QUATERNARY PERSPECTIVES

Newsletter of the International Union for Quaternary Research (INQUA)

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Editorial

Dear readers,

With regret we have to inform you of the passing away of INQUA's former president Sir Nicolas Shackelton, who left us on 24th February, 2006. In honour of Nick, as he liked to be called by his friends and colleagues, Stephen Porter summarises the scientific life of one of the most important geoscientists of our time. We will all miss Nick's brilliant intelligence and ideas and he leaves a space that is almost impossible to fill.

The results of the vote regarding the status of the Quaternary are available now together with an open letter by the INQUA executive committee to Felix Gradstein, chair of the International Stratigraphic Commission (ICS). The result of the voting is that the Quaternary community is clearly not accepting the compromise suggested at last years meeting of ICS. It seems that further negotiations are necessary to solve the problem of the status of the Quaternary. As INQUA is now a fully accepted union within the International Council of Scientific Unions, we expect that its negotiation position with ICS becomes much stronger.

Beside the above-mentioned topics, the present issue provides an overview on the state-of-the-art in radiocarbon dating, two conference reports and some announcements for future meetings and scientific activities. Most important for the INQUA community is of course the next congress to be held at Cairns, Australia, in July 2007 and we expect to see many of you "down-under".

The editors would also like to highlight that all of you have the chance to present your research activities and INQUA related meetings as brief reports in *Quaternary Perspectives*. This is the ultimate chance to establish yourself before the INQUA congress. The editorial team is open for any suggestions!

Frank Preusser, Christian Schlüchter

Open letter by INQUA Executive Committee

Dear Dr. Gradstein,

The INQUA Executive Committee has finished polling its constituents on the status of the 'Quaternary.' Specifically, the Executive Committee asked individuals and INQUA National Committees whether the recommendation of the International Commission on Stratigraphy (ICS), based on discussions at Leuven in the fall of 2005, was acceptable or unacceptable. That recommendation is that the Quaternary be assigned the status of a Sub-Era/Sub-Erathem with its base at the base of the Pliocene Gelasian Stage GSSP at ca. 2.6 Ma at Marine Isotope Stage 103. INQUA received 204 responses, of which 188 were from individual scientists and 16 were from INQUA National Committees.

Of the 188 individual respondents, 30 (16%) stated that the ICS recommendation was acceptable; 123 (66%) stated that the recommendation is unacceptable; and 23 (13%) expressed acceptance with considerable misgivings (Fig. 1). Most of the respondents in the last group noted that they didn't agree with the ICS recommendation, but preferred it over the apparent alternative that the Quaternary might be removed entirely from the stratigraphic column. Three respondents (1%) recommended that the Quaternary be removed from the Geological Time Scale; and the position of eight respondents (4%) could not be gauged.

Thirteen of the 16 National Committees deemed the recommendation unacceptable; two National Committees stated that it is acceptable, and one Committee voted for acceptance with misgivings. In summary, 66% of individual respondents and 81% of National Committees advised the Executive Committee to reject the recommendation and to continue to work with ICS to find a solution satisfactory to the Quaternary community.

The respondents nearly unanimously support ICS's proposal to define the base of the Quaternary at the base of the Gelasian Stage (2.6 Ma), which is widely recognized as the time at which key changes in Earth's climate, oceans, and biota occurred and corresponds to the Gauss–Matuyama magnetostratigraphic boundary. The vast majority of respondents, however, do not welcome the proposal to assign the Quaternary to a Sub-Erathem. They consider the status of System/Period to be justified and essential. The ICS proposal would leave the base of the Quaternary detached from the base of the Pleistocene, which most respondents consider would violate established practice concerning hierarchical structures. Their view is that it makes more sense to extend the Pleistocene back to 2.6 Ma.

Based on its consultation and lengthy deliberations, the INQUA Executive Committee cannot accept the ICS proposal. Our reasons, which we consider well founded, are as follows: (1) the proposal would allow the extension of the Neogene from the base of the Quaternary to the present day, an extension for which there is no historical precedent or scientific justification; (2) the status of the Quaternary is likely to be progressively

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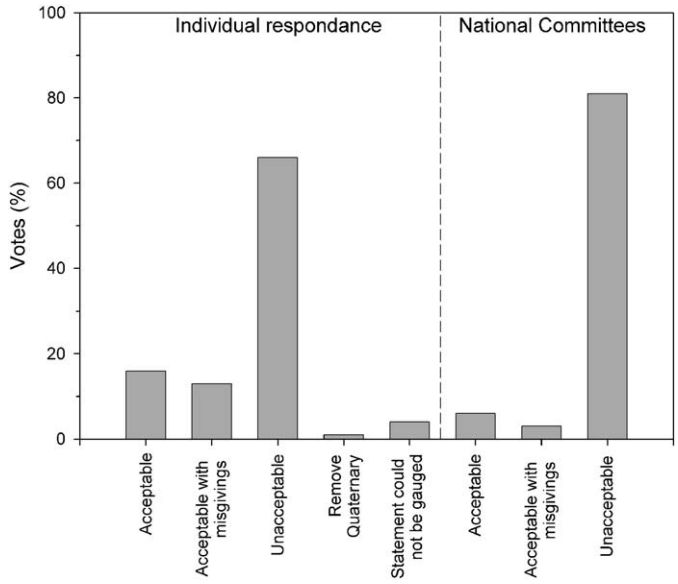

Fig. 1. Results of the vote regarding the status of the Quaternary.

diminished. There are no other Sub-Era/Sub-Erathem divisions in the Geological Time Scale, unless the Tertiary is readopted and promoted to this position. The most likely outcome is that the Quaternary will simply be omitted from charts and quickly side-lined in all but local circles or national timescale schemes; (3) most significantly, the current proposal, with the base of the Quaternary detached from that of the Pleistocene, infringes the hierarchical structure of the Geological Timescale.

The Executive Committee has noted that some recently published stratigraphic schemes already marginalize the status of the Quaternary, and some have omitted the term altogether. It finds this practice regrettable and considers it may be unsustainable in the long term. It is difficult to envisage that the term 'Quaternary' could be effectively supplanted or marginalised, given that it is already embedded within our daily lexicon and that the study of Quaternary stratigraphy is attracting an ever-increasing number of practitioners who are content with the term and its geological importance. Further, the term is gaining greater public attention and recognition. A four-volume Encyclopaedia on the Quaternary is soon to be published by Elsevier, in both hard and electronic form, which will embed the term and its geological meaning even deeper into the public and scientific psyche. The view of the Executive Committee is that the term will continue to be used widely to facilitate communication and learning, and that there will be wide resistance to any attempt to impose a scheme that does not fit with widespread professional practice and has a sound geological justification for its existence. We would regret confrontation between ICS and the Quaternary community, especially if aired publicly during the *International Year of Planet Earth*, when the eyes of the world will be upon us.

The unanimous position of the INQUA Executive Committee is the following:

(1) The Quaternary must be a full formal chronostratigraphic unit, the appropriate status for which is the Period (or System).
(2) The base of the Quaternary should be placed at the current base of GSSP Gelasian Stage (currently in the Pliocene) at MIS 103.
(3) The base of the Pleistocene should be lowered to 2.6 Ma to coincide with that of the Quaternary Period/System boundary.

INQUA understands that the lower boundary of the Pleistocene cannot be changed until 2008, at the earliest; it is prepared to wait until that time to consider this matter further. We note, however, that the top of the Neogene has never been defined and therefore insist that ICS not extend it to the present. An attempt to do this would be a unilateral and hostile action to the Quaternary community. We respectfully requests that ICS continue its dialogue with INQUA and not simply dismiss the Union's position. Our community is now united, knows what it wants, and will settle for nothing less than control over our period of geological time. We ask that you circulate this letter and the poll results to all members of your Commission as a basis for continued discussion.

Sincerely,

John Clague (President INQUA) *and the INQUA Executive Committee*

Obituary

Sir Nicholas Shackelton 1937–2006

Professor Sir Nicholas Shackleton of the University of Cambridge died on February 24 at his home in Cambridge, England. Among the most famous and productive Quaternary/Tertiary paleoceanographers and paleoclimatologists of his era, Shackleton revolutionized Quaternary geochronology and paleoclimate studies through his meticulous isotopic investigations of deep-sea sediment cores and his collaborative work on the role of Milankovich astronomical cycles in controlling the primary pattern of climate change during the glacial ages (Fig. 2).

I first met Nick Shackleton at the Paris INQUA Congress in 1969, two years after he had completed his doctoral thesis on "The Measurement of Paleotemperatures in the Quaternary Era." Our paths crossed many times since then, and especially during the eight years when we served together on the INQUA Executive Committee. The bulk of my research has concerned alpine glacial and Chinese loess records of Quaternary climate change, and progress in both these areas has benefited immensely from Shackleton's deep-sea isotope studies that provide a continuous high-resolution record of changing global ice volume and ocean temperature, to which the often-discontinuous terrestrial records of climate change can be compared and correlated.

Nick's significant early work came a decade and a half after Cesare Emiliani's classic 1955 paper on "Pleistocene temperatures" appeared in the Journal of Geology. In that landmark paper, Emiliani attributed most of the variation in oxygen isotopes in deep-sea sediment cores to changes in ocean–water temperature. Shackleton's subsequent major contribution was to demonstrate that the marine oxygen–isotope signal was primarily a measure of global ice volume. This opened the way for the isotope record to be used as a global marine correlation tool, as well as a standard worldwide proxy for variations in the volume and extent of Quaternary glacier ice. The evidence was published in Quaternary Research in a 1973 paper (v. 3, pp. 39–55), co-authored by Neil Opdyke, that likely holds the record as the most widely cited article in the journal's 35-year history.

Shackleton was a key member of the CLIMAP project, which revolutionized our understanding of the Pleistocene glacial and interglacial oceans. Isotopic time-series provided the basis for global correlation that permitted past sea-surface temperatures to be reconstructed, and they also were a key piece of the evidence used by the SPECMAP project to demonstrate the significance of orbital variations in controlling the pattern of global climate and ice-volume changes, thereby validating the Milankovitch hypothesis.

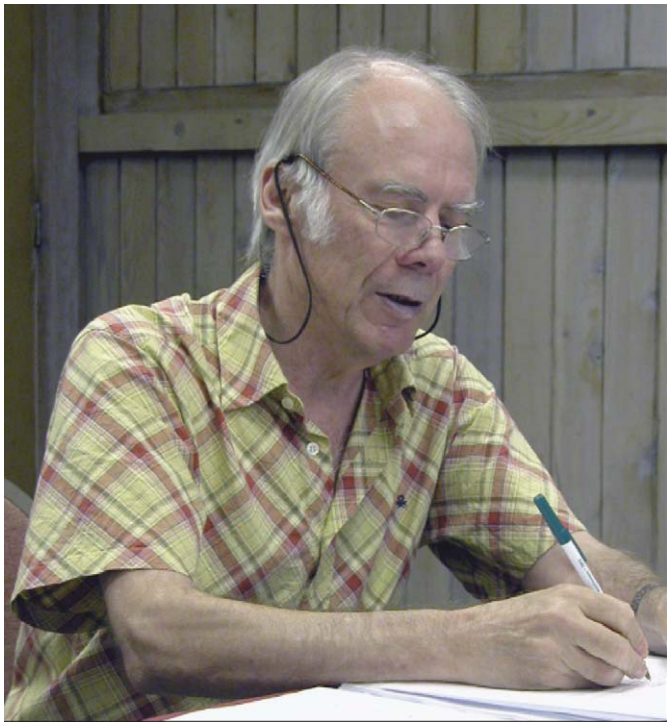

Fig. 2. Nick Shackleton at the 2003 INQUA Congress in Reno, Nevada.

Following this major collaborative work, Nick continued his studies of marine cores and made significant contributions both to Quaternary and Tertiary paleoceanography. The latter studies were largely an outcome of his work on DSDP and ODP ocean-sediment cores that extended the isotopic time scale back to the early Cenozoic. However, his interests spanned a much-broader range of topics, as exemplified by his publications on the archaeology of cave sites in South Africa, Pleistocene sea-level variations, calibration of Tertiary stage boundaries, marine–terrestrial correlations in the northeastern Atlantic Ocean, and sub-Milankovich-scale climate variations in marine records, to name only a few. In these various studies he collaborated with colleagues from some 20 countries who represented a broad array of leading marine and nonmarine Quaternary and Tertiary geoscientists.

Shackleton played a major role in developing initiatives for international research programs of the International Union for Quaternary Research. During his 12 years on the INQUA Executive Committee, including 4 years as President, he helped bring this organization to renewed prominence and strengthened the role of paleoceanography in INQUA's long list of collaborative disciplines. During his tenure as President, he helped implement the streamlining of INQUA's Commission and Committee structure that was begun at the Berlin Congress in 1995. Nick also participated in the organizational meeting of IGBP's Past Global Changes (PAGES) program, which has played a leading role in encouraging and funding international investigations on a broad array of Quaternary problems. These initiatives came at a time when the significance of global warming and global environmental change was capturing the attention of the scientific community and the broader public as well. His dedication to furthering international interdisciplinary research is further evidenced by his 30 years of service on the Editorial Board of Quaternary Research and for 16 years on the Board of Paleoceanography since its founding in 1981.

At Cambridge, Nick served as Director of the Subdepartment of Quaternary Research and subsequently of the Godwin Institute for Quaternary Research. He was a long-time Fellow of Clare Hall, and sponsored the membership of a long succession of Quaternary colleagues in that Cambridge college.

A Fellow of the Royal Society and a Foreign Associate of the US National Academy of Sciences, among the many other honors he received were the Crafoord Prize of the Royal Swedish Academy, a Knighthood for service to the Earth Sciences, the Ewing Medal of the American Geophysical Union, the Lyell Medal of the Geological Society of London, the Royal Medal of the Royal Society of London, honorary doctorates from Padova University and Stockholm University, and the 2005 Blue Planet Prize, which he received shortly before his death.

Although one could go on at length to list many other scientific contributions that Nick has made over his long and very fruitful career, it should be evident that he has had a major impact on the geosciences. He certainly was multitalented, and rightfully could be identified as a paleoceanographer, a Quaternary stratigrapher, an isotope geochemist, and a paleoclimatologist. More accurately, however, he was a wide-ranging geoscientist whose interests and work encompassed an impressive range of research topics, in each of which he made major contributions that advanced our science.

Stephen C. Porter (Washington)

Radiocarbon dating for Quaternary studies—new developments and perspectives

Introduction

For nearly 60 years radiocarbon has been an important Quaternary dating tool. When developing the new dating method based on measuring the abundance of the cosmogenic radioactive carbon isotope ^{14}C, Willard Libby and his co-workers collaborated with geologists who selected geological samples. Quaternary scientists promptly recognized the significance of the new method for the development of time scales of the last ten thousands of years. Questions such as the timing of the last deglaciation or the rate of change observed in pollen records could finally be addressed. During the first 20–30 years the radiocarbon dating method led to 'the revolution' in archeology and provided a new opportunity for dating carbon-bearing Quaternary deposits such as peat bogs, lake and marine sediments. The development of the accelerated mass spectrometry (AMS) technique in the late 1970s brought another breakthrough for applications by allowing the dating of samples that contain as little as one milligram of carbon. This downscaling of the amount of material from the few grams needed for the decay-counting technique to the milligram used in the AMS dating created a new spectrum of applications in Quaternary. The well-known example of such new applications is radiocarbon dating of hand-picked foraminifera shells or macro remains of fragile vegetal fragments of plants such as seeds or leaves to date marine and lake sediments. High-resolution ^{14}C chronologies became a standard procedure for the construction of time scales in palaeoclimate studies.

Great efforts are being made to extend the radiocarbon calibration curve beyond the tree ring based time scale of the last 12,410 years. Archives such as corals, laminated sediments and stalagmites provide reconstructions of the atmospheric ^{14}C concentrations over the last 50–60 ka (Reimer et al., 2004; van der Plicht et al., 2004).

During the last 10 years novel solutions in the AMS technique resulted in lowering the energy needed for successful separation of C isotopes (Jull and Burr, 2006). Carbon dating dedicated small AMS setups are becoming a reality allowing for higher throughput and shorter turnaround time of samples. Moreover,

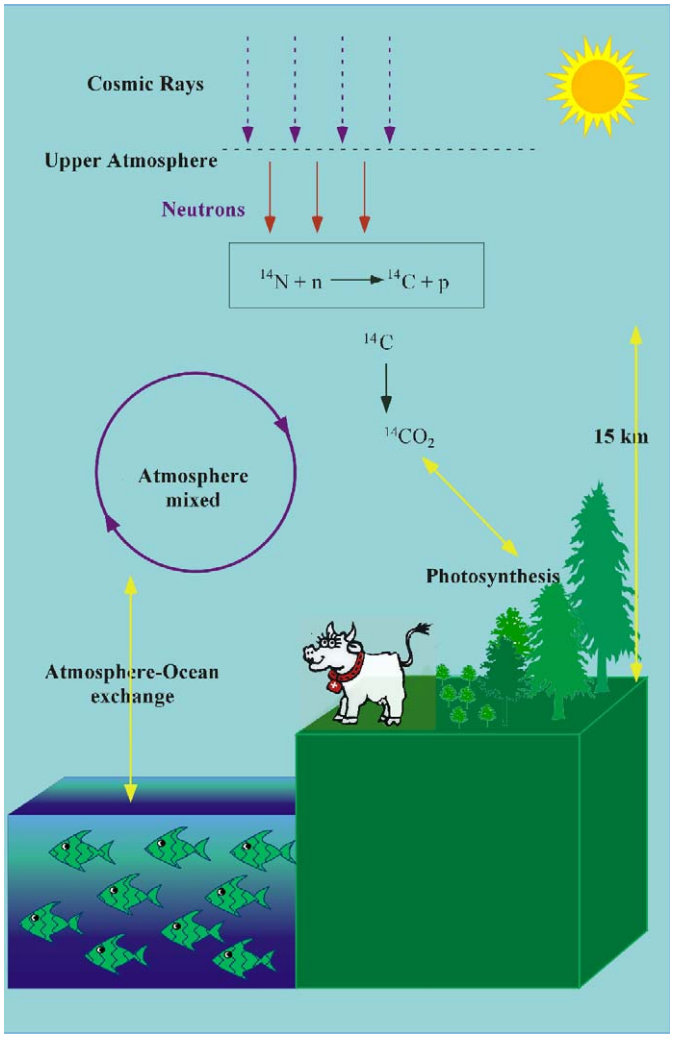

Fig. 3. The cosmogenic isotope of carbon ^{14}C is produced, oxidized and mixed in the atmosphere. Through the gas exchange with the ocean and photosynthesis ^{14}C enters other reservoirs, i.e. the oceans, the biosphere, soils and sediments. The radioactive ^{14}C clock begins to measure the time when the equilibrium between the production and decay is broken.

sophisticated preparation methods allow for separation of carbon at the molecular level providing opportunity for tracing contamination. All these achievements are very promising and add to the more effective application of radiocarbon dating as a tool in Quaternary studies.

Principles of radiocarbon dating

The cosmogenic isotope ^{14}C ($T_{1/2} = 5730$ yr), the only radioactive of the three naturally occurring isotopes of carbon, is a product of a reaction between cosmic radiation produced secondary neutrons and atoms of nitrogen. The resulting atoms of ^{14}C are quickly oxidized and uniformly distributed in the atmosphere. The $^{14}CO_2$ is then transferred into the major reservoirs, i.e. the ocean, biota and soils through gas exchange processes and photosynthesis, respectively (Fig. 3). Based on radioactive decay, the measurement of the abundance of the radioactive isotope ^{14}C in carbon bearing material in respect to the initial values corresponding to the time of deposition gives a measure of the time elapsed since deposition. Problems and sites, for which radiocarbon time scales are constructed include archaeological as well as palaeoclimatic records such as marine sediments, lake and peat deposits.

Preparation methods

Prior to the ^{14}C measurements all samples are treated to remove contamination with older or modern carbon, which might attach to the sample during burial time. The main goal of the treatment is to remove carbonates and humic acid that is not primary material of the sample. The choice of the appropriate procedure depends on the type of material subjected to radiocarbon dating.

Wood, charcoal, macrofossils, peat, paleosols

The standard procedure of acid–alkali–acid (AAA) washes (Fig. 4) applied to samples of wood, charcoal, peat and palaeosols, removes carbonate and humic acid in the first acid and the second alkali step, respectively. An additional acid step is applied to remove any contamination with modern atmospheric CO_2, which occurs during the alkali step. However, such treatment might not be adequate for the treatment of very old material, where ages can be significantly affected even by very small amounts of contamination with younger carbon. Recently modified procedures of the AAA pre-treatment of either wet oxidation and or pre-combustion have demonstrated effectiveness of such approaches (Hatte et al., 2001). Clean organic matter is then combusted to obtain pure CO_2.

Bones

The dating of bones provides a direct age of the studied record and therefore is being sought frequently, particularly in archaeology. The most efficient methods of removing contamination, which have been developed over the past decades, focus on the selection and purification of collagen, i.e. the organic fraction that makes up ca. 20% of fresh bone. Preservation of collagen in fossil bones and its contamination varies with environment and time. Separation of gelatine and elimination of humic contaminants by an alkali wash or ultra filtration are commonly used by the radiocarbon laboratories (Piotrowska and Goslar, 2002; Ramsey et al., 2004). Measurements using the AMS technique are required in the case of using the ultra filtration method or HPLC separation of bone specific amino acids.

Carbonates

Contamination by secondary calcite is the biggest concern in the case of dating calcareous samples (shells, corals, stalactites). Handpicked shells of foraminifera are cleaned in an ultrasonic bath or by leaching in a weak acid or H_2O_2 solution. Differences have been observed between ages obtained on foraminifera shells of different species, which can be attributed to the shell preservation and/or bioturbation of sediments. Sequence leaching experiments performed on ostracod shells and corals resulted in older ages, which leveled off as the surface of the sample was removed.

Sediments

Selection of terrestrial macrofossils (Fig. 5) from lake sediments allows the bypassing of the 'hard water' effect, a problem that appears when dating organic matter of bulk sediment samples. The 'old' carbon dissolved from bedrock carbonates is incorporated into the lake organic matter thus causing the ages to be older. It is hard to construct an accurate radiocarbon chronology of large lakes, which contain no terrestrial macrofossils and are generally poor in organic matter. In some cases, however, radiocarbon ages can be

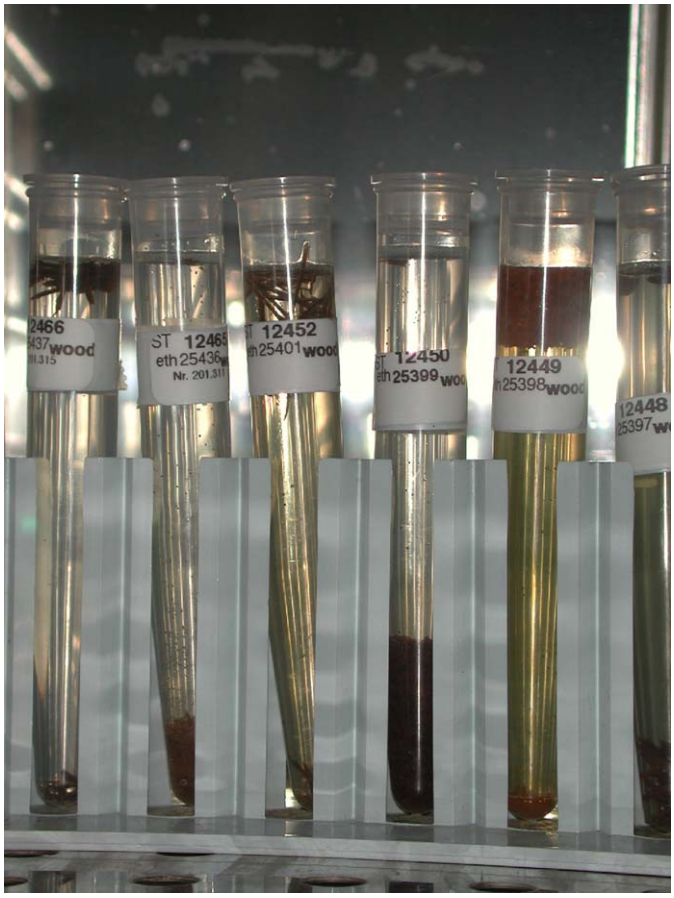

Fig. 4. The standard acid–alkali–acid procedure of cleaning organic material involves a sequence of washes in acid, base and acid to remove contamination by carbonates and humic acids.

Fig. 5. Terrestrial macrofossils (seeds of birch and alder) washed from laminated sediments of Soppensee (Switzerland) and used to obtain ^{14}C time scale of sediments (hard water effect free).

obtained on concentrates of pollen grains. Separation of various fractions of organic matter by step-combustion has been proposed for dating sediments. Moreover, a new potential for dating sediments is expected from the development of compound specific radiocarbon dating, which allow for selection of carbon at a molecular level specifically from lipids, black carbon, wax, or diatoms.

AMS dating

Most of the refinements in the sample preparation methods discussed above require the AMS technique to be applied as only a few milligrams of pre-treated organic matter or pure carbonate are needed for such analyses. The purified carbon dioxide acquired from the combustion of organic matter or acidification of carbonates is reduced in a reaction with hydrogen over a catalyst (iron or cobalt powder). The filamentous graphite is pressed into the cathodes (targets). A set of unknown targets together with the standard samples (known $^{14}C/^{12}C$ ratio) and blank samples (prepared of ^{14}C free material) for measurements of chemical and machine background is then placed in the ion source of the accelerator. A set of magnetic and electrostatic filters applied in the AMS system results in separation of carbon isotopes (Bonani et al., 1987). The measured $^{14}C/^{12}C$ or $^{14}C/^{13}C$ of unknown samples in relation to the measured standards are corrected for background values before ^{14}C ages are calculated. During the past 10 years novel solutions have been proposed that allow for the downscaling of the terminal voltage required for ^{14}C dating from 5 to 0.5 MV and marks a new era of small, dedicated ^{14}C machines coming into operation. Even smaller machines (250 kV) are now being developed (Fig. 6) and their commercial appearance will finalize the AMS revolution in radiocarbon dating.

Calibration of radiocarbon ages

The need for calibration of radiocarbon ages was recognized early in the development of radiocarbon dating. The assumption of a constant atmospheric ^{14}C content proved to be unrealistic. This is mainly due to changes in the production rate of cosmogenic isotopes caused by solar variability or geomagnetic field variations, and climate driven changes in distribution of ^{14}C between global carbon reservoirs, of which the ocean is the largest one (Fig. 3). In effect, the ^{14}C time scale does not correspond to the calendar time scale and requires calibration. A tree-ring-based radiocarbon calibration curve extending back to 12,410 cal BP is the result of decades of long efforts and collaboration between dendrochronologists and the radiocarbon community (INTCAL group).

The calibration procedure 'translates' radiocarbon ages ($\pm$error) into the corresponding calendar year ranges. The complicated nature of the ^{14}C time scale includes periods of constant ^{14}C ages (plateaus or slow ^{14}C clock) as well as rapid changes in radiocarbon ages (fast ^{14}C clock) that have long been known as 'wiggles'. Radiocarbon specialists have developed numerous calibration programs such as Calib and OxCal, which allow not only calibration of ^{14}C ages but various statistical analysis of data and the development of age models. These programs are freely available via www.radiocarbon.org, the web page of the Radiocarbon journal.

Extension of the calibration curve

Due to the lack of a continuous tree ring chronology the extension of the calibration curve back to 26 ka BP has been proposed using records other than tree rings. Marine sediments, corals and stalagmites have been included in the data set used to establish

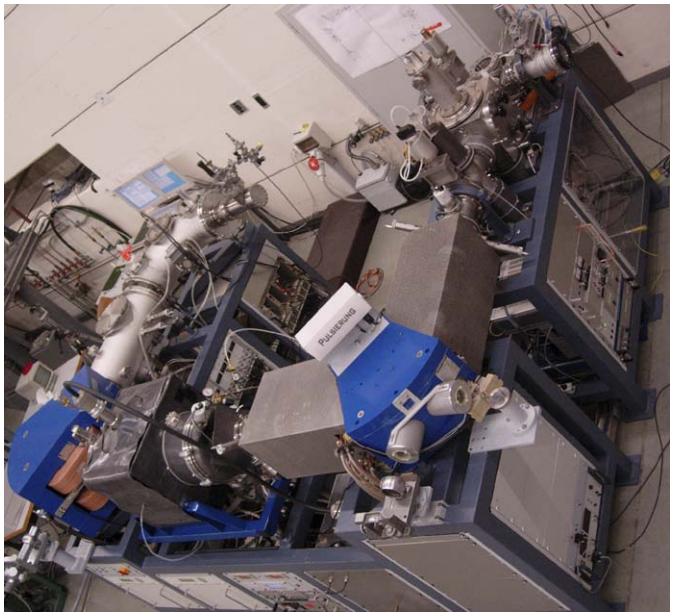

Fig. 6. Micadas—The newest generation of dedicated ^{14}C AMS machines, which is developed at PSI/ETH Zürich.

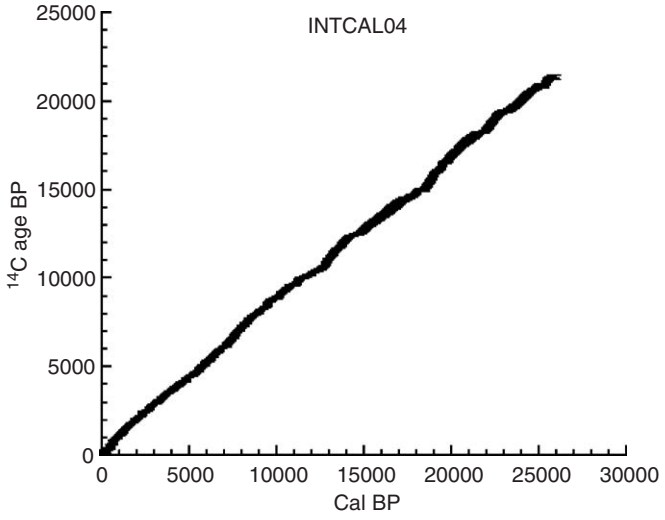

Fig. 7. The INTCAL04 radiocarbon calibration curve based on tree rings, corals, marine sediments and speleothems.

the INTCAL04 calibration curve (Fig. 7). Beyond 26 ka BP other studies have been addressing the relation between the ^{14}C time scale and the calendar time scale. Recently published data sets of marine sediments, corals or stalagmites present the general relation between the ^{14}C and other time scales (references in van der Plicht et al., 2004). However at present, none of the curves can be called a calibration curve. The main challenge is the difference between the time scales used by various data sets. In addition all records published to date require reservoir correction. Future work of the INTCAL group will focus on providing a comprehensive data set that will incorporate the data currently available and place them on a common calendar time scale.

Radiocarbon for Quaternary research—a perspective

Recent high-resolution studies of marine and terrestrial records have shown that understanding the mechanisms behind the observed changes requires reliable time scales. The quest for inter-comparison and correlation between Quaternary records of the past 40–50 ka highlights the need for the ^{14}C calibration curve to extend back to the limit of the method (at least 50 ka). Equally interested in the full length of the calibration curve are archeologists studying the transitional period of the Middle to Late Paleolithic. The construction of a final calibration curve might take another decade or longer and requires the collective effort of both the radiocarbon as well as the Quaternary research community. On the other hand, the present calibration curve and the calibration models already available provide a great tool for the development of high-resolution absolute (calendar) chronologies. In the near future ever growing number of ^{14}C dedicated, compact AMS facilities will allow easier access to this dating technique, which will in effect provide higher resolution chronologies of records. Moreover, the ability to date very small samples (1 mg of C and less) and innovations in sample preparation provide new possibilities for obtaining more accurate ages of complex materials (such as bone and sediments). Although the list of ^{14}C applications other than Quaternary (biomedical, environmental) is a fast growing one, chronologies of the last 40–50 ka years remain at the heart of the radiocarbon dating research.

Irka Hajdas (Zürich)

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First Circular

28 July - 3 August, 2007
www.INQUA2007.net.au

Quaternary Research and Global Change

Rising greenhouse gases are driving climatic boundaries beyond the Quaternary envelope; rising tides of humanity are pushing the ecosphere towards an impoverished and uncharted state. The world approaches a crossroad.

In uncharted seas, sailing directions are taken from historical knowledge. Never has the need to understand Quaternary history been greater: history of climate, the biosphere and humankind. Quaternarists are skilled in integrating with other disciplines. The challenges are clear; our goal is that INQUA 2007 enhances our global ability to meet them.

Host

Australasian Quaternary Association Inc.
ABN 78 458 664 047
www.aqua.org.au
AQUA

Welcome On behalf of INQUA, the Organising Committee has pleasure in announcing the next congress, to be held at Cairns, in Australia's tropical north, and invite expressions of interest in participating. Please notify us of your interest, and continue to visit the website 〈http://www.INQUA2007.net.au〉 as momentum for the Congress increases.

When Saturday 28 July – Friday 3 August, 2007

The Venue Set between the Great Barrier Reef and rain-forest mountains, the tropical city of Cairns lies within the climatic heat-engine of the western Pacific. INQUA 2007 will be held in the Cairns Convention Centre, a splendid facility in downtown Cairns, close to the waterfront. The Centre comprises a main auditorium (capacity 1100 in tiered seating), a large hall for poster and sponsor displays, seven conference rooms (capacities from 65 to 160) plus a number of smaller meeting rooms (capacities from 10 to 30) (click to view), together with extensive open-plan spaces.

Accommodation Cairns offers plentiful accommodation ranging from five-star hotels to motels and back-packer hostels, much within short walking distance from the Convention Centre. The conference will have block bookings in 3 1/2 star – 5 star hotels. Family apartments will also be available. A wide variety of inexpensive accommodation within walking distance of the Conference Centre also is available; from October 2006, this website will provide a full guide to accommodation.

Registration and indicative costs Registration will open in October 2006 and standard-rate registration will continue until 31 January 2007. The standard rate is expected to be around US$600 (Aus$850), and the late rate will be around US$700. The discount student rate will be about US$430. Mid-conference excursions and the conference dinner event are expected to be around US$70 (AU$100).

Travel support Limited funds are available to assist young scientists and students to attend the Congress. INQUA will preferentially support attendees from developing countries and Eastern Europe, and AINSE (Australian Institute of Nuclear Science and Engineering) and AQUA will be able to assist some Australian and New Zealand postgraduate students. Persons wishing to apply for such financial support will be requested to provide their proposed abstract and other details by 31 January 2007. Further details of this process will be provided on the Congress website by July 2006.

Abstracts, submission and publication All abstracts should be submitted by 31 January 2007. Submission will be electronic, via this website, and will be accessible from July 2006. Abstracts will be published as an issue of *Quaternary International* and will be distributed to delegates at the Congress.

Program outline

A draft program outline is provided on the website and will be continuously updated. The program will include about six major plenary sessions in the main auditorium, together with a series of keynote addresses linked to topical symposia. There will be up to 8 parallel sessions of symposia and oral sessions. Except for plenary and keynote addresses, oral presentations will be 15 min in length. Poster presentations will be displayed in two 3-day blocks of 400+, separated by the mid-conference excursion. Poster authors will be available for discussion from 1.15 to 2.45 pm each day.

The program outline allows for about 800 oral papers, excluding keynote and plenary presentations. There are nine slots for half-hour keynote presentations; with eight parallel sessions, there could be 72 keynotes but the real number is likely to be fewer than 30, being the number of symposia and topical sessions.

Plenary sessions and keynotes

Six major ***plenary events*** (one per day in the main auditorium) are proposed; each would have 2–3 principal speakers addressing a theme of global significance. One ***plenary event*** will be held to honour the late Sir Nicholas Shackleton and will be devoted to "Innovation in Quaternary Science". Symposia and sessions have the option of including a ***keynote address***; these will be held either in the main auditorium or larger conference rooms, and may run in parallel. Two time-slots daily are allocated to keynotes.

Symposia and sessions

The Local Organising Committee strongly urges persons interested in leading a symposium or session to propose a title or theme. Groups wishing to convene workshops or business meetings within the Congress are also invited to contact the Local Organising Committee. A list of possible symposia and sessions is provided on the web site.

Pre- and Post-conference field trips

A wide variety of field trips will be offered, catering for a diverse range of interests including landscape evolution, coastal geomorphology and archaeology (Figs. 8–11). Trips will be conducted through Australia, Southeast Asia, and New Zealand. A current list of offered trips is provided on the website.

Organizing Committees

An organizing committee deals with the administration and running of the Congress. Subcommittees deal with the program, excursions, publicity, sponsorship and publications arising from the meeting. A current list of committee members is provided on the web site.

All enquiries should be directed to the Congress email address INQUA2007@icms.com.au or addressed to XVII INQUA Congress 2007, ICMS Pty Ltd, GPO Box 2200, Canberra ACT 2601, Australia, Telephone: +61 2 6257 3299, Facsimile: +61 2 6257 3256

Episodes: Your Window to the World

Episodes is the official quarterly journal of the International Union of Geological Sciences

Fig. 8. The Fox Glacier drains an ice field of the central Southern Alps in New Zealand. On the west coast, glaciers extended out onto a piedmont plain and beyond the present coastline leaving some of the best preserved glacial sequences in the Southern Hemisphere. Three trips will visit New Zealand to look at the exceptional Quaternary geomorphology preserved there. (photo: Peter Almond)

Fig. 9. Spectacular uplifted coral terraces at Kanzarua. The palm trees are on the Holocene platform crest formed 7000 years ago. The highest elevation gradually sloping structure at the skyline is the Last Interglacial terrace at 350 m elevation above sea level. The Huon Peninsula will be the focus of a trip led by Prof. John Chappell and another trip will visit the volcanic and tectonic landscapes of Indonesia. (photo: Tezer Esat)

(IUGS – www.iugs.org). It covers developments of regional and global importance in the earth sciences and is distributed worldwide in four issues (March, June, September and December) each about 80 pages long. The journal is likely the most widely distributed earth science journal since copies go to more than 150 countries worldwide. Articles cover a wide range of earth sciences and authors are from all over the world. The content is of interest to a broad audience of professional earth scientists having diverse cultural and linguistic backgrounds. Whether you live in the developing or developed world, you will find lots of content of interest. Published articles include current reviews, new results from research projects of more than local significance, and discussion of the infrastructure of science, including techniques, research programs, organizations, science policy, or technical assistance. The journal offers earth scientists:

- authoritative articles that reflect worldwide research advances and evolving trends in geoscience disciplines;
- a forum for information exchange within the global earth-science community;
- book reviews by experts in your field;
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- concise reports concerning results of international meetings, conferences, and symposia.

Episodes welcomes thoughtful contributions in the topical areas listed above. Please consult the Episodes web site for submission guidelines (http://www.episodes.org/). Feel free to direct further inquires concerning preparation and submittal of manuscripts and illustrations, special requirements, and pre-press processing to the Episodes staff whose contacts are listed on the web site.

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Deep drilling projects in the Upper Rhine Graben, Germany

The Upper Rhine Graben is part of the European Cenozoic Rift System and provides an important archive for the Quaternary evolution of central Europe (cf. Quaternary Perspectives 15-1). Deposited in the rift basin are the sediments of the River Rhine, which rises in the Alps. It is thus connected to the origin of alpine glaciations as well as transporting sand and gravel transported by local streams, which originate from the up-lifting low mountain chains of the Vosges Mountains and the Black Forest. The geological history of the northern part of the graben structure has recently been investigated by three scientific drilling projects in the area to the northwest of the city of Heidelberg. The whole project is a joint venture of the Institut für Geowissenschaftliche Gemeinschaftsaufgaben at Hannover (GGA, Institute for joint geoscientific research activities) together with the geological surveys of the German federal states of Hessen, Rheinland-Pfalz and Baden Württemberg, in co-operation with several universities and non-university-based research facilities. It

Fig. 10. Strzelecki Desert, central Australia. The linear dune in the foreground has an active crest and vegetated flanks typical of Australian desert dunes. Most of Australia was covered by (now inactive) dunes during the last Ice Age. Several field trips will venture into the arid landscape of Australia and explore its unique dunes, lakes and rivers. (photo: Kathryn Fitzsimmons)

Fig. 11. Desert flora after rainfall, Strzelecki Desert, central Australia. More than 90 mm rain fell on the Strzelecki Desert in winter 2004. Ephemeral herbs such as yellow-tops and Billy Buttons (*polycalymna stuartii*) blanketed and stabilised the sandy soils at this site just south of the Cooper Creek, in contrast to the dune activity of previous years. Two trips will look at key palaeoenvironmental sites in Australia, where pollen records have shaped our knowledge of Quaternary vegetation change. (photo: Kathryn Fitzsimmons)

is expected that sediments in the so-called Heidelberg Basin, which represents a regional low within the graben structure, will reveal important information on the impact of Quaternary climate change as well as neotectonic movements on the depositional processes within the geosystem Alps–Rhine Valley–Northern Sea. Two of the drillings (Viernheim and Ludwigshaden) have already reached their final depth of 350 and 300 m, respectively, while the third drilling is expected to reach its final depth of 500 m in summer 2006.

Media information (translated and compiled by F. Preusser)

Meeting of the subcommission on European Quaternary Stratigraphy (SEQS), 5–9 September 2005, Bern, Switzerland

The annual meeting of the Subcommission on European Quaternary Stratigraphy (SEQS) was hosted by the Institute of Geological Sciences at the University of Bern (Switzerland). The Quaternary record of Switzerland formed the central theme of the meeting and excursions. Contributions on Quaternary glacial stratigraphy were subdivided into regional orientated sessions covering the southern, eastern, northern and western parts of Europe and, of course, the Alps. The largely undisturbed glacial geomorphology as shown in presentations about the Romanian Carpathians and the Anatolian Kackar mountains impressed the audience. Research in such sparsely populated areas far from the well-known classical European Quaternary sites is of extreme importance because it improves the knowledge on glacial phenomena and processes over a very wide area. Moreover, application of new dating methods, especially cosmogenic nuclide and luminescence dating, in such regions provide more insights in the timing and interrelationship of glacial advance and retreat in the main mountain chains.

Reports from well-studied areas such as Latvia and the Lower Rhine Embayment demonstrated that until a wealth of data is available, former research on the reconstruction of a firm stratigraphy still remains problematic. Of major interest was the presentation on Late Pleistocene climate evolution in the Crimean Mountains by combined lithopedological, palynological and archaeological evidence. Here a quite good correlation with the standard European stratigraphy seems to exist. A tremendous amount of work has been done on the Quaternary stratigraphy of the southern Urals. Such inventories are useful for understanding regional Quaternary development. It provides a base for future correlation with central and western Europe. In an example from the Italian Apennines it was shown that the correlation of long term palaeoclimatic records (e.g. from crater lakes) and the evolution of landscapes is hampered by scattered data sets and many gaps in the sedimentary record. Ongoing age determination of Eemian deposits from Denmark to the Barents Sea are resulting in an improved time resolution. A comparison of the Late Saalian/Eemian and Late Weichselian/Holocene development shows clearly a similar succession of events. However, such trends can only be described in a qualitative way. Reconstructing the palaeoenvironmental change in the eastern part of Europe (i.e. Russian Plain) on the basis of large datasets of pollen and small mammals has made considerable progress over the last few years. Such efforts make it possible to gain insight into the Middle and Late Pleistocene palaeoclimatic development of a large part of the European continent.

The session on physical dating of glacial deposits presented a state of the art outline of the application of relatively new methods such as cosmogenic nuclides and luminescence dating. As was shown, there are many obstacles and pitfalls in applying these techniques. Nevertheless, the many examples presented from the Alpine foreland as well as the inner Alps clearly demonstrate that the upgrading of time resolution will cause a considerable improvement to the understanding the Quaternary glacial record

Fig. 12. Thalgut gravel pit, a complex sequence of Middle to Late Pleistocene deposits.

Fig. 13. Erratic bolder at Steinhof dated by cosmogenic nuclides to have deposited about 21–19 ka ago.

Fig. 14. Eraatic bolder on terminal of the early 1990 near Arolla, Val d′Hérens.

with respect of this it is worth mentioning a few highlights. First the Early Pleistocene glaciations as expressed by the gravel accumulations in the 'Deckenschotter'.

Secondly the pre-LGM sites in Switzerland and the correlation of the Alpine glacial phases with the glacial processes dominated by fluvial deposition in the Upper Rhine Graben. The LGM to Holocene transition is another topic where improved resolution in timing of stratigraphic evidence is promising. A final point to be mentioned is the study of Holocene glacier retreat. The combination of geomorphologic features, physical dating methods and historical data is valuable for unravelling this relatively recent climatic history. It also provides a check on the reliability and applicability of cosmogenic nuclides in dating. Following the two days of scientific program three days of excursions were scheduled. The first excursion day was focussed on the Pliocene and Pleistocene glaciations of Northern Switzerland. Starting with beautiful weather at the Rhine Falls near Schaffhausen we learned about the complex shifts of the main river courses. The terminal moraines of the last glaciation played an important role in this process. The Late Pliocene or Early Pleistocene 'Deckenschotter' form evidence of early glaciations and were already described by Penck more than a century ago. In the small exposures at Irchel Hill we could observe this coarse grained gravel resting directly upon the fine-grained Tertiary Molasse sandstones. For many participants it was their first time to see these famous deposits known from the classical literature and their origin gave rise to extensive discussions. Near Regensberg a splendid view was available of the morphology of the Swiss Midlands. In an easterly direction here, one can see the decreasing altitude of the Jura Fold Belt, which dips into the Molasse basin. Thanks to the good view we were able to discuss the marked differences in geomorphology between the north eastern and south central Swiss Midlands, a phenomenon clearly related to the tectonic configuration of the area. It is worth mentioning our visit to the small Museum at Niederweningen. This museum was build thanks to private local initiative, following the nearby find of an almost complete mammoth. It is dedicated to the subsequent research that this find generated and it is a must for the traveller trough Switzerland. The second excursion day concentrated on the Middle and Late Pleistocene record of the Swiss Midlands. The deep excavation near Thalgut (Fig. 12) was impressive and, together with the sequences near Meikirch, the Swiss colleagues now have here substantial evidence of pre-Eemian interglacial deposits. It is not surprising that correlation of this site with the NW-European Holsteinian or MIS 9 and 11 brought up extensive discussions. The excavation at Finsterhennen (near Lake Neuchatel) is situated well within he limits of the LGM and shows a sequence of gravels overlain by a lodgement till. It is interesting to note that the petrography of the deposits here indicates a sediment source from the Valais region (southern Switzerland). Also near Steinhof a series of large erratic boulders resting upon the LGM terminal moraines were shown (Fig. 13). The boulders originate from the Val de Bagne in the Valais region. Dating by cosmogenic isotopes (^{10}Be, ^{26}Al) yield mean ages between 21 and 19 ka proving that the Rhone glacier reached far into the Aare valley during MIS2. The last excursion day brought us to Val d'Hérens (Valais region) and the small ski resort of Arolla. Halfway along the valley, that can be entered near the city of Sion, are some beautiful examples of earth pyramids. Locally they are known as *Pyramides d'Euseigne*. At the end of the valley, which is really within the high Alps at altitudes of more than 2000 m, good examples of recent glacier retreat are visible. Of interest was a

Fig. 15. White River tephra (c. 800 AD) exposed near the present-day ground surface, Whitehorse-Dawson City Highway. The White River tephra is the leading hypothesis to explain a migration of northern Athapaskans from southern Yukon and Alaska about a thousand years ago. John Westgate on microphone.

Fig. 16. The Dawson Tephra (c. 24 ^{14}C ka BP) overlying a prominent ice-wedge at Quartz Creek. The Dawson tephra is the most prominent tephra (typically 15–30 cm thick) in the Pleistocene deposits of the Klondike area and has been so far identified at twenty sites in western Yukon.

small moraine now covered with a pine wood and with trunks of trees protruding from the outer steep moraine side. Radiocarbon dates of 240 yr BP are in accordance with the historical known glacier advance of 1750–1810 AD. The present glacier however is situated some 300 m higher up in the valley. The after lunch walk to the glacier terminus was a final attempt to exhaust all participants (Fig. 14). Until the rain began we had enjoyed it greatly. In summary we can look back to a very well organized and scientifically successful SEQS meeting. Frank Preusser and Christian Schlüchter and their collaborators of the University of Bern did an extremely good job in organizing it. They deserve our most cordial thanks for their introduction to Swiss Quaternary geology.

Wim Westerhoff (Utrecht)
Hans Axel Kemna (Köln)

International Field Conference and Workshop on Tephrochronology and Volcanism, July 31st–August 8th, 2005, Dawson City, Canada

The fourth inter-congress meeting of the INQUA Sub-Commission on Tephrochronology and Volcanism (SCOTAV), convened by Duane Froese (University of Alberta) and John Westgate (University of Toronto), was held in Dawson City within the beautiful Canadian Yukon Territory. This international field conference and workshop maintains the long tradition of very successful inter-INQUA meetings held previously by SCOTAV (including the USA, New Zealand and France) over the past 15 years. Not only do these meetings facilitate an opportunity for the presentation and discussion of latest advances in tephra studies, but they also provide an exceptional insight into the palaeoenvironmental history of a specific region and the Yukon Territory was an ideal location for this purpose.

The unglaciated region of Yukon and Alaska (collectively known as eastern Beringia) is scientifically unique. The lack of glaciation has resulted in the preservation of Cenozoic paleoenvironmental archives that are seldom recorded elsewhere in North America. Many of these archives are uniquely preserved in areas of relict permafrost, and unlike permafrost areas of eastern Eurasia, the occurrence of numerous distal tephra beds originating from the Aleutian arc-Alaska Peninsula (AAAP) and Wrangell volcanic field (WVF) makes the correlation and dating of many of these archives accessible by a variety of methods. The Yukon also has an interesting mining history commencing with the Klondike Gold Rush of 1898. Since that time over 16 million crude ounces of placer gold have been mined from Yukon Territory, 85% of which is derived from unglaciated areas where gold-bearing gravels are often buried by thick sequences of frozen organic-rich silt (locally referred to as 'muck') that preserve tephra and fossils (bones and soft tissue remains). In many cases, the identification of key stratigraphic sequences in eastern Beringia can be directly attributed to gold-mining operations that strip away this overburden material to expose the underlying gold-bearing gravels.

Thirty four participants from 15 countries attended the meeting that officially opened with an ice-breaker reception amongst woolly mammoths, ground sloths and scimitar cats at the Yukon Beringia Interpretative Centre in Whitehorse. In association with the Yukon Science Institute, two public talks, given by Grant Heiken (Los Alamos New Mexico), were arranged as part of the conference—the first of which took place at the ice-breaker reception and the second at Dawson City. With over 40 years experience in the field of volcanology and tephra studies, Grant Heiken explored the different human perceptions of volcanoes and the risks of living in the shadow of a volcano.

This first day gave us our first glimpse of the tephrostratigraphy of this region as the White River Ash flanked parts of the road north (Fig. 15). The White River tephra forms two distinct lobes spreading east and north from an assumed common source, the late Holocene eruption of Mount Churchill in southeastern Alaska. The northern lobe is the older (1887 ^{14}C BP), less extensive of the two lobes and extends north from the source area straddling the Alaska–Yukon border. The younger eastern lobe (1147 ^{14}C BP), is more widespread extending over much of southern Yukon and extending into the Mackenzie Valley of the adjacent Northwest Territories. The White

Fig. 17. Gustavo Villarosa (Argentina) and Supriyati Andreastuti (Indonesia)—standing in front of a frozen 'muck' sequence exposed at a placer mine operation in the Klondike Goldfields. Such exposures are amongst Canada's most prolific sources of Pleistocene vertebrate fossils. Both scientists were INQUA-funded to attend this SCOTAV meeting (Project-0507).

River tephra is the leading hypothesis to explain a migration of northern Athapaskans from southern Yukon and Alaska about a thousand years ago.

The talks and poster sessions were spread over three days with 44 presentations given in eight themed technical sessions. Both oral and posters presentations demonstrated the enormous diversity of tephra studies conducted by the participants with session themes ranging from regional tephra studies (Beringia, New Zealand, Japan, Indonesia, Ethiopia and Argentina), advances in geochemical characterisation techniques, the application of cryptotephra investigations for correlating terrestrial, marine and ice-core records, the dating techniques available for tephrochronology studies and the environmental impacts of volcanic eruptions. Some noticeable highlights included a presentation by Nick Pearce (University of Wales Aberystwyth) on the latest advances and future potential of employing Laser Ablation ICP-MS techniques for single-shard analyses, and the strides made by Gustavo Villarosa (Universidad Nacional del Comahue) and Kaori Aoki (Geological Survey of Japan) in developing a tephrochronology framework for NW Patagonia and the NW Pacific Ocean, respectively. The posters presented also emphasised the diverse nature of the tephra work currently ongoing amongst SCOTAV members—ranging from the impact of volcanism on early Maori society in New Zealand (David Lowe; University of Waikato) and 10th century central Javanese society (Supriyati Andreastuti; Directorate of Volcanology and Geological Hazard Mitigation, Indonesia) to the characterisation of Pliocene—Early Pleistocene marker tephras in central Japan (Itoko Tamura; Tokyo Metropolitan University).

The last two days of the meeting were dedicated to a field excursion in the Klondike Goldfields led by Duane Froese and John Westgate. A fascinating tour of Plio-Pleistocene gravels, loess deposits and excellent examples of ice-wedge casts highlighted the central role of tephra horizons in providing age control and precise tie-points between sequences in this region—work that has been predominantly led by John Westgate over the last 20 years. Indeed, a number of different tephra horizons were observed from the reworked pods of the Midnight Dome tephra (c. 1.09 Ma), thin discontinuous layers of the Quartz Creek tephra (c. 2.97 Ma) and the thick deposits of the Dawson Tephra (24 ^{14}C ka BP) (Fig. 16). The varied degrees of preservation emphasised the complex nature of undertaking tephra studies in this region. In addition to the well-known tephra horizons of this region, some 'new' undiscovered tephra horizons were also identified during this excursion—maybe hereafter named the SCOTAV tephras? By far, the highlight of the excursion was the visit to the 'muck' exposures, the fine-grained ice-rich deposits of late Pleistocene age that overlie gold-bearing gravels, and contain well-preserved megafaunal remains (Fig. 17). It is probably one of the few areas of the world in which you can really experience the putrid smell of the Plio-Pleistocene!

We would like to sincerely acknowledge and warmly congratulate Duane Froese and John Westgate for their hard-working efforts in convening a very memorable and stimulating SCOTAV meeting. We would also like to thank Jeff Bond (Yukon Geological Survey) and Jeff Hunston (Yukon Heritage Resources Unit, Yukon Government) who cheerfully provided support in the organisation of this field conference. The generous support from the Government of Yukon, Yukon Geological Survey and Yukon Science Institute, University of Alberta—Northern Research Conference Fund (to DGF) and International Union for Quaternary Research (INQUA project-0507 to BVA) is gratefully acknowledged.

Anyone who is interested in any aspect of tephrochronology and/or volcanism can visit our website (http://www.gns.cri.nz/inquatephra/) and/or contact the SCOTAV-secretary (Brent Alloway, b.alloway@gns.cri.nz) to find out more about SCOTAV membership, activities and upcoming events. The Proceedings of the recent meeting held in the Yukon can be freely downloaded from the SCOTAV website (address above).

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