the Late Glacial to Holocene.

Future

Project plans

Future plans are focused on a project that will describe the nature of forest disturbances through the Holocene, using a range of methods, including charcoal-based reconstructions of fire history, and developing new methods, such as the tracking of populations of large grazers via proxies such as dung-beetles. The new project represents expansion into new areas and a creative new look at how disturbances might be elucidated.

Balance between resources and goal

Lemdahl now has a teaching position and not much time for research. The group size is quite small, but expansion of the group is not necessarily the priority. Time is the resource in shortest supply, and its lack is reflected in slowness at getting a large body of good data written up and published.

The priority must be to write up material, as this will enable him to retain a chance to be competitive for further research funding. Also, given time constraints, it might be fruitful to prioritise work and focus on his own projects as much as possible, as in the longer term this will also improve his chances for more funding.

Comments on the Area

Position within Quaternary Geology

The field of palaeoentomology is relatively new and has the potential to make important and challenging contributions to Quaternary Science. The rapidity of insect response to climate change, for example, highlights the slower response of more widely used proxies such as climate change. It is, however, a "niche" field; it contributes very useful information, but it can be somewhat constrained by its own specialisation. Lemdahl has exploited his expertise well and participated in a wide range of projects.

Importance and future potential of the area

The challenge for a specialist is to put a personal stamp on research questions, rather than provide a service to other projects. However, insects are ubiquitous and numerous, and they have the potential to be used in a number of new ways, for example, ecological reconstructions, reconstructions of pest infestations, forensics, etc. In the work he intends to focus on in the future, Lemdahl is going some way to meeting this challenge. The work will be a collaborative approach to reconstruct forest disturbance histories at a level of detail that has not been tried before. With the increasing recognition of changes in disturbance regime as long-term mediators of plant response to climate and/or human impacts, this project is timely.

General Judgement

Geoffrey Lemdahl is very well regarded as an expert palaeoentomologist. As such, he will never be short of projects. However, some prioritisation is required in the context of severe time constraints. While it is recognised that two moves and a change to a predominantly teaching role have reduced his productivity in recent years, to remain competitive for research funding, the Expert Panel considers that he might usefully focus future work on projects that relate to his own science goals; he would also benefit from publishing more of the data he has already obtained. Lemdahl's contribution is assessed as *very good*.

Kjell Nordberg
Department of Earth Sciences, Göteborg University

Fjords as High-Resolution Climatic and Environmental Archives

Abstract (the submitted version)

We performed detailed studies on the relation between climate, hydrography, human impact, and oxygen deficiency in the bottom water of sill fjords. Work with seasonal studies on benthic foraminifera, hydrography, and sediment records from periodically dysoxic sill fjords show that oxygen deficiency is not a modern phenomenon on the Swedish West coast.

By studying sediment records characterised by very high temporal resolution, sediment laminations, organic carbon, foraminifera, diatoms, dinocysts and stable isotopes, together with meteorological and climatic data as well as unique, historical long hydrography records from the fjords and oceanographic/mathematical modelling, we were able to correlate the sediment records with the records of oxygen deficiency and historical data reflecting differences in climate and salinity.

We also combine seasonal information on proxies with instrumental, hydrographic records and meteorological data to tune our proxies, including the stable isotopes. In a recently started study on global climate change effects on the marine environment and the ecosystems in coastal areas, we detail the climatic responses of the Medieval Warm Epoch and the Little Ice Age, as they appear in the sediments of Gullmar Fjord. The temporal resolution here is as high as 2 – 7 years. These true effects from real, significant climatic changes can be used to forecast the effects from ongoing and future climate changes. Important methods/proxies are: an ultra-high resolution sediment core from Gullmar Fjord, benthic foraminifera, stable isotopes, AMS and ^{210}Pb datings, instrumental hydrography data, AD 1890 to present, meteor-ology data 1650 to present, and historical climate data 800 to present.

Past Performance

Methodology

The research area of Nordberg is focused on marine environmental development in coastal areas, on particularly the Swedish West coast. This is done by analyses of sediment cores recovered from areas with high sedimen-

tation rates. Methods used are mainly analyses of microfossils (foraminifers, diatoms, dinoflagellates) and stable isotopes. Of special interest is the more recently applied approach to combine marine geological data with local instrumental hydrographic and meteorological data.

Position within the area

Nordberg lists 22 peer-reviewed publications since 1996. Additionally, two papers are in press or accepted for publication. He is senior author on three of the articles. The articles are moderately to poorly cited. Nordberg has supervised two Ph.D. students.

Particular achievements

Perhaps the most important result of the group is that they have shown a close relation between climate variability and instrumentally recorded hydrographic parameters. Furthermore, they have published strong indi-cations that these environmental changes are related to NAO variability (North Atlantic Oscillation). Eutrophication in Swedish West coast fjords is shown not to be a function of anthropogenic activity, but rather related to natural causes.

Future

Project plans

In particular, Norberg focuses on detailed reconstruction of the climate development during the Late Holocene, in particular the Roman period, Medieval warm period, and the Little Ice Age.

Balance between resources and goal

The department is suffering from lack of funding to invest in Ph.D. students that would be necessary to fulfil the outlined plan for the future.

Comments on the Area

Position within Quaternary Geology

High resolution local palaeoclimatic data is an essential component of regional climate modelling. Nordberg's group has found an important niche within the Swedish Quaternary Geology community.

Importance and future potential of the area

There is a great interest for high-resolution climate proxy data. The research localities of Nordberg are particularly interesting, because of the

possibilities given for calibrating the data from the sedimentary record with long series of instrumental data.

General Judgement

Nordberg and his group have identified important localities for retrieving high-resolution records of climate proxies in the marine system. The funding situation in Quaternary Geology at Göteborg University is particularly difficult. Thus, this requires Nordberg to be competitive and work hard for funding the research of his group. The Expert Panel assesses Kjell Nordberg's contribution as *very good*.

Johan Nyberg
Geophysics and Marine Geology Division, Geological Survey of Sweden

Reconstruction and Analysis of Interannual to Centennial Climate Variability in the North Atlantic Region Using Caribbean Corals

Abstract (the submitted version)

Instrumental environmental records are generally too short to determine decadal and centennial climate variability and underlying mechanisms with sufficient accuracy. Previous analyses have demonstrated that the Caribbean and the tropical Atlantic is a key area for the reconstruction of North Atlantic climate variability and trends. The tropical ocean is the primary source of energy and water vapour to the atmosphere, and interactions between the ocean and atmosphere in the tropics have global climate ramifications on various timescales. The objective of this project is to reconstruct environmental parameters, such as sea-surface temperature, sea-surface salinity, precipitation, and trade wind variability on interannual scales through the last 1 000 years in the Caribbean, using geochemical tracers within massive coral skeletons. Massive corals are the only palaeoclimate archive that offers both the annual resolution and multi-century record length needed for quantification of seasonal – centennial changes in the tropical surface ocean. The work focuses on the analyses of terrestrially derived humic acids, using luminescence intensity, stable oxygen isotopes ($\delta^{18}O$), and trace elements (Sr/

Ca, Mg/Ca, Si, and Fe). The variations in these environmental parameters through time and their climatic implications are evaluated and compared with appropriate instrumental and proxy climate records from the Caribbean, other areas surrounding the Atlantic Basin, and around the globe.

Past Performance

Methodology

Nyberg has used cores from corals in the Caribbean to generate highresolution climate records. These cores have been analysed for various geochemical parameters, stable isotopes, humic acid content, and luminescence intensity.

Position within the area

After his Ph.D. exams in 2001, Nyberg spent a postdoctoral year at the University of London. He is now employed by the Geological Survey of Sweden. Nyberg lists seven peer-reviewed publications. He is first author on five of these. The seven articles are moderately to poorly cited.

Particular achievements

A record of Atlantic major hurricane activity dating back to 1730 has been developed by interpreting Nyberg's coral record in terms of changes in trade wind intensity, which in turn can be related to the development of hurricanes using a new reconstruction technique.

Future

Project plans

Nyberg wishes to continue to publish and analyse results from the retrieved coral material.

Balance between resources and goal

Nyberg's situation in the near future in terms of research will depend on the possibilities given him by his present employer, the Geological Survey of Sweden.

Comments on the Area

Position within Quaternary Geology

Nyberg's study of the subrecent climatic parameters derived from Caribbean corals, and their importance for the reconstruction of the North Atlantic

climatic variability, has a central position in the current research activities in Quaternary Geology.

Importance and future potential of the area

The past frequencies and magnitudes of major hurricanes are highly relevant to improve the predictability and understanding of the causes of hurricane activity.

General Judgement

Johan Nyberg's results of his project on "Reconstruction and analysis of interannual to centennial climate variability in the North Atlantic region using Caribbean corals" we consider *excellent*. However, since he is no longer in academia, the Expert Panel decided not to give him a specific assessment mark for his overall performance.

Göran Possnert
Tandem Laboratory, Uppsala University

Accelerator-Based Isotope Geology

Abstract (the submitted version)

The research deals with application of natural and anthropogenic radioactive isotopes in geology for dating purposes and general trace element appli-cations. The isotopes used are the following: ^{10}Be ($T_{1/2}$ = 1.6 Ma), ^{14}C ($T_{1/2}$ = 5730 a), ^{36}Cl ($T_{1/2}$ = 310 ka), and ^{129}I ($T_{1/2}$ = 15.1 Ma).

The analysis is based on the ultra-sensitive Accelerator Mass Spectrometry method. Besides chronological information, applications in dynamic phenomena, e.g., ocean circulation, atmospheric transport as well as chemistry and correlation between cosmic rays and climate, are studied. Measurements are carried out of ^{10}Be and ^{36}Cl in the NGRIP ice core from Greenland, in order to correlate climatic records with the cosmogenic radionuclide production.

Past Performance

Methodology

Application of radionuclides for dating and trace element analysis. The

analysis is based on the ultra-sensitive Accelerator Mass Spectrometer (AMS).

Position within the area

Possnert lists a total number of 160 refereed articles. From the period of 1996 – 2005, he lists 91 peer-reviewed articles and an additional 21 that are submitted, accepted, or as manuscript. The articles are with one exception multi-authored, and Possnert is first author on two of the published articles. Some of the articles are highly cited, the rest are moderately to poorly cited. Possnert has supervised six Ph.D. students.

Particular achievements

Possnert has established an internationally recognised Accelerator Mass Spectrometry laboratory of excellent quality. The laboratory offers many possibilities to elucidate a broad spectrum of scientific questions in Quaternary Geology and related environmental research. The laboratory is heavily involved in interdisciplinary research, and it supplies the Scandinavian geologic community with dating of samples of small size (› 0.2 mg C). During the last five years, particular attention has been devoted to the application of ^{10}Be and ^{129}I in natural systems. The laboratory has demonstrated the potential of using anthropogenic signals in tracing water and air mass transport, particularly in the Arctic.

Future

Project plans

Besides the ongoing research, the laboratory intends to start a programme on exposure dating.

Balance between resources and goal

Exposure dating would be enhanced with some additional funding.

Comments on the Area

Position within Quaternary Geology

The Uppsala laboratory has a strong position within Quaternary Geology, in the Swedish community as well as in the Nordic and the International scientific communities. The results are regarded as very reliable.

Importance and future potential of the area

A reliable chronology is essential for most of the current projects in Quaternary Geology. A national leading facility for this purpose is mandatory for the Swedish geosciences.

General Judgement

The Uppsala group has established experimental facilities within radioisotope geology that offer a range of possibilities to elucidate scientific questions in Quaternary Geology. Reliable AMS dates provided by the group are essential for most of the researchers of Quaternary Geology in Sweden, and thus the laboratory is a vital resource. The laboratory is running smoothly. The Expert Panel's overall rating of Göran Possnert's work is *excellent*.

Ingemar Renberg
Department of Ecology and Environmental Science, Umeå University

Lake Sediments and Environmental History

Abstract (the submitted version)

The project covers three grants with goals to improve knowledge about:

1. Formation of varved lake sediments in order to allow high-resolution inferences of past environmental conditions from varves. Sediment-core data, sediment-trap data, limnological data, catchment data, and meteorological data are used to assess relationships between varve properties and environmental variables. Geochemical and biological analyses are used and evaluation of four years of data is in progress (Ph.D. project);
2. Arctic pollution of Hg, Pb, and persistent organic pollutants (POPs) is studied using lake sediments from Greenland and Northern Sweden. Sediment cores from >20 lakes are analysed. Time trends and loads of pollutants are assessed in relationship to known emission trends at lower latitudes, as well as, for Hg and Pb, to past climate fluctuations during 8 000 years. Evaluation of data in this Ph.D. project is in progress and reported in two papers;
3. Pre-industrial hemispheric airborne lead pollution. Lead concentration and stable lead isotope ($^{206}Pb/^{207}Pb$ ratio) analyses of deposits from >40 lakes and some peat bogs have shown that pre-industrial pollution was extensive and started >3 000 years ago. It mainly came from metal pro-

duction, and the changes over time followed economic growth in Europe. Already in Medieval time, lead pollution fall-out reached similar levels as today in Sweden. The cumulative lead pollution load until 1800 AD is as large as the load since. This Swedish Research Council-project finished in 2000 with two Ph.D.-theses and has continued in projects on airborne lead pollution in boreal soils, regional waterborne pre-industrial pollution from mining, and metal records in bogs in relation to climate changes.

Past Performance

Methodology

For the study of lake sediments, geochemical and biological analyses were applied. The properties measured include metal concentrations, stable lead isotopes, C, N, diatoms, pollen, and pigments. Sediment coring (freeze core technique) was developed and Near Infrared Spectroscopy applied. Ongoing monitoring of varve formation in Lake Nylandssjön commenced in 1978.

Position within area

Renberg is among the world-class scientists in palaeolimnology. In particular, his studies on pre-industrial airborne lead pollution and lake acidification, which were published in *Nature*, were well received. He has published 44 co-authored papers in peer-reviewed journals since 1996. He is first author of four of these papers, moderately to well cited.

Particular achievements

Renberg's study on varve formation processes started in the 1970s and continues as a monitoring study. Methods to work out past lake water pH using diatoms, fly-ash particles as indicators of fossil fuel burning, pre-industrial alkalisation by land-use in acid sensitive lakes, and pre-industrial atmospheric pollution in Sweden and in Greenland are among the main achievements of Renberg's group. An important, new discovery is the great loss of carbon and nitrogen from the sediments during the first years after their formation.

Future

Project plans

Renberg will focus on past environmental conditions in relation to contemporary environmental issues. The monitoring of sedimentation processes and varve formation continues.

Balance between resources and goal

Renberg has a heavy load of administrative work until the end of 2006. After that he will go back to full-time research. Funding for a Ph.D. or a post-doctoral position will be required.

Comments on the Area

Position within Quaternary Geology

Renberg is leading one of the most innovative groups in palaeolimnology.

Importance and future potential of the area

Palaeolimnology is a growing international discipline in the study of past global change.

General Judgement

Ingemar Renberg is among the world-class scientists in the field of palaeo-limnology. He has used lake sediment archives in order to understand the role of natural processes and human activity on environmental conditions during the last several thousand years and at the present-day. He has deve-loped new innovative methods especially for the study of annually laminated lake sediments, including their formation processes. The Expert Panel regards his work as *excellent* to *outstanding*.

Gunhild Rosqvist
Department of Physical Geography and Quaternary Geology, Stockholm University

Quantifying Climate Change from Lake Sediments

Abstract (the submitted version)

The overall objective of the research projects is to decipher the pattern of climate variability on centennial – millennial timescales in the polar front zones during the last 10 000 years.

Our approach in the Swedish Research Council-funded project in Northern Scandinavia was to use stable isotope records of different lacustrine components to reconstruct past changes in atmospheric circu-

lation. We used oxygen isotopes in biogenic silica provided by diatoms and in carbonate material to reconstruct past changes in hydrology and climate. Our results so far indicate that the stable isotope labelling of precipitation can be derived from those archives – and thus past changes in atmospheric circulation.

We combined the isotope data with records of glacier fluctuations derived from pro-glacial lake sediments. Glacier mass balance is primarily forced by summer temperature and winter precipitation and is thus sensitive to changes in atmospheric circulation. Temporal variations in glacier activity were determined from different physical and geochemical properties of the sediments.

Past Performance

Methodology

Rosqvist has worked on lake sediments from sites close to the boundary between cool temperate and polar atmospheric circulation systems in both hemispheres. She has used reconstructions of glacier fluctuations using sediment stratigraphy, as well as the newly emerging technique of stable isotope analysis of freshwater diatom silica. She is engaged in validating the latter by comparison with other stable isotope records and through calibration using contemporary measurements.

Position within area

Rosqvist is one of a small number of scientists focusing on oxygen isotope analysis of freshwater diatom silica. By working with M.J. Leng in the NERC isotope facility (UK), she is able to produce excellent results and build into her research strategy careful evaluation of her data and its palaeo-environmental significance. This promises to give her a key role in the development of the field. She has published 12 peer-reviewed papers since 1996. Of these, she is first author of three. Eight of her papers have been published during the last two years. The level of citation for the earlier papers is moderate. As yet, the most recent papers have not been cited. She has supervised one completed Ph.D. and is currently supervising two others.

Particular achievements

Her main achievement is the development and evaluation of oxygen isotope signatures in diatom silica.

Future

Project plans

Her proposals to evaluate and apply her research skills in critical areas in both hemispheres, promise to yield vital results elucidating Holocene changes in climate and atmospheric circulation in these regions. These proposals should also link into the North – South Atlantic transect study led by Svante Björck.

Balance between resources and goal

Rosqvist has begun to publish high-quality research results despite rather poor resources in terms of both financial support and time availability. Recent progress in what promises to be an important area of research justifies a higher level of research support.

Comments on the Area

Position within Quaternary Geology

She is one of a small group of experts in a highly specialised field within Quaternary Geology.

Importance and future potential of the area

Provided validation of the diatom-based methodology continues to be positive and can be more widely confirmed, it promises to be of great importance, given the near ubiquity of diatom silica in lake sediments. There is also the possibility that her research might be combined with some exploration of the scope for dating by ^{32}Si.

General Judgement

The Expert Panel proposes *excellent* as assessment mark, despite our realisation that Gunhild Rosqvist's overall publication record is not so impressive. We do this for three reasons: First, she is developing research using stable isotope signatures in freshwater diatoms that is innovative and very challenging, but potentially extremely significant. Second, her approach within both this field and her related research, concerned with reconstructing past glacier fluctuations, is marked by a high level of critical evaluation of the methodologies involved. Third, it is apparent that her publication record has begun to improve significantly over the last 2 – 3 years, despite heavy administrative and teaching commitments and a rather low level of external funding.

Mats Rundgren
Department of Geology, Lund University

Atmospheric CO_2 — Climate Interactions during the Last Interglacial – Glacial Cycle and the Role of the Terrestrial Biosphere

Abstract (the submitted version)

The overall aim of my group's research is a better understanding of global carbon cycle – climate interactions on decadal to millennial timescales. This requires high-resolution atmospheric CO_2 records from key periods within the last interglacial – glacial cycle (the last ca 130 000 years) to be compared with palaeoclimatic data for the same intervals. CO_2 records are constructed using stomatal index analysis of subfossil leaves found in lake sediments, a method with the capability to detect CO_2 changes on short timescales, and directly compared with climate proxy data from the same sediments. Local and regional climatic conditions are reconstructed using standard geochemical (LOI, elemental, biogenic silica), physical (grain size, magnetic) and biological (pollen, plant macrofossil) methods.

To assess the potential for obtaining palaeoclimatic data from the same leaves as used in the CO_2 reconstructions, one subproject investigates the stable carbon isotope ($\delta^{13}C$) composition of modern leaves collected along climatic gradients and the influence of decomposition on $\delta^{13}C$ signals. In addition to information on local climatic conditions, leaf $\delta^{13}C$ data also may provide information on global carbon cycle dynamics. Two subprojects focus on the role of the terrestrial biosphere in atmospheric CO_2 variability. One uses an ecosystem model to investigate the nature of climate – ecosystem interactions and their contribution to decadal to centennial CO_2 variability during the Late Glacial and Holocene. The other deals with the potential contribution of subarctic wetlands to Holocene CO_2 variations by reconstructing changes in the carbon balance of a mire in Northern Sweden.

Past Performance

Methodology

Rundgren's main focus is use of stomatal density to estimate atmospheric

CO_2. His postdoctoral training was in Sheffield with D.J. Beerling, and Rundgren has gone on to develop a sound methodological approach. The CO_2 reconstructions are typically a part of a broader, multi-proxy reconstruction. The stomatal approach is a useful check on ice core trace gas records, but it is, as is any biophysically based approach, potentially reflecting a complex physiological response in the plant.

Position within area

Rundgren has published 18 papers since 1996 and is first author on 12, most of which are moderately to well cited. This field is highly specialised, and Rundgren has the only group in Sweden using the stomatal density tech-nique; his group has developed into one of the leading ones in the field.

Particular achievements

He has produced some excellent high-resolution records from key transitional phases and other periods of current interest, such as the last interglacial, the late-glacial to Holocene transition, and the early Holocene. Patterns largely echo ice core records, but they show more detailed variability and greater amplitudes of change. If these reconstructions are more accurate than ice cores (which are somewhat smoothed by post-depositional processes), the implications for short-term carbon dynamics are important – century-scale carbon dynamics are more variable than previously thought.

Future

Project plans

Rundgren's new direction is to develop modelling of past carbon dynamics. This is a good choice, as the quantification and modelling of long-term carbon dynamics is becoming feasible and is clearly a crucial part of the Earth's climate system. This goal is particularly feasible given the presence of the M. Sykes modelling group in Lund. This work has already begun, and initial comparisons of simulations of CO_2 levels under changed climatic conditions have been compared with the proxy data, e.g, for the LIA. A second area discussed with the Panel was possible contributions to the current debate, engendered by W.F. Ruddiman, about the role of humans in affecting trace gases from the early Holocene and over recent millennia.

Balance between resources and goal

To date, funding has been good, and Lund has most of the infrastructure to support the work, although not all resources are to hand (stable isotopes are done in Swansea, for example, though these are not central to the work and the Swansea connection works fine). However, the insecurity of a non-permanent position is a problem, and threatens the long-term future of the whole group.

Comments on the Area

Position within Quaternary Geology

Stomatal density analysis is one of several areas arising from cross-disciplinary thinking that has broadened the scope of Quaternary Geology and maintained or enhanced its relevance to key issues of the day; here the contribution is to global climate change and Earth-system modelling.

Importance and future potential of the area

Gaining detailed trace gas records is an area that needs more development. Future potential for the stomatal method depends on both the availability of suitable material (good macrofossil sequences) and the repeatability of results (if repeatable, then there is a limit to the number of reconstructions needed – if not repeatable, then there may be a problem with the method). Given that it is likely that not all the differences between ice core and stomatal records are due to ice core smoothing, further development of physiological understanding is probably an important aspect of future work in the area.

General Judgement

Mats Rundgren has put his postdoctoral training to good effect, and he has made excellent use of the funding and the facilities that have been available to him over the first part of his scientific career. His publication record is good, he works in a field of great topical interest, and he has developed interesting and potentially highly fruitful collaborations. However, despite these achievements, his future is currently uncertain owing to the constraints of the employment system in Swedish universities. The Expert Panel assesses his work as *excellent*.

Per Sandgren
Department of Geology, Lund University

Palaeoenvironmental and Palaeoclimatic Studies of Late Quaternary Lacustrine and Marine Sediment

Abstract (the submitted version)

The very broad, general title includes a number of projects, in which I have been engaged. Studies of the Baltic Sea-level history, which include one successful Ph.D. defence (2003), addressed the question of possible multiple water level fluctuations during the Littorina Sea phase and their possible climatic significance, partly based on new proxies. For a comparison with the development in Blekinge, studies of the Littorina Sea-level history south of the Finnish Bay have been performed in collaboration with Russian scientists. In an ongoing Ph.D. work (with defence planned before the end of 2007), in collaboration with IOW in Warnemünde, deep-sea sediment cores from Southern Baltic Sea are being analysed.

In this project, special efforts are devoted to the application of the OSL technique for dating these sediments that generally are devoid of organic material. In collaboration with Greek scientists (at the Greek Geological Survey, IGME), studies of a terrestrial sediment core, covering the entire Weichselian, are in progress. Special efforts have been made to obtain a reliable chronology based on the OSL technique. I am also engaged (in collaboration with Ian Snowball) in multi-disciplinary studies of varved lake sediments in Fennoscandia and Poland, with the aim to reconstruct climatic and geomagnetic field variations over the last 13 000 years. This part of the project includes another successful Ph.D. defence (2003); with one more planned for 2007. Outside my control, the currently supported Swedish Research Council-project has been postponed until 2007.

Past Performance

Methodology

Much of Sandgren's work has focused on Baltic coastal evolution and shoreline changes, on multi-proxy studies on deeper water cores from the South Baltic, and on the late Quaternary Geology of Southern Skåne. He has also

been involved in the Xinias project in Greece, with Gunnar Digerfeldt. Chronology and delays of various kinds have hindered progress in this study.

Position within area

Sandgren is widely recognised as a key figure in the field, especially for his role as mentor and adviser to many young colleagues. He has played a key formative role within his department. Since this department is a world leader in the field, his role has been of considerable international importance. Sandgren's past publication record reveals a willingness to give more prominence to his junior co-authors than to his own contributions. His papers are notable for high quality and consistency. He lists 35 peer-reviewed articles, of which he is first author of three. His papers are moderately cited.

Particular achievements

One may highlight the innovative application of OSL dating to sediment sequences and the importance of the palaeomagnetic research (with Snowball) for geochronology, and for reconstructions of the Earth's magnetic field and its influence on cosmic flux.

Future

Project plans

Sandgren proposes to complete the write-up of his current projects, then to withdraw from seeking further research funding. This reflects his impending appointment to a directorship in his department that will bring him to within a year of retirement. Despite his future senior administrative role, every effort should be made to ensure that his positive influence on younger researchers and their development continues.

Balance between resources and goal

Sandgren has well matched resource input with achievements. Investment in costly equipment has been fully justified with excellent research results. His future needs will largely involve time to complete and present research already completed.

Comments on the Area

Position within Quaternary Geology

Sandgren is a well established leader in several important aspects of Quaternary Geology.

Importance and future potential of the area

The geomagnetic and palaeomagnetic aspects of the work are especially important, and their implications lie both within and beyond Quaternary Geology. With further development, the experimental use of OSL is also likely to be of considerable methodological importance. These comments illustrate the fact that much of the work currently classified as Quaternary Geology makes important contributions to related fields ranging, in this instance, from Solid Earth Geophysics to Palaeoclimatology.

General Judgement

Per Sandgren has had a strong, positive influence on the field of Quaternary Geology in Sweden. The work on shoreline evolution has confirmed the existence of several short-term fluctuations in level during the *Littorina* transgression, two of which have been recognised in cores from coastal sites in Russia. One area of innovation arising from the deep water studies has been the partially successful application of OSL dating to marine sediments. Sandgren has made a major contribution through his role as mentor for younger colleagues. This is well illustrated by the very significant work on geo- and palaeomagnetism with Ian Snowball. The Expert Panel regards Sandgren's work as *excellent*.

Ian Snowball
Department of Geology, Lund University

Environmental Magnetism, Varved Lake Sediments, and Late Quaternary Palaeo-oceanography

Abstract (the submitted version)

This project has followed two themes, which are linked by their content of "Environmental Magnetism". The first subproject includes multi-disciplinary studies of varved lake sediments in Fennoscandia and Poland, with the aim to reconstruct climate and geomagnetic field variations over the past 13 000 years. Apart from chronological studies and environmental magnetism, proxies include pollen, diatoms, stable isotopes and geochemistry. Of particular interest during the past three years has been the intimate link between geomagnetic field intensity variability and cosmogenic nuclide

production rates. If nuclide production rates can be better corrected for geomagnetic field intensity, the quality of solar activity reconstructions will be improved. Similar efforts are being made to identify the full range of Icelandic tephra horizons in these annual resolution archives. These isochrons form an important tool for the synchronisation of palaeoenvironmental records in the North Atlantic and on adjacent land masses. The second subproject has focused on the application of palaeomagnetic and mineral magnetic methods for studies of late Quaternary (ca 50 ka) marine sediment cores recovered from the central North Atlantic and Greenland/Norwegian seas. Palaeomagnetic isochrones have been (and will be) used as a means of independent correlation between marine, terrestrial, and ice core archives, while records of bottom current velocity have been obtained from magnetic grain size analyses, which has contributed to our understanding of the thermohaline circulation in these regions. The project has included one successful Ph.D. defence (2003), with another planned before the end of 2007.

Past Performance

Methodology

Snowball's method of study is palaeomagnetism. He has studied secular variations of the Earth's magnetic field from lacustrine and marine sequences, and used these variations for chronological studies. The chronology is based on varved lake sediments. Mineral magnetism was also used in environmental reconstructions. Proxies in collaborative studies include pollen, diatoms, tephra analysis, stable isotopes, and geochemistry.

Position within area

Snowball is one of the leading scientists in the field of Quaternary palaeomagnetism and environmental magnetism. He has published 27 peer-reviewed articles since 1996, including one in *Nature* in 2005. He is first author of 11 of the articles, and is moderately cited.

Particular achievements

These include studies of secular variations of the geomagnetic field during the Holocene and their dating, synchronisation of palaeoenvironmental records in the sphere of North Atlantic (currently the main emphasis), and development of criteria and methodologies for the extraction and evaluation of reliable geomagnetic palaeointensity records from lake sediments.

Future

Project plans

Snowball plans to continue multi-disciplinary studies of varved sediments in Fennoscandia and Poland in order to reconstruct geomagnetic field variations (both directional vectors and intensity) over the past 13 000 years. He will also work on North Atlantic cores and archives from surrounding land areas for the synchronisation of palaeomagnetic records. There is great promise in attempts to link variations in the intensity of the geomagnetic field and cosmogenic nuclide production rates, since this topic is vitally important if we are to improve reconstructions of past variability in solar activity. Further work on palaeointensity, and especially on the role of magnetotactic bacteria, is also planned.

Balance between resources and goal

Snowball's resources and goals are in good balance, and there is every indication that his newly secured position will allow him to continue to generate and publish original and productive research at the highest level.

Comments on the Area

Position within Quaternary Geology

Snowball has become one of the leading scientists in Europe, if not worldwide, in Quaternary palaeomagnetism and mineral magnetism.

Importance and future potential of the area

Palaeomagnetic studies are vital in correlation and dating of Quaternary sequences. Their implications in the study of variations in cosmogenic nuclide production are most promising.

General Judgement

Ian Snowball is one of the leading specialists in Quaternary geomagnetism, especially the use of secular variations of the geomagnetic field in chronological studies and mineral magnetism. He is the head of the well equipped palaeomagnetic laboratory at Lund University and has gained experience in several European laboratories. He has worked on lake sediment sequences and recently on marine cores from North Atlantic. Attempts to link variations in the intensity of the geomagnetic field and cosmogenic nuclide production rates are most promising. He is widely recognised as an emerging

leader in the field at the international level. The Expert Panel regards his work as *excellent*.

Stefan Wastegård
Department of Physical Geography and Quaternary Geology, Stockholm University

Correlation and Dating of Marine, Terrestrial, and Ice Core Records from the Late Quaternary in the North Atlantic Region through the Common Occurrences of Tephra Horizons

Abstract (the submitted version)

My research is directed towards the Late Quaternary and the climate development during this dynamic period in the history of Earth. I work with diverse climatic archives, ranging from marine cores from the North Atlantic, Greenland ice cores to terrestrial deposits in Scandinavia, France, Estonia, and in the Azores. Although close similarities are evident in the palaeoclimatic reconstructions obtained from terrestrial, marine, and ice core records from the Late Quaternary, uncertainties exist as to the degree of synchroneity (or asynchroneity) between them, largely due to the limitations of the radiocarbon dating method (radiocarbon plateaux, reservoir effects) and the lack of suitable dating methods for the time period before 40 ka BP. Therefore, new approaches are required for geochronology models and correlation of sequences and events. One method that holds much promise of effecting more precise regional correlations is tephrochronology. Since 1997, I have developed a technical expertise within tephrochronology and a network of scientific contacts in order to fully exploit this method for dating and correlating deposits around the North Atlantic. My group works with terrestrial sequences on the European mainland, tephra horizons from the North Atlantic, and tephra samples from the NGRIP ice core. These tasks involve extraction, identification, and dating of tephra. The main objective is to investigate lead-lag relationships between different records (e.g., Dansgaard-Oeschger *vs.* Bond cycles) enabling a unprecedented insight into the spatial complexity of rapid climatic changes as well as providing means for determining the extent of the radiocarbon marine reservoir.

Past Performance

Methodology

Tephrochronology is the key method in Wastegård's scientific work. It includes extraction, identification and dating of tephras. In the identification of tephra, optical parameters and geochemical analyses are used; their dating is established by radiocarbon analysis and to some extent by OSL.

Position within area

Wastegård is a leading specialist in the field of tephrochronology, and he has developed his methodological skills to high international level. He has listed 34 peer-reviewed articles and is first author of 14, moderately cited.

Particular achievements

His main achievements are tephra-based marine – terrestrial correlations in the North Atlantic area, including linking of NGRIP ice core record with marine records. Crucial to this was the discovery of the 26 ka Fugloyarbanki tephra. He has also identified tephras in annually laminated lake sediments in Sweden and mires in Estonia, as well as in lake sediments in North-western Russia.

Future

Project plans

Wastegård will continue tephrochrological correlation of terrestrial and marine sequences focusing on identification of tephras from the NGRIP ice core, North Atlantic, and long terrestrial sequences on the mainland of Europe. Of special interest will be the identification and correlation of tephras in cores from the Arctic Ocean; extending several glacial cycles back in time.

Balance between resources and goal

At the moment, the funding is in balance – but in the near future, funding for instruments for geochemical analyses of tephra would be helpful.

Comments on the Area

Position within Quaternary Geology

Wastegård is a well-established specialist in tephrochronology, and in fact the Stockholm group is one of the leading in this field worldwide.

Importance and future potential of the area

Correlation and dating of events is an essential part of Quaternary Geology, and tephrochronology is gaining more and more importance worldwide in the correlation and dating of ice cores, marine and lacustrine sediment cores and peat deposits. Tephrochronology is of vital importance for identifying leads and lags in past environmental changes. It is also a vital tool in assessment of reservoir effects in ^{14}C dating of marine sediments.

General Judgement

Stefan Wastegård has developed a speciality in the demanding field of tephrochronology. His methodology is advanced, and he has applied it to a variety of correlation and dating problems within Quaternary Geology. Stefan Wastegård is the leading scientist in Scandinavia in his field, and the work that he is doing towards improving methodology also promises well for future advances in new geographical areas and time periods. The Expert Panel regards his work as *excellent*.

Barbara Wohlfarth
Department of Physical Geography and Quaternary Geology, Stockholm University

Lake Sediments as Climatic and Environmental Archives

Abstract (the submitted version)

Submillennial-scale climatic variability is a distinct feature seen in ice core and marine records, but the impact of and response to this variability on land is much less known, despite the fact that the terrestrial biosphere forms an important part of Earth's climate system. A number of hypotheses have been brought forward to explain the observed fluctuations, but understanding the relationship between different mechanisms is hampered by large dating uncertainties and insufficient sampling resolution to perform detailed correlations between different archives.

Lake sediment and peat sequences are among the most prominent terrestrial archives, which allow recording submillennial-scale changes when analysed with appropriate time resolution and with an array of different litho-

logical, biological, geochemical, and geophysical methods. Detailed chronological control and time-synchronous marker horizons facilitate correlations to other archives and allow deciphering if the observed environmental changes are time synchronous with marine and ice core archives, thus indicating a complex coupling between ocean, atmosphere, and biosphere.

Our projects focus on multi-proxy and high-resolution lake sediment/peat studies in selected areas (Sweden, Russia, Romania, France) to trace the impact of and response to rapid, submillennial-scale climatic variability on land during the past ca 60 000 years. Specific focus has been placed on MIS 3 and 2 (Dansgaard-Oeschger cycles, last termination) and on the early and late Holocene (e.g., Medieval Climate Anomaly, Little Ice Age, and 20th century warming).

Past Performance

Methodology

Most of Wohlfarth's research has focused on lake sediment analyses, with a strong emphasis on stratigraphy and chronology. From this base, her research has expanded into broader multi-proxy sediment studies, within which her approach has been to reconstruct multiple aspects of past ecosystem responses to environmental (including climatic) change. This approach has been mainly applied to selected periods of rapid change during MIS 2 and 3 as well as the last termination, with results mainly coming from Scandinavia, Western Russia and the French Massif Central. Her concerns with chronology have led to key publications on tephra and on the interpretation of radiocarbon chronologies.

Position within area

Wohlfarth has become a major, internationally recognised leader in the field by consistently upholding the best traditions of Quaternary Geology. Both her regionally based and her more methodologically oriented studies are significant contributions to the field. She has published 37 peer-reviewed papers since 1996; and of these, 14 have her as first author. Overall, the level of citation is moderate, but a number of highly cited papers may be noted from the late 1990s. She has supervised three completed Ph.D. theses.

Particular achievements

Most notable are her contributions to the development and evaluation of sediment chronologies. These include several key, critical evaluations of radiocarbon dating. Also significant are her contributions to palaeoenvironmental

reconstruction over a wide area in Northern Europe, though always within the framework of relatively well established, conventional methodologies.

Future

Project plans

These include a major project funded by the Swedish Research Council (2005 – 2008) aimed at linking evidence for rapid environmental changes over the last ca 60 ka recorded in ice core, marine, and terrestrial archives. This is an extremely important initiative. During the period selected for study, issues of phasing, lagged responses, thresholds, and rates of change are of outstanding importance. The research will therefore require a very high degree of chronological control and a willingness to tackle the difficult problem of selecting proxies directly linked to climate forcing, and distinguishing these from proxies that best serve as indicators of environmental responses to these forcings. She is also leader or participant in several other important research projects, ranging geographically across Eastern and Northern Europe and extending her expertise into the late Holocene.

Balance between resources and goal

Wohlfarth is well placed in terms of resources, with good opportunities for continuing as a research leader. This reflects both an adequate level of funding and the availability of a high proportion of her time for research, now that she has become securely established in her current position. Happily, her high level of productivity and the active role she plays in several important national and international research initiatives ensure that her output will continue to be commensurate, both quantitatively and qualitatively, with the high level of support she receives.

Comments on the Area

Position within Quaternary Geology

She occupies and will continue to play a major role in Quaternary Geology, with strong emphasis on lake sediments, stratigraphy, and geochronology.

Importance and future potential of the area

It is important to recognise that the best empirical evidence for past environmental changes depends on a thorough understanding of the archives and proxies used. In the case of lake sediments, for example, this requires a full

appreciation of the processes that underpin the data. This, in turn, means that the range of skills and experience deployed by Wohlfarth remains of crucial importance in the field. They must be encouraged to flourish alongside the wider range of research now included within Quaternary studies, and they should be fully embedded in graduate training; otherwise there is a risk that basic skills and important understanding will be lost.

General Judgement

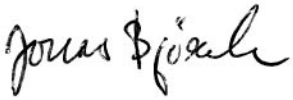
Barbara Wohlfarth has made a lively and sustained contribution to Quaternary Research in Scandinavia and beyond. She has been a key member in several groups and a leader of important initiatives in lake sediment stratigraphy, late Quaternary geochronology, and palaeoenvironmental reconstruction. Her research can be more closely identified with conventional Quaternary Geology than can that of most of the other scientists under review. Her role as an excellent exponent within the discipline is therefore of great importance. She has an excellent record of publications, research supervision, and collaboration. The Expert Panel regards her work as *excellent*.

ACKNOWLEDGEMENTS

On behalf of the Swedish Research Council, we wish to express our sincere thanks and great appreciation to the Members of the Expert Panel. The work was carried out with impressive scientific knowledge, efficiency, and integrity. The ease of interaction shown by the invited experts was a great asset during the evaluation week. We are confident that the present report will contribute to the development of research in Quaternary Geology in Sweden. We would also like to thank the evaluated researchers for their participation and helpful co-operation in the process.

Our special thanks go to Daniel Wadskog, who carried out a bibliometric analysis. Finally, we would like to express our gratitude for the assistance provided by Gun Malmberg and the staff members at the Swedish Research Council, and in particular, Sven Larsson Östergren and Petronella Lönnroth.

Birger Schmitz
Lund University
Chairperson



Jonas Björck
Head of Unit
Natural and Engineering Sciences
Swedish Research Council

Dan Holtstam
Research Officer
Natural and Engineering Sciences
Swedish Research Council

APPENDIX 1: BACKGROUND OF THE EXPERTS

Dr. Mary E. Edwards

School of Geography, University of Southampton, United Kingdom

Telephone: +44 (0)23 8059 2217
E-mail: M.E.Edwards@soton.ac.uk

- *Born* in the United Kingdom, in 1955;
- B.Sc. (Botany and Zoology), University of Wales, Aberystwyth (1976);
- M.Sc. (Forestry and Land Management), University of Oxford (1977);
- Ph.D. (Botany: Palaeoecology), University of Cambridge (1981).

Employment History

Reader, School of Geography, University of Southampton, Southampton (2000 – present) and Senior Research Associate, Institute of Arctic Biology, University of Alaska, Fairbanks (1998 – present); Professor, Dept. of Geography, NTNU, Trondheim (1996 – 1999); Associate Professor, Dept. of Geology and Geophysics and Dept. of Biology and Wildlife, University of Alaska, Fairbanks, AK (1993 – 1996); Assistant Professor, Dept. of Geology and Geophysics and Dept. of Biology and Wildlife, University of Alaska, Fairbanks. (1989 – 1993); Assistant Professor, Dept. of Geography, University of Oregon, Eugene, OR, USA (1988 – 1989); Assistant Professor, Natural Sciences, Marlboro College, Vermont, and Research Associate, Quaternary Research Center, University of Washington, Seattle (1984 – 1988); Postdoctoral Research Associate, College of Forest Resources, University of Washington (1981 – 1983).

Special Assignments

Associate Editor (palaeoecology) *Ecology* and *Ecological Monographs* (2002 – 2005); Co-Editor, Norwegian Journal of Geography (1999 – 2005); Co-Chair, Palaeoclimates from Arctic Lakes and Estuaries (PALE), then PARCS, Steering Committee for NSF Arctic Systems Science (ARCSS) and Earth System History (ESH) (1998 – 2001); Director, Alaska Quaternary Center, University of Alaska, Fairbanks (1994 – 1996); NSF Review Panel Member (Ecology: palaeoecology) (1988 – 1989); Distinguished Visiting Professor, Alaska Quaternary Center, University of Alaska, Fairbanks (Spring of 1987).

Scientific Activities and Interests

Late-Quaternary vegetation history, landscape evolution and climate change, particularly in northern regions; palynology and plant palaeoecology; Quaternary biogeography; human impact on landscape and vegetation; rural land use, conservation and development. Field areas: Alaska, Siberia, North-western Canada, Norway, UK, Madagascar.

Professor Emerita Vera Markgraf

Institute of Arctic and Alpine Research, University of Colorado, Boulder, United States of America

Telephone: +(303) 492-5117
E-mail: vera.markgraf@colorado.edu

- *Born* in Germany, in 1942;
- University of Zürich, Switzerland, 1962 – 1964;
- University of Tübingen, Germany, 1964;
- University of Bern, Switzerland, 1964 – 1968.

Employment History

Research Assistant 1968 – 1971: Research Assistant, Geobotanical Institute of the University of Bern, Switzerland; Research grant from the Swiss National Research Council (1968 – 1971); Research grants from the French Atomic Energy Agency ("Bourse Joliot Curie" and "Collaborateur Etranger") at the Centre des Faibles Radioactivités, Gif-sur-Yvette, France (1972 – 1975); Research Associate, Dept. of Geosciences, Laboratory of Paleoenvironmental Studies, University of Arizona, Tucson (1975 – 1978); Assistant Professor of Palynology, Dept. of Geosciences, University of Arizona, Tucson (1978 – 1981); Research Associate, Institute of Arctic and Alpine Research, University of Colorado, Boulder (1981 – 1987); Visiting Fellow at the Department of Biogeography and Geomorphology, Australian National University, Canberra, Australia (1984); Professor Attendant Rank, Dept. of Geography, University of Colorado, Boulder (1985 – 1987); Research Professor, University of Colorado (1987 – 2003); Visiting Professor, Eidgenössische Technische Hochschule, Zürich, and University of Bern, Switzerland; Visiting Scientist, PAGES Office, Bern, Switzerland (1999 – 2000); Research Professor Emerita, University of Colorado (2003 – present).

Special Assignments

Co-Editor with H.F. Diaz of the volumes "El Niño: Historical and Paleoclimatic Aspects of the Southern Oscillation" (1992), Cambridge University

Press, and the volume "El Niño and the Southern Oscillation: Multiscale Variability and Global and Regional Impacts", published in 2001 by Cambridge University Press. Editor of the volume "Interhemispheric Climate Linkages", published in 2001 by Academic Press, representing the outcome of the "Pole – Equator – Pole Paleoclimates of the Americas" (PEP 1); "IGBP-PAGES research initiative", developed and chaired by Vera Markgraf.

Scientific Activities and Interests

South America and Southern Hemisphere paleoclimates and interhemispheric paleoclimate correlations. Late Quaternary palynology primarily in southern South America and other land areas in the Southern Hemisphere with focus on reconstruction of past climate, dynamics and forcing of climate change, especially during times of transition, such as the late glacial. Development of national and international research initiative PEP 1 (Paleoclimates Pole – Equator – Pole in the Americas) in context of PAGES-IGCP. High resolution, multi-proxy paleoclimate analysis, using pollen (vegetation history), charcoal (fire history), and stable isotopes (temperature history) from late-Quaternary lake and bog sediments in southern South America, in collaboration with J.W.C. White and E. Pendall (both INSTAAR) and INSTAAR graduate students. International co-operative research: Patagonian Lake Drilling Project (PATO), focusing on recovery and multi-proxy analysis of sediment cores from large, extra-Andean lakes.

Professor Emeritus Frank Oldfield

Department of Geography, University of Liverpool, United Kingdom

Telephone: +44 (0)151 625 7418
E-mail: frank@maryoldfield.wanadoo.co.uk also oldfield.f@gmail.com

- *Born* in England, in 1936;
- BA (Geography) University of Liverpool (1956);
- MA (Geography) University of Liverpool (1958);
- Ph.D. University of Leicester (1962);
- D.Sc. (Honorary) University of Plymouth (2000).

Employment History

Assistant Lecturer/Lecturer, University of Leicester (1958 – 1964); Lecturer in Environmental Sciences, University of Lancaster (1964 – 1967); Professor of Geography and Dean of the School of Biological and Environmental Studies, New University of Ulster, Coleraine, N. Ireland (1967 – 1972); Deputy and Acting Vice-Chancellor, University of Papua New Guinea

(1972); Director of the School of Independent Studies, with a Personal Chair in Geography, University of Lancaster (1973 – 1975); John Rankin Professor of Geography, University of Liverpool (1975 – 1996); Executive Director IGBP Past Global Changes (PAGES) Core Project (1996 – 2001); Emeritus Professor and Senior Research Fellow, University of Liverpool (from 1996 to present).

Special Assignments

Royal Society John Murray Fellow (1970); Leverhulme Fellow, (1977 – 1978); Distinguished Visiting Professor, Quaternary Research Centre, University of Washington, Seattle, (1981); Sir Frederick McMaster Fellow, CSIRO, Division of Land and Water Resources, Canberra, (1986); Research Advisor, International Atomic Energy Agency, Vienna, (1986 and 1992); Advisory Professor, East China Normal University, Shanghai(1987 – present); President, Quaternary Research Association, UK (1993 – 1998); Linton Award (British Geomorphology – Research Group) in 1992, and the Murchison Prize (Royal Geographical Society and Institute of British Geographers) in 1995; Associate/Assistant Editor of several international journals.

Scientific Activities and Interests

Palynology, palaeolimnology, environmental magnetism, sediment and peat chronologies, radioisotope contamination, peat mass balance; changing philosophical underpinnings of palaeo-science, late-Quaternary environmental change and past human impact. Published over 150 peer-reviewed research papers, co-edited three books and authored two.

Professor Matti Saarnisto

Geological Survey of Finland, Espoo, Finland

Telephone: +358 20 550 2184
E-mail: matti.saarnisto@gtk.fi; matti.saarnisto@acadsci.fi

- *Born* in Pietarsaari, Finland, in 1942;
- Ph.D. (Geology and Palaeontology, thesis evaluation: laudatur, University of Helsinki (1970);
- Docent of Physical Geography, University of Helsinki (1979 – 1991).

Employment History

Postdoctoral Visitor, Brock University, St. Catharines, Ontario, Canada (1971 – 1973) (and Research Associate, Royal Ontario Museum, Toronto); Post-

doctoral Visitor, University of Cambridge, England (1973 – 1974); Associate Professor of Quaternary Geology, University of Oulu, Finland (1975 – 1988) (appointed in 1977); Senior Research Scientist, Geological Survey of Finland (1988 – 1990); Research Professor (acting), Geological Survey of Finland (1991); Professor of Geology and Palaeontology, University of Helsinki (1991 – 1992); Head (Professor), Dept. of Quaternary Geology, Geological Survey of Finland (1992 – 1996); Research Director (Professor), Geological Survey of Finland (1996 – present).

Special Assignments

Impact of aircraft emissions upon atmospheric composition and climate; Stratosphere – Troposphere Exchange; Remote Sensing of the atmospheric composition from satellites; Chemical Data Assimilation; Chemistry – Climate Interactions; and Tropical Dynamics.

Scientific Activities and Interests

Quaternary environments (glacial geology, stratigraphy, palaeohydrology, glacial isostasy, biostratigraphy, chronology, laminated sediments); More than 150 publications; Field expeditions in (Arctic) Canada, N Fennoscandia (incl. Kola), Siberia (Wrangel Island), etc.; Supervised ten doctoral theses 1991 –, currently supervising two; Evaluator for full professor position, Universities of Montreal, Bergen, and Uppsala.

Professor Tore Ola Vorren

Faculty of Science, University of Tromsø, Norway

Telephone: +47 90056241
E-mail: tore.vorren@matnat.uit.no

- *Born* in Norway, in 1944;
- Cand.mag., University of Bergen, 1967;
- Cand.real., University of Bergen, 1970;
- Dr.philos., University of Tromsø, 1978.

Employment History

Professor (1979 – present); Visiting Professor, University of Colorado at Boulder, USA (Spring of 2000); Visiting Professor, Geomar, Kiel, Germany (Fall of 1995); Visiting Professor, Oregon State University, Corvallis, USA (Fall of 1989/spring of 1990); Guest Scientist, Wood Hole Oceanographic Institution, Ma., USA (Fall of 1983/Spring of 1984); Utdanningsstipendiat

(1978 – 1979); Visiting Associate Professor at Lehigh University, Bethlehem, Penn., USA (Fall of 1977); Utdanningsstipendiat (1976 – Fall of 1977); Universitetslektor (Lecturer) at the University of Tromsø (1973 – 1976); Forskningsstipendiat (research stipendiate), employed by the Norwegian Council for Science and the Humanities and working at the Department of Geology, University of Bergen (1970 – 1973).

Special Assignments

Prorektor (Vice Chancellor) at the University of Tromsø; Vice Chairman of the Research Committee of the Norwegian Universities; Member of the Board, Centre for Advanced Study, Oslo; Dean at the Faculty of Science, University of Tromsø; Member of the Board, NORUT IT; Member of the Council, Sintef; Chairman of the National Committee for "Scientific Committee on Oceanic Research (SCOR); Member of the National Committee for International Union of Geological Sciences (IUGS); Chairman of the Board, Nordnorsk Vitensenter; Memberships of societies: Norwegian Geological Society, 1966 –; Quaternary Research Association, UK, 1973 –; International Glaciological Society, 1974 –; International Association of Sedimentologists, 1982 –; Norwegian Petroleum Society, 1985 –; European Union of Geosciences, 1989 –; Norwegian Academy of Science and Letters, 1993 –.

Scientific Activities and Interests

Quaternary Geology (glacial geology, sedimentology, and stratigraphy) of Southwest Norway (Inner Sogn and Hardangervidda); Marine Geology of the continental shelf off Troms and Finnmark, in the Barents Sea and in the Arctic Ocean; Elucidation of the origin of glacigenic sediments on the continental shelf; Detailed reconstruction of the Late Weichselian palaeoenvironment, both offshore and onshore. Currently, project leader of a strategic university programme financed by the Research Council of Norway: "Sedimentary Processes and Palaeoenvironment on Northern Continental Margins" (SPONCOM). Also partner in a programme financed by the European Commission: "Eurostrataform", and one project on palaeoclimatic studies (Norpast II) financed by the Research Council of Norway. More than 180 publications, of which more than two thirds are articles published in refereed international journals; Supervised and trained 34 cand.real./cand.scient. and 13 dr.scient.

APPENDIX 2: EVALUATION OF RESEARCH PROJECTS

Evaluation of Research Projects Supported by the Swedish Research Council

Quaternary Geology

1. Introduction

As from January 1, 2001, the Swedish Research Council (VR) took over the activities previously pursued by the Swedish Council for Planning and Co-ordination of Research (FRN), the Swedish Council for Research in the Humanities and Social Sciences (HSFR), the Swedish Medical Research Council (MFR), the Swedish Natural Science Research Council (NFR), and the Swedish Research Council for Engineering Sciences (TFR). There are three scientific councils within the Swedish Research Council: one for humanities and the social sciences, one for medicine, and one for the natural and engineering sciences. There is also a Committee for Educational Research as well as a Committee for Research Infrastructure. The Swedish Research Council is an agency under the auspices of the Ministry of Education, Research and Science. The main objective of the Swedish Research Council is to support basic research of high quality in an international comparison, in all fields of science.

In accordance with its Statutes, as laid down by the Government, the Swedish Research Council evaluates the research to which it has given financial support.

For each scientific field, a panel of experts is given the task of carrying out the evaluation. None of the experts are in any way involved in the projects under review. The expert panel is composed of scientists from abroad, who are able to judge the research projects in an international perspective without being influenced by considerations on a national level. The composition of the panel is based on suggestions from the grant holders, who are to be evaluated. The Swedish Research Council attaches considerable weight to the advice given by such foreign experts and are most grateful for the positive response with which invitations to serve on the expert panel have been met.

The purpose of the evaluation is to provide the Swedish Research Council with independent comments and findings regarding the scientific quality of the supported research projects, seen in an international context. The projects are thus the main elements entering into the evaluation. However,

the expert panel is encouraged to comment also on structural matters. The evaluation should be forward-looking where possible, and the reports are important elements in future priority considerations.

The present document describes the evaluation and the general framework for its execution.

2. Organisation of the Work and Other Procedural Matters

The Scientific Council for Natural and Engineering Sciences appoints the Swedish rapporteur (chairperson) of the expert panel, as well as a research officer from the Swedish Research Council as secretary to the panel.

The international expert panel itself decides on the distribution of work among its members. However, to distribute the work of writing the report among the members of the panel, it is suggested that one panel member acts as the main reviewer. The main reviewer then has the responsibility to write and summarise the assessments made by the panel as a whole of the projects/grant holders. The final report will be produced during the stay in Sweden, when the panel is assembled, performing the interviews with the grant holders. *(Conf. points 3 and 4 below)*.

Prior to the review panel's stay in Sweden, the panel is asked to give preliminary assessment marks (Conf. point 6 below) on the projects/grant holders under evaluation. These marks are based on research reports beforehand submitted by each one of the researchers to be evaluated. Furthermore, the main reviewer is asked to rank the projects/grant holders for which he/she is responsible. Prior to the panel assembles, the main reviewer is also suggested to write preliminary comments on, e.g., the researcher's past performance, future, and position within Quaternary Geology. These preliminary assessment marks, rankings, and comments act only as working material and a first input to the evaluation, which is to be finalised during the period of time when the panel is assembled in Sweden.

3. Collection and Distribution of Basic Documentation

Each research project or research programme supported by the Swedish Research Council has a principal grant holder who is responsible for the project or the programme. These grant holders are requested by the Secretariat to submit scientific reports and other documentation on which the evaluation shall be based. Points 3.1 – 3.8 below describe what is normally asked for in such a request. Of course, details may change, depending on the subject, etc.

3.1 A financial overview listing the support granted from the Swedish Research Council or the former Swedish Natural Science Research

Council (NFR) during the last five fiscal years, as well as support from other organisations granted in 2000, 2001, 2002, 2003, 2004, and 2005.

3.2 A list of personnel involved in the project including research staff, graduate students, support staff, and visiting scientists. Information on overhead costs is also included.

3.3 A summary of dissertations within the project during the last five years.

3.4 A brief description of ongoing co-operation with other research groups in formal research projects, EU-networks, etc.

3.5 A summary of the research.

3.6 A brief description concerning objectives and methods for the most recently submitted grant proposal.

3.7 A summary of the main results for the project/projects under evaluation.

3.8 Future plans.

4. Interviews

The written overviews serve as a background for the interviews. The interview starts with a short presentation by the grant holders under review, followed by a short interview and discussion between the review panel and the grant holder. The review panel has a short meeting after each interview, in order to summarise and write a short report on the quality of the research performed by each grant holder.

5. Aspects to be Covered by an Evaluation

The documentation (point 3), the presentations, and the outcome of the interviews (point 4) together form the basis of the evaluation. Points 5.1 – 5.7 below list the aspects or questions that one would like to see addressed by the panel, when reviewing individual projects. Experiences from reviews performed by the former Research Councils have shown great advantages with this scheme. However, each panel is free to modify the scheme when necessary.

5.1 The scientific quality of the results obtained.

5.2 The scientific value of proposed projects (including the question of possible improvements by changing the aim and direction of the project).

5.3 The merits of the methods used and proposed.

5.4 The capability of the project leader and the staff (including issues such as size and composition of the group).

5.5 The adequacy of existing and proposed research positions, facilities, and equipment.

5.6 Other considerations or viewpoints, which may be of importance for the projects.
5.7 The question of increased, unchanged or decreased support. Termination of projects (constructive alternatives if possible).

In addition, the expert panel may be addressed with particular questions by the Research Council, which has set up the panel. Such questions may relate to specific projects or to an entire field of science.

6. Report of the Expert Panel
The work of the expert panel shall result in a report to the Swedish Research Council. This report should comprise a section with comments on the general scientific level in an international perspective of the research performed, including discussions of structural and organisational problems. The need for expensive equipment and other points of general relevance could also be raised here. Another section should deal with each project individually in an international perspective as outlined under point 5 above.

The expert panel should be aware of the fact that the Scientific Council for Natural and Engineering Sciences due to the present budget situation has to reject applications of excellent quality, and that many applications are funded at a suboptimal level.

In order to standardise the terminology used in the assessment of the individual projects, the following assessments marks (Grades US) should be used:

Outstanding (5)
Outstanding research in an international perspective; of great international interest with broad impact and with publications in internationally leading journals; the grant holder is among the leading in the whole evaluated field of research in an international perspective.

Excellent (4)
Research at a very high international level; of international interest with impact within its field and with publications in internationally leading journals; the grant holder is among the leading in Sweden in the evaluated field of research.

Very good (3)
Research at a very good international level with publications in internationally well-known journals; the grant holder has a good international reputation within the field and the research should receive funding from the Swedish Research Council if possible.

Good (2)
Research that is of good international standard and partially published in well-known international journals. To receive the grade "Good", the research should be of sufficient quality to be eligible for funding from the Swedish Research Council provided there are economical means.

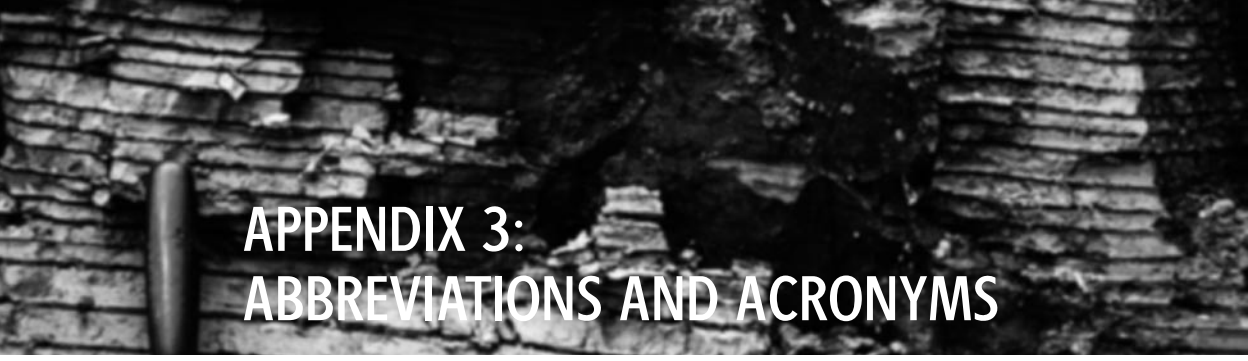
Insufficient (1)
Research of insufficient quality for funding from the Swedish Research Council. The grade "Insufficient" does not necessarily mean that the research is of low quality. The research could be good but not good enough to fulfil the high demands of quality maintained by the Swedish Research Council.

The Swedish Research Council appreciates a discussion on priorities of actions, both in terms of financial support and of more structural matters.

To indicate the relative importance of different recommendations, the following expressions should be used: recommends, strongly recommends or most strongly recommends.

7. Handling and Distribution of the Report
The report of the expert panel is presented to the Swedish Research Council and the Scientific Council for Natural and Engineering Sciences. It is also circulated to all grant holders concerned and, on request, to universities and any other agencies or persons who have expressed an interest in this kind of information. All reports of this kind become, by Swedish law, public documents. Not unexpectedly, an evaluation report sometimes gives rise to comments by grant holders whose work has been reviewed. If they are in a written form, they are distributed to the members of the Scientific Council for Natural and Engineering Sciences.

8. Honorarium
The members of the expert panel receive a small honorarium according to the regulations of the Swedish Research Council. Travel costs and other expenses are reimbursed or paid by the Swedish Research Council.



APPENDIX 3: ABBREVIATIONS AND ACRONYMS

ACEX	Arctic Coring Expedition
AMS	Accelerator Mass Spectrometry
ATLANTIS	Palaeoclimatic Analyses of Late Quaternary Lacustrine and Terrestrial Records of the Atlantic Islands
BP	Before Present (1950 AD)
DNA	Deoxyribonucleic Acid
GIS	Geographic Information System
HOLIVAR	Holocene Climate Variability
IODP	Integrated Ocean Drilling Program
IOW	Institut für Ostseeforschung Warnemünde
IRD	Ice-Rafted Debris
ISOMAP	Isotope Calibration and Mapping Study
ka	Thousand years
LIA	Little Ice Age
LOI	Loss On Ignition
Ma	Million years
MCR	Mutual Climatic Range
MIS	Marine Isotope Stage
NAO	North Atlantic Oscillation
NERC	Natural Environment Research Council
NGRIP	North Greenland Ice Core Project
NorFa	Nordisk Forskerutdanningsakademi (Nordic Academy for Advanced Study)
OIS	Oxygen Isotope Stage
OSL	Optically Stimulated Luminescence
PAGES	Past Global Changes
PLATINA	People, Land, And Time In Africa
TOC	Total Organic Carbon
$T_{1/2}$	Half life

APPENDIX 4: SUPPORT FROM THE SWEDISH RESEARCH COUNCIL DURING THE PERIOD OF 2000–2005

	Contract	Surname	Project/subject title	2000	2001	2002	2003	2004	2005	Summa
	G 650-19981503	Andrén	The drainage events of the Baltic Ice Lake and the possible consequences of the climate development in the North Atlantic region	123 597	36 990					160 587
Total		Andrén								160 587
	G 650-19981505	Arnold	Asian monsoon variability	123 597	61 722					185 319
Total		Arnold								185 319
	G 5103-20005802	Backman	High resolution Holocene climatic and environmental variability in the Skagerrak			308 069	184 408			492 477
Total		Backman								492 477
	G 5103-2594	Bennett	Drill equipment	140 000						140 000
	G 5103-20005375	Bennett	DNA in pollen: towards fossil-based DNA lineages		123 662	123 662				247 324
	G 5103-565 & 621-2002-4791	Bennett	Late Quaternary environmental dynamics of western Tierra del Fuego, Chile	246 976	246 238	246 238	135 200	135 200	135 200	1 145 052
	G 640-20001073 & 629-2002-291	Bennett	PhD student position		384 002	402 500	414 500	355 800		1 556 802
	629-2002-442	Bennett	Postdoctoral research fellow (Laura Parducci)			356 100				356 100
Total		Bennett								3 445 278

	Contract	Surname	Project/subject title	2000	2001	2002	2003	2004	2005	Summa
	G 5103-20005076 and 621-2003-3611	Björck	An interhemispheric transect: Palaeoclimatic analyses of late quaternary lacustrine and terrestrial records of Atlantic islands		493 561	493 561	493 561	472 500	675 000	**2 628 183**
	342-2002-3435	Björck	AMS equipment			2 500 000				**2 500 000**
	629-2004-7959	Björck	ESF EUROCORES Euroclimate						150 000	**150 000**
Total		Björck								**5 278 183**
	G 650-19981526	Gaillard-Lemdahl	PhD student position	385 152	384 002	201 200				**970 354**
	G 5103-1683	Gaillard-Lemdahl	Landscape openness and floristic diversity during the Holocene in Southern Sweden. Reconstruction based on fossil pollen data and predictive models	500 480	379 663					**880 143**
	621-2001-3096	Gaillard-Lemdahl	SWEHITE: Human Impacts on Terrestrial Ecosystems in Southern Sweden 3 000 - 0 cal. years BP - a Swedish contri-bution to the IGBP-PAGES Focus "Human Dimensions and Environmental Systems"			390 000	390 000	390 000		**1 170 000**
Total		Gaillard-Lemdahl								**3 020 497**
	G 640-19991635	Hammarlund	PhD student position	385 152	384 002	402 500	310 900			**1 482 554**
	621-2002-4856	Hammarlund	Equipment for geochemical analyses				536 000			**536 000**

	Contract	Surname	Project/subject title	2000	2001	2002	2003	2004	2005	Summa
	621-2001-1837	Hammarlund	Hydrological and Meteorological Analysis of Precipitation Isotopic Composition as a Key to Present and Past Climates (HYDRO-ISO-CLIM)			325 000	442 000			**767 000**
	629-2002-1179	Hammarlund	Senior research position for DH			768 100	798 100	798 100	798 100	**3 162 400**
	2003-3506	Hammarlund	Holocene changes in carbon cycling of a subarctic peat land (Stordalen, Abisko)					540 000	540 000	**1 080 000**
Total		Hammarlund								**7 027 954**
	G 650-19981533	Holmgren	Regional and temporal patterns in climate	370 899	369 791					**740 690**
	621-2001-1912	Holmgren	Regional and temporal patterns in climate			650 000	650 000	650 000		**1 950 000**
Total		Holmgren								**2 690 690**
	G 5103-20005164	Kullman	Climate tree-line dynamics - bio-geographic and historic aspects	562 822	184 408	184 408	184 408			**1 116 046**
Total		Kullman								**1 116 046**
	629-2002-7827	Lemdahl	Senior research position for GL	657 914	670 267					**1 328 181**
	G 5103-1376	Lemdahl	Equipment (stereo microscope)	130 000						**130 000**
Total		Lemdahl								**1 458 181**
	G 650-19981576	Nordberg	The relation between climate, hydro-graphy and oxygen deficiency in the bottom water of periodically anoxic fjords: a multidisciplinary study	432 698	431 405					**864 103**

	Contract	Surname	Project/subject title	2000	2001	2002	2003	2004	2005	Summa
	621-2004-5320	Nordberg	Global climate change effects on the marine environment and the ecosystems in the Skagerrak coastal areas, as it appears in a sediment record from Gullmar Fjord						337 500	**337 500**
Total		Nordberg								**1 201 603**
	621-2003-317	Nyberg	Reconstruction and analysis of interannual to centennial climate variability in the North Atlantic region using Caribbean corals				330 000	100 000		**430 000**
Total		Nyberg								**430 000**
	G 650-198881580	Possnert	Accelerator based isotope geophysics. Dating and trace element analysis with ^{10}Be, ^{14}C, ^{26}Al, ^{36}Cl, ^{90}Sr, ^{129}I	185 504	170 500					**356 004**
	2002-5181	Possnert	Cosmogenic Be-10 and Cl-36 in the GRIP and North GRIP ice cores.				405 600	405 600		**811 200**
Total		Possnert								**1 167 204**
	G 5103-1329	Renberg	Temporal assessment of Arctic pollution of mercury and persistent organic pollutants using lake sediments	244 800	244 069					**488 869**
	G 5103-20005578	Renberg	Varved lake sediments in boreal lakes		344 951	344 951				**689 902**
	G 15103-2597	Renberg	Equipment (Hg-analyzer)	344 000						**344 000**
Total		Renberg								**1 522 771**
	G 650-19981586	Rosqvist	Quantifying climate change from lake sediments	123 597	61 722					**185 319**
Total		Rosqvist								**185 319**

	Contract	Surname	Project/subject title	2000	2001	2002	2003	2004	2005	Summa
	G 5103-20000962	Rundgren	Junior research position for MR		990 702	574 500	591 700	406 300		**2 563 202**
	629-2002-1373	Rundgren	A reconstruction of CO_2 levels and climatic conditions during the last interglacial-glacial cycle			343 200	343 200			**686 400**
	621-2003-3351	Rundgren	The role of the terrestrial biosphere in atmospheric CO_2 variability during the Lateglacial and Holocene					243 000	661 500	**904 500**
Total		Rundgren								**4 154 102**
	G 650-1587	Sandgren	Palaeoenvironmental and palaeoclimatic studies of Late Quaternary lacustrine and marine sediments	457 504	456 137					**913 641**
	621-2002-4136	Sandgren	A high-resolution continental record from Ancient Lake Xinias, east central Greece - climatic coupling between the North Atlantic and the eastern Mediterranean region during OIS 2 and 3?				405 600	405 600		**811 200**
Total		Sandgren								**1 724 841**
	G 650-19981594	Snowball	Environmental magnetism	86 605						**86 605**
	G 5103-20005013	Snowball	Environmental magnetism and varved lake sediments		184 408	184 408	123 662			**492 478**
	G 510-19991629	Snowball	Junior research position for IS	515 494	141 777	619 300	159 500			**1 436 071**
	621-2002-4782	Snowball	Environmental Magnetism: Varved Lake Sediments and North Atlantic Ocean Dynamics				405 600			**405 600**

	Contract	Surname	Project/subject title	2000	2001	2002	2003	2004	2005	Summa
	2003-3510	Snowball	Environmental studies of varved lake sediments and Late Quaternary palaeo-oceanography					607 500	540 000	**1 147 500**
Total		Snowball								3 568 254
	G 650-19991625	Wastegård	Tephrochronology, long-term vegetation dynamics and climate change on the Faeroe Islands	173 101						**173 101**
	G 5103-20005842	Wastegård	Tephrochronology and climate variation around the North Atlantic during the Late Weichselian and the Holocene		123 662	123 662	123 662			**370 986**
	G 650-19991624	Wastegård	Junior research position for SW	475 238	540 965	567 000				**1 583 203**
	621-2003-3529	Wastegård	Correlation and dating of marine, terrestrial and ice-core records from the Late Quaternary in the North Atlantic region through the common occurrences of tephra horizons					675 000	607 500	**1 282 500**
Total		Wastegård								3 409 790
	702-241/98	Wohlfarth	Senior research position for BW	680 326	693 155	173 288				**1 546 769**
	G5103-853	Wohlfarth	Temporal and spatial variations of the climatic Pleistocene-Holocene boundary and early Holocene climatic events in western Russia	136 000	165 967					**301 967**

	Contract	Surname	Project/subject title	2000	2001	2002	2003	2004	2005	Summa
	621-2001-2371	Wohlfarth	Sub-millennial scale climate variability during and around the Last Glacial Maximum in western Romania			286 000	286 000			**572 000**
	621-2003-3607	Wohlfarth	Terrestrial and limnic response to rapid climate variability between 20,000 and 60,000 years before present.					594 000	567 000	**1 161 000**
	629-2004-8154	Wohlfarth	ESF EUROCORES Euroclimate						790 000	**790 000**
Total		Wohlfarth								4 371 736

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Regeringsgatan 56 103 78 Stockholm Tel 08-546 44 000 Fax 08-546 44 180 vetenskapsradet@vr.se www.vr.se

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