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Quaternary AUSTRALASIA

Seeing the flood for the sediment

Young Quaternary ambassadors take it to Parliament

Bern, glorious Bern - reports of the XVIIIth INQUA Congress

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Quaternary AUSTRALASIA

COVER: Brisbane River at Moggill. Image credit: Heidi den Ronden.

BELOW: Australasian Quaternarists gather under the Geomorphology of the Central South Island, New Zealand map on day 1 of the INQUA congress. Image credit: Martine Couapel.

Editorial

Dear Fellow Quaternarists,

This year the 18th INQUA Congress took place in Bern, Switzerland, at the end of July. It was certainly a spectacular location in which to hold one of the most exciting events in Quaternary science – rivalling even our effort at the last congress in Cairns in 2007 – surrounded as it was by some magnificent examples of glacial geomorphology and classic archives for European Quaternary palaeoclimates. The field trips associated with the meeting made the most of Bern's close proximity to such sites, even if the alpine weather didn't always cooperate! Our colleague, Lincoln Steinberger, reports on one such field trip to investigate the ice extent at LGM of the Aletsch Glacier in the Swiss Alps. The conference, as Steve Chilcott and colleagues discuss, was a most interesting and busy one with a strong interdisciplinary flavour, reflecting increasing recognition of the importance of interconnections between research fields. The group of sessions focussing on interactions between humans, the biosphere and geosphere, was a case in point. In fact, it is in many ways the interdisciplinary nature of our Australia-based colleague Zenobia Jacobs' research which earnt her the lauded Sir Nicholas Shackleton medal, which was awarded at this year's meeting. Australasians were numerous and strongly engaged at the conference, which also included a dedicated session on the Australasian INTIMATE initiative, a project which many Quaternarists on both sides of the Tasman are involved with.

We also publish a research article by researchers from the Australasian region. David Haberlah and colleagues report on novel technology which enables mapping of the mineralogy of sediments, including individual grains, and they discuss the implications of the technique for Quaternary science. Some of their work is profiled here on the front cover.

We would like to use this forum to encourage applicants for the AQUA executive post of IT Editor, from which one of our longest-serving committee members, Tim Barrows, will soon be stepping down. Additional news items, including information about upcoming conferences and workshops, can be found in our recently reinstated News section.

Finally we would like to remind you that QA is available through the Humanities and Social Sciences Collection of InformIT, which most Australasian institutions already subscribe to. We urge you to recommend it (and AQUA membership!) to your colleagues now that we offer wider access.

Yours Quaternarily

Kathryn Fitzsimmons and Jessica Reeves

Editors, Quaternary Australasia

President's Pen

Impressions from INQUA

The INQUA Congress is the big event for many Quaternary scientists, and the VIII Congress in Bern was the biggest yet, with 2000 delegates. While the size of INQUA Congresses is growing, membership of AQUA is stagnant or falling. We as the executive must take some responsibility for this in that methods of managing membership details have not kept pace. If there are former members of AQUA for whom you think membership has lapsed please ask them to go to the web page www.aqua.org.au and fill in a membership form. Likewise, if you know of potential new members please do the same. AQUA is a vibrant association with a good magazine and interesting meetings in wonderful places, with cutting edge science. We need to all do our bit to keep it in good health. The next biennial AQUA meeting is at Lake Tekapo in the NZ South Island mountains between 13 and 17 February 2012. Early bird registration closes 23 November, and the abstract deadline is 19 December. See the Conferences page on the AQUA website.

Here are some vignettes from the INQUA Congress:

I was responsible for 3 T of CO_2 being added to the atmosphere getting to the meeting. If the average for all delegates is about half of this we accounted for 3 kilotonnes of CO_2. More than half of that threatened to be released on the Bay of Plenty coast in New Zealand by the stranding of a single container vessel on Astrolabe Reef (The Rena).

"Glaciers are sensitive indicators of climate change " – Johannes Oerlemans. The Rhone Glacier has retreated 2.6 km upvalley since 1856; retreat of more than 9 km is expected by 2050. The Rhone Glacier buried the present city of Geneva in ice at the LGM.

Thomas Stocker (Co-Chair IPCC Working Group I) (paraphrased) – "Don't let IPCC demands drive your science – do what excites you". Guidelines for NZ Antarctic research proposals (paraphrased): "Research must have outcomes that directly feed into end users, e.g. IPCC".

Don't build mediaeval cities in seismically active regions. New Zealand's shaky isles can't maintain a late Victorian one. The contrast of the devastation of Christchurch illustrated in David Barrell's Plenary and the beauty of old Bern.

The Swiss Franc is a stable currency insulated from the meltdown of Eurozone economies – the equivalent of NZ$7 for a cup of tea. Greece unfortunately did not have a proposal for the next INQUA Congress (Japan did).

Peter Almond

Update from INQUA

Craig Sloss and Steven Phipps, from Australia and David Lowe from New Zealand represented the Australasian Quaternary community at the INQUA International Council meeting, which took place during the recent Congress in Bern, Switzerland. Margaret Avery from South Africa was elected as the next INQUA President and Allan Chivas thanked for his term. Japan were also chosen to be the hosts of the next meeting, with the 19th INQUA Congress to take place in Nagoya from 27 July to 2 August 2015.

Call for papers in a special session at the International Palaeolimnology Symposium, Glasgow, 21st-24th August, 2012

Past climates of the Southern Hemisphere

Understanding the past climates of the Southern Hemisphere is important at local, regional and global scales. Despite this, palaeolimnology in the Southern Hemisphere has been neglected relative to "The North". This session will highlight recent paleoclimate research in the Southern Hemisphere. It will focus on records that document the behaviour of important climate phenomena such as ENSO, the Southern Hemisphere Westerlies, and the bipolar seesaw, particularly during key time periods such as the Younger Dryas Chronozone, the "Medieval Climate Anomaly" and "The Little Ice Age".

Session organisers:

John Tibby: University of Adelaide (john.tibby@adelaide.edu.au)
Curt Stager: Paul Smith's College, New York
Santiago Girault: Institute of Earth Sciences, Spanish Research Council

New position: Assistant IT Editor urgently required

The Australasian Quaternary Association is looking for a candidate to fill a new committee position of Assistant Information Technology Editor. The candidate will have a keen interest in the Quaternary and be willing to playing a role in the organisation of AQUA. The new committee position will assist the Information Technology Editor in updating the organisation's web site and explore ways to increase its functionality, including online membership database and subscription payment. They will need to have experience creating modern web sites. The new committee member will be expected to run for office of Information Technology Editor in 2012 upon retirement of Tim Barrows.

Enquiries can be made to Tim Barrows T.Barrows@exeter.ac.uk and applications for the position can be forwarded to the Secretary, Craig Woodward Secretary@aqua.org.au.

AQUA Conference, 2012

There is just time to get your abstracts in for the next AQUA Biennial Conference, which will be held in New Zealand in 2012. The venue is Lake Tekapo in the McKenzie Basin, a dry inter-montane basin on the eastern front range of the Southern Alps near Aoraki/Mt Cook. The dates for the conference are **February 13 to 17**. Please see the flyer insert for further details.

We will be offering support for 3 students to attend. Details will be made available shortly on AQUA-list.

Gathering of AQUA members at the "Altes Tramdepot", Bern's premier brewery-restaurant, overlooking the River Aare and the Bear Park. With beer brewed on the premises sold by the keg, a very merry time was had by all. Image credit: Jessica Reeves.

Automated petrography applications in Quaternary Science

David Haberlah, Craig Strong, Duncan Pirrie, Gavyn K. Rollinson, Paul Gottlieb, Pieter P.W.S.K. Botha, Alan R. Butcher

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David Haberlah, Craig Strong: Atmospheric Environment Research Centre (AERC), Griffith School of Environment, Griffith University, Brisbane, QLD, 4111, Australia
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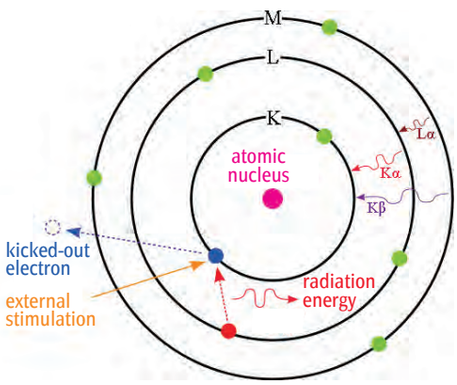
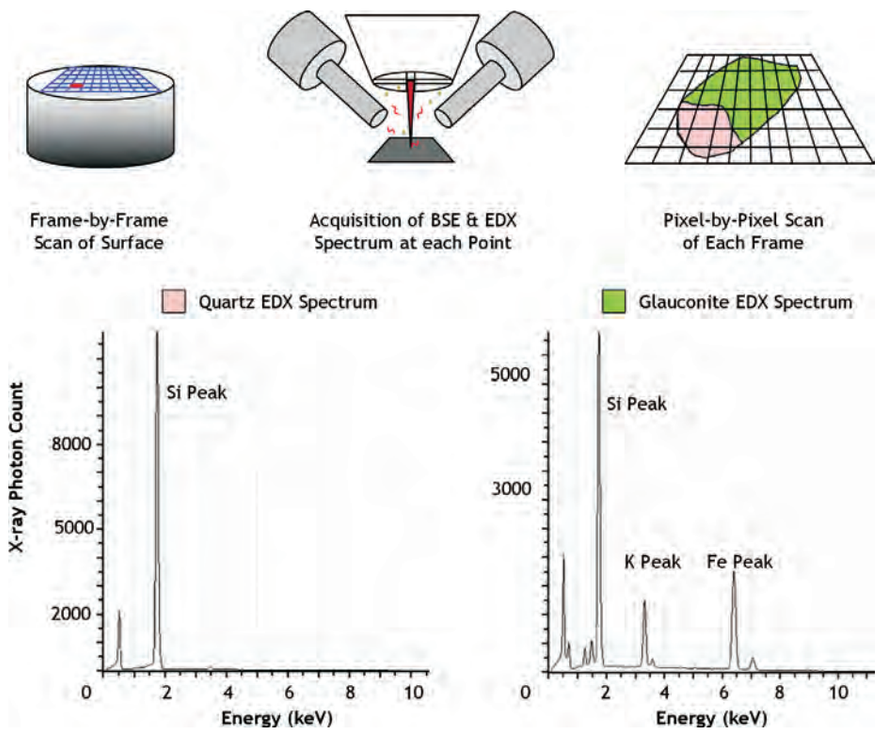
Abstract

Automated petrography analysis integrates scanning electron microscopy and energy-dispersive x-ray spectroscopy (SEM-EDS) hardware with expert software to generate micron-scale compositional maps of rocks and sediments. While automated petrography solutions such as QEMSCAN® and MLA are widely used in the mining, mineral processing, and petroleum industries to characterise ore deposits and subsurface rock formations, only few Quaternary scientists have applied SEM-EDS compositional mapping to palaeo-environmental research. This paper explains the fundamentals behind the analytical method, describes the type of data that can be generated, and presents the latest advances. Potential applications in Quaternary Science are discussed, including the study of: 1) depositional and formation environments; 2) weathering and diagenetic history; 3) sediment provenancing and pathways; and, 4) the provision of complimentary data in chronostratigraphic studies.

Three case studies illustrate potential applications in fluvial, aeolian and coastal research. The first case study applies automated petrography analysis to dust fingerprinting on samples collected from the 'red dawn' dust event that swept across eastern Australia on the 23 September 2009, and from the Icelandic Eyjafjallajökull volcanic eruptions that caused enormous disruption to air travel across Europe in April 2010. The second case study investigates flood deposits collected across Brisbane in the aftermath of the January 2011 floods. In the final case study we consider how automated petrography can aid the understanding of human impacts on the environment. Automated SEM-EDS technology was first developed by CSIRO in Australia, and made commercial by companies based in Brisbane. This proximity has proven an advantage to a wide range of researchers in Australasia pioneering innovative applications.



ABOVE: **Figure 1.** Schematic of energy exchange between the accelerating electron beam (e-beam) and a single atom of the measured specimen. The incident electron beam (blue) displaces a low-energy orbital electron from its position (red). The void is filled by an outer orbital electron (green), emitting some of its excess energy as a characteristic secondary photon of either K-, L- or M-type.



RIGHT: **Figure 2.** Schematic of automated SEM-EDS measurement, with examples for high-count EDX spectra of quartz and glauconite.

Introduction

Automated petrography analysis was first applied to the study of environmental processes two decades ago (Riley *et al.*, 1989). With the advances in computational power, expert software solutions were developed, providing colour-coded compositional maps and quantitative mineral and textural information from rock and sediment samples. Today, SEM-EDS based petrography analysis is widely applied in mining and mineral processing (Rollinson *et al.*, 2011; Lotter *et al.*, 2011), hydrocarbon exploration and production (Armitage *et al.*, 2010; Fröhlich *et al.*, 2010), archaeology (Knappett *et al.*, 2011), and forensic geoscience (Pirrie *et al.*, 2009a). However, to date only a small number of researchers have applied automated petrography to environmental process and palaeoclimate studies (Pirrie *et al.*, 2003; Speirs *et al.*, 2008; Martin *et al.*, 2008; Pirrie *et al.* 2009b: Haberlah *et al.*, 2010, Scott et. al., 2011; Mondillo, *et al.*, 2011). As is shown in this paper, the generation of micron-scale compositional maps combined with quantitative chemical, mineralogical and textural data, has considerable future potential in Quaternary Science. Here, the fundamentals of automated petrography analysis are explained based on the QEMSCAN analytical platform, and potential applications in Quaternary studies are outlined. Sample requirements and preparation, measurement, elemental identification and quantification, mineral identification and quantification, and data analysis are discussed and illustrated by three case studies.

Methodology

In scanning electron microscopy, a specimen is scanned by a narrow focussed beam of mono-energy electrons (e-beam). The electrons interact or "excite" a minute volume (2-5 μm) of sample material near the sample surface. The energy exchange between the electron beam and the specimen results in the reflection of high-energy electrons by elastic scattering, emission of secondary electrons by inelastic scattering, and the emission of electromagnetic radiation, each of which is detected by specialised detectors. Orbiting electrons of the excited atoms are ejected. Electrons from higher energy orbitals fill the voids and release excess energy in form of x-ray photons (**Figure 1**). Energy-dispersive x-ray detectors fitted in the SEM chamber count and measure the photons at each measurement point and plot them as energy dispersive x-ray (EDX) spectra. The energy lines are characteristic of the presence of particular elements, and the amplitude corresponds to the relative elemental contribution to the sample composition (Russ, 1984). QEMSCAN automatically collects low-count EDX spectra and backscattered-electron (BSE) signals along a user-defined grid across the sample surface, in turn producing a compositional raster map (**Figure 2**). The e-beam stepping interval defines the spatial resolution and is set to adequately resolve the texture of each phase in the sample (Gottlieb *et al.*, 2000) depending upon the required resolution of the resultant data set.

In the QEMSCAN workflow, EDX spectra acquisition is controlled by the BSE signal, using a threshold to discriminate sample material from the mounting medium which is reported as background (**Figure 3**). This limits the time-consuming x-ray acquisition to the analysis of sample material only. A total count of typically 1,000 photons is set (Grant *et al.*, 1976), sufficient to reliably discriminate most mineral phases in ~1ms.

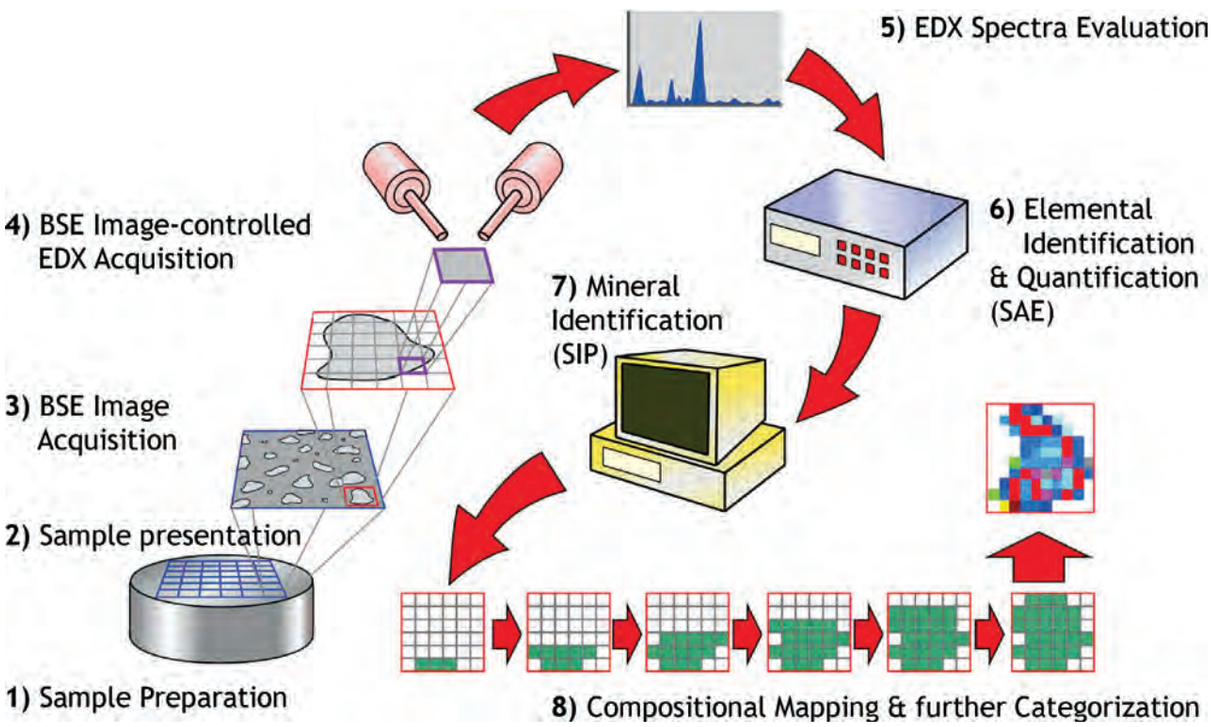


Figure 3. Schematic illustrating the QEMSCAN® workflow from sample preparation to data analysis.

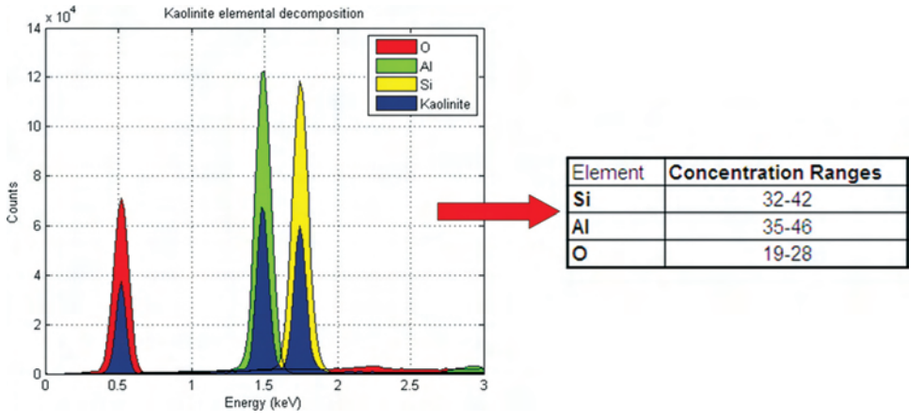


Figure 4. Schematic of elemental identification and quantification by the new QEMSCAN® Spectral Analysis Engine (SAE). The unknown measured EDX spectrum (blue) is analysed by comparing it with a built-in library of up to 72 elemental reference spectra. The software recognizes which elemental spectra are required to calculate a best match (red, green, yellow), thereby identifying the elements present (Si, Al, O) and providing the basis for quantifying their relative contributions (adapted from Haberlah *et al.*, 2011a).

Elemental identification

The measured EDX spectra are first processed by a Spectral Analysis Engine (SAE), which identifies and quantifies the elemental contributions at each measurement point. With the latest software release of iDiscover™ (version 5) by FEI in 2011, a new method of spectral analysis known as the "elemental concentrations method" has been implemented. It is based on a built-in library of 72 elemental reference spectra, collected from SPI reference standards (Structure Probe Inc®, West Chester, PA, USA) on a range of SEM-EDS detector combinations and accelerating e-beam voltages. The new QEMSCAN SAE performs three analytical steps to identify and quantify elements present in the measured spectrum (**Figure 4**):

1) An EDX spectrum of typically 1,000 x-ray photons is measured for ultra-fast and statistically reliable discrimination of most minerals.

2) A synthetic EDX spectrum matching the measured EDX spectrum is generated from a built-in library of elemental reference spectra. The elemental composition of the synthetic spectrum is reported, which is a good indicator of the underlying chemistry of the unknown measured spectrum.

3) The elemental composition at each EDX acquisition point is quantified by applying corrections taking into account matrix interferences. These include the effects of atomic number impact on x-ray production, x-ray absorption by the specimen, and secondary fluorescence. In addition, a rule set of elemental overlap corrections is applied to the composite elemental spectrum.

Mineral Identification

The elemental composition at each measurement point is subsequently compared to a list of phase definitions defined in the Species Identification Protocol (SIP) and translated into discrete minerals. Minerals are defined as ranges and ratios of "must have" and "may have" elemental contributions. Optional thresholds for BSE grey-scale values, x-ray count rates, and confidence levels can be set to better discriminate chemically similar minerals (Haberlah *et al.*, 2011a). Mineral identification works on a first-match basis. The definitions can be created from measured high-count spectra of reference material, synthetic spectra generated from chemical formulas, or interactively defined from the measured raw data on the compositional maps. The new SAE and a multi-layered mineral identification workflow significantly improve clay mineral identification and have been successfully applied to reference material from the Clay Minerals Society (Haberlah *et al.*, 2011b).

Mineral Quantification and reports

The SIP can produce multiple definitions for a given mineral or mineral group, e.g. beidellite, montmorillonite, nontronite, saponite end-members for smectites. These can be combined into single entries in the form of mineral lists. Mineral lists provide the opportunity to assign properties such as chemical composition and relative densities to phases which are required for reporting mineral mass contributions, chemical assays, and for calculating grain densities. With QEMSCAN data, all numerical reports are based and directly linked to compositional maps. Reports can be generated for any selection of samples or particles, such as size fractions.

Automated petrography reports include mineral and geochemical assay reports, similar to those generated by conventional bulk sample analytical techniques such as x-ray fluorescence (XRF) and x-ray diffraction (XRD). However, a key advantage of automated petrography is the contextual information provided by the colour-coded mineral maps. The micron-scale images provide texture and composition of the sample, including mineral associations and mineral grain sizes. Compositional maps can be visually interpreted in terms of depositional and diagenetic features without requiring any mineralogy or SEM training (**Figure 5**). The detailed information can be interactively investigated offline and, in the latest version of iDiscover (5.2, released November 2011), include elemental maps. Elemental mapping can help

to work out subtle but important characteristics, such as mineral phase definitions highlighting features of particular interest, e.g. mixed spectra of grain coatings (**Figure 6**). Categories can be defined that sort sediment particles into classes which share similar mineral association, size and shape attributes. Recent studies on subsurface drill cuttings have demonstrated that composition and texture-based categorisers of lithologies can provide a more detailed picture of reservoir heterogeneity than bulk sample mineral and chemical assays (Haberlah *et al.*, 2011c).

Key advantages of automated petrography analysis over optical petrographic microscopy are:

1) Micron-scale resolution
2) Measurement statistics based on thousands of measurement points per sample
3) Mineral detail including clay minerals quantification
4) Particle classification into meaningful categories, e.g. lithologies, for which properties can be reported separately
5) Fully automated workflow and ultra-fast data acquisition requiring no SEM or mineralogy training

Key advantages of automated petrography analysis over XRD and XRF analysis are:

1) Compositional maps providing texture and spatial context, including mineral grain sizes
2) The ability to interactively create reports for any selection of samples or particles
3) The ability to refine phase discrimination, or to group minerals during post-processing
4) Image-based and particle-based data analysis which allows to filter out contaminants and report on sample fractions
5) Non-destructive analysis, easy archiving of mounted samples

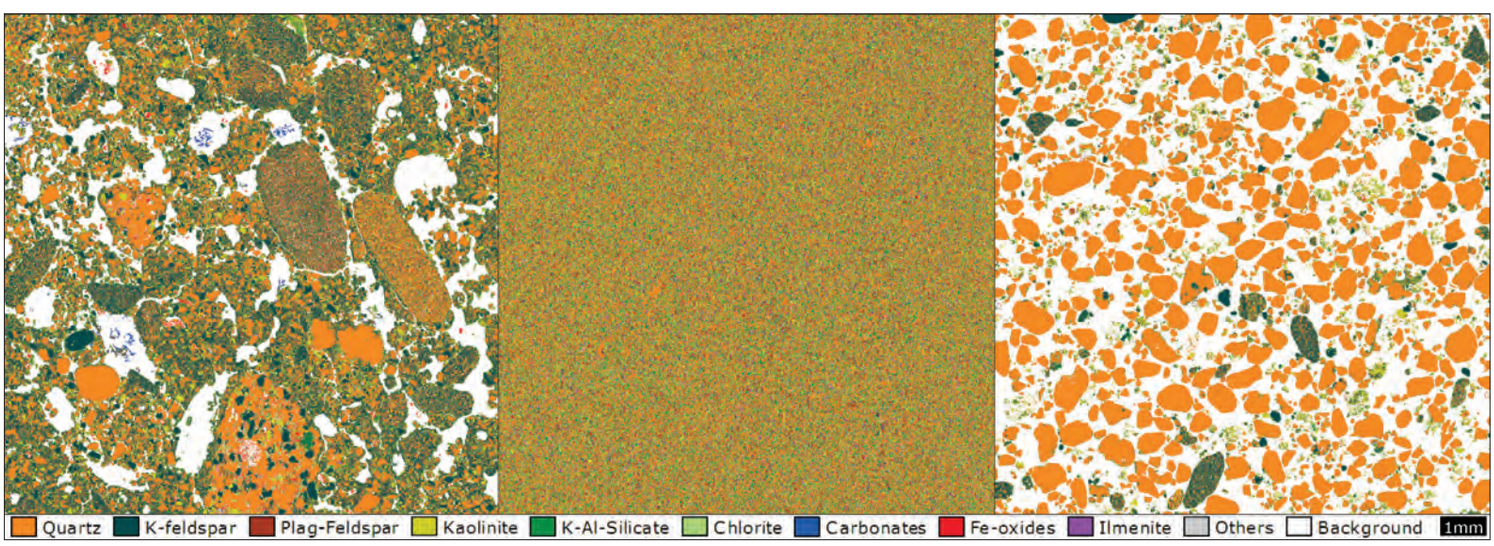
Sample Material and Preparation

Automated petrography can be performed on any material that remains stable under the electron beam and in a high vacuum. A number of studies have been performed on solid rock (e.g. Grauch *et al.*, 2008), soil (Pirrie *et al.*, 2004; Zala, 2007), estuarine sediments (Pirrie *et al.* 2009b), regolith (Haberlah *et al.*, 2010), volcanic aerosols (Martin *et al.*, 2008), atmospheric dust (Morrison *et al.*, 2011), coal (van Alphen, 2007), glacial till (Ehlers, 2011), ceramics and mineral precipitates (Power *et al.*, 2009; Knappett *et al.*, 2011) and even lunar material (Botha *et al.*, 2009). Samples can be consolidated, cemented, or loose. The only sample preparation requirements are that the sample material is dry and presented with an even and electrically-conductive surface.

In contrast to sampling material for conventional whole-rock mineral and geochemical analysis, it is advised to take additional care during sample collection to preserve sedimentary structures, and to take note of the horizontal and vertical placement of the specimen in the landscape.

Loose sediment can be split into aliquots of a few grams and mixed with graphite, counteracting density segregation and aiding random distribution and orientation of the particles. Generally, samples are mounted within 30 mm resin blocks, ground back by at least the maximum diameter of the largest particles to expose a random 2-D section, and polished (**Figure 7**). More recently, sample preparation methods are being developed that do not require filler material (Kwitko-Ribeiro, 2011), and substitute grinding and polishing with sectioning. The sample is usually coated with a ~25 nanometre thin layer of carbon to prevent charge build. Dust samples can be presented directly on carbon tape or on filter papers for atmospheric particulates (Pirrie and Rollinson, 2011). Thin sections and larger rock samples can be loaded into dedicated sample block holders, as long as the sample specimen fits into the SEM chamber.

Figure 5. Compositional maps of sediment samples from the Brachina catchment in the Flinders Ranges, South Australia, used in a provenancing study: A) an aggregated fluvial deposit; B) underlying bedrock; and, C) upwind dune sand of monomineralic grains and lithics (adapted from Haberlah *et al.*, 2010)



Applications in Quaternary Science

Quaternary studies aim at reconstructing atmospheric, terrestrial, and marine circulation patterns and palaeo-environments at different points in time, and at regional to global scales. An important part in the reconstruction of the palaeo-landscape is to understand the sedimentary record, including depositional, formation and weathering environments, sediment pathways, and the nature and timing of events. Automated petrography can play an important role in palaeo-environmental reconstruction by providing detailed information on: 1) formation and depositional environments; 2) chemical weathering and diagenesis; 3) sediment sources and pathways; and, 4) the composition of the material sampled for chronostratigraphic analysis.

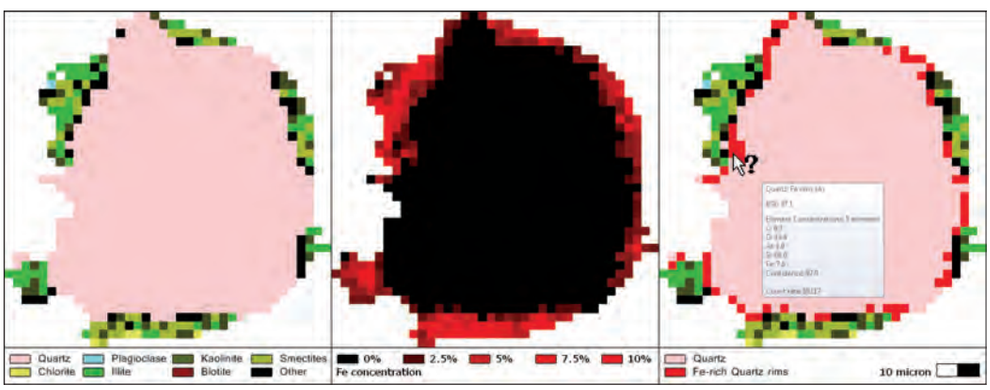
Formation and depositional environments

Automated petrography can depict primary sedimentary micro-structures invisible to the naked eye, thereby providing valuable information on the formation environment of the sediment or rock. Sedimentary micro-structures can include analogues of larger, possibly lost sedimentary features such as cross-lamination. An illustrative example on the type of information that can be obtained on the formation environment by QEMSCAN are images of concretionary grains of pisoliths, highlighting the nucleus and core surrounded by several concentric layers of different material (**Figure 8**). The sorting and type of the constituents can provide information on the transport and depositional regime (Haberlah and McTainsh, 2010).

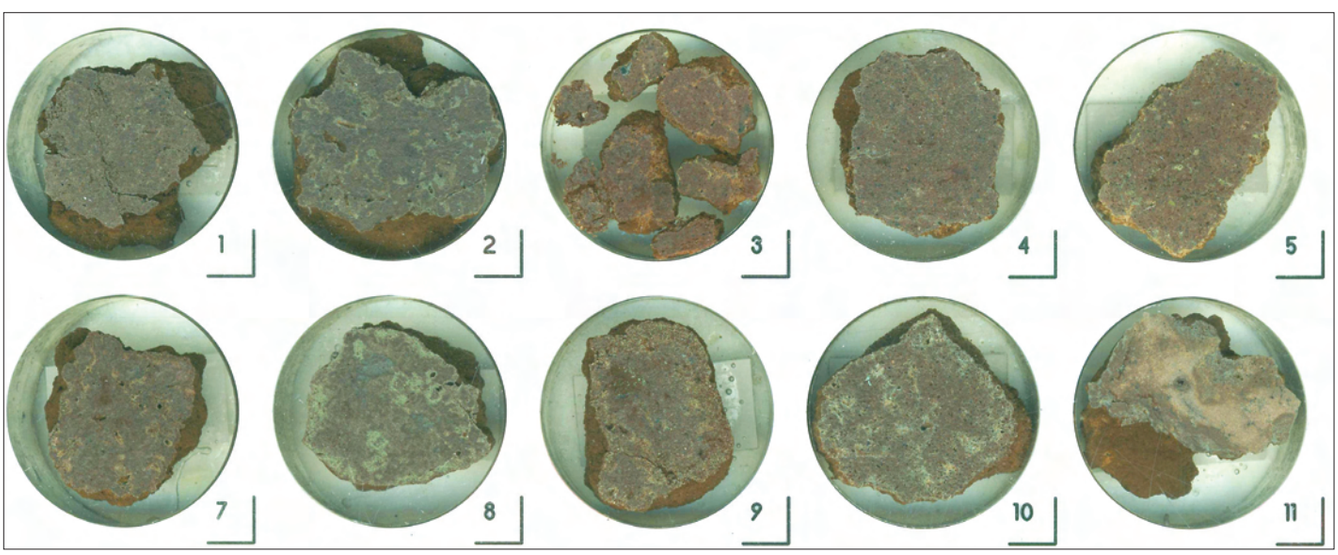
Weathering and diagenetic environments

Clay minerals are ubiquitous in soils and reflect the chemical weathering environment. The degree and type of clay mineral formation is often determined by the local climate and topographical position of the sediment body in the landscape. Clay typing by automated petrography analysis can be used to assess the nature and degree of weathering, establish if the material weathered in-situ or is reworked, and be expressed in terms of weathering indices. Clay identification and quantification has been significantly improved by the new QEMSCAN SAE and multi-voltage support in iDiscover (version 5.2), and a multi-layered mineral identification workflow discriminating a large variety of clay minerals and groups (Haberlah *et al.*, 2011b). The latest SIP, which is made freely available to QEMSCAN users, includes the following clay mineral groups which are characteristic of different weathering and diagenetic environments (Velde, 1985):

RIGHT: **Figure 6.** Single dust particle collected in Brisbane during the 'red dawn' dust event on the 23rd September 2009. The left figure shows the standard compositional map highlighting the clay mineral coating around a single quartz grain. The central image provides an elemental map on the same particle displaying high iron concentrations towards the particle rim. The right image highlights the Fe-rich quartz grain coating, by defining a separate iron-sensitive quartz definition. Elemental concentrations, BSE value, and x-ray count rate are shown for a single measurement point (pixel) from the iron-rich mineral grain coating.



BELOW: **Figure 7.** Example of regolith specimen collected from the Flinders Ranges, South Australia, prepared as resin-mounted 2-D sections for QEMSCAN® analysis



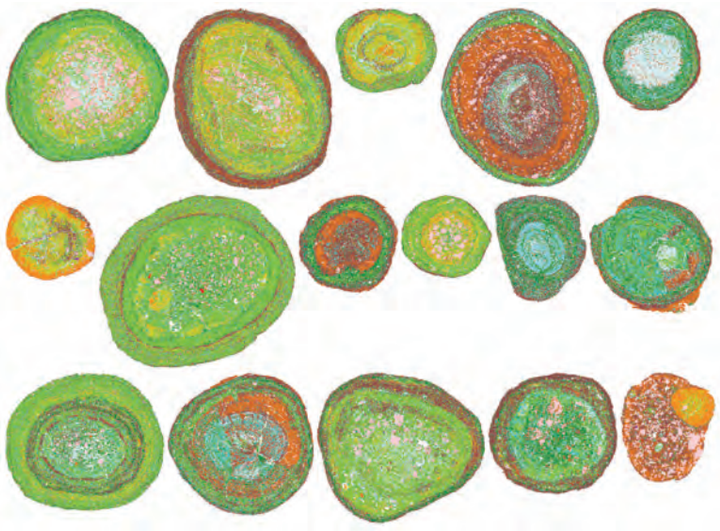


Figure 8. QEMSCAN® compositional maps of sectioned pisoliths from a bauxite deposit. The blue signature shows Ti-rich gibbsite, the orange hematite, the light green gibbsite, the pink quartz grains, and the brown kaolinite.

1) The kaolin group is a weathering or alteration product of aluminosilicate minerals, primarily plagioclase and muscovite. Kaolinite is a major component of chemical weathering profiles in hot moist climates. It is also common in hydrothermally altered felsic rocks.

2) The smectite group is characterised by high cation exchange capacity (K^+, Na^+, $0.5Ca_2^+$). Smectites include: beidellite, a common early weathering product of feldspars; montmorillonite, occurring in large deposits also known as bentonite; nontronite, a common weathering product of iron-bearing silicates; and, saponite, an alteration product of magnesium silicates. Smectites are typical weathering products in drier climates.

3) The illite group include non-expanding, clay-sized, micaceous clay minerals. Illite is a typical weathering product of muscovite and feldspar in cooler climates. It can also be an important diagenetic mineral in deeply buried marine sediments. Glauconite is an iron-rich member which forms under reducing conditions in near-shore sands and is considered a diagnostic mineral of marine deposition on continental shelfs.

4) The chlorite group are common in metamorphic rocks, some igneous rocks, hydrothermal rocks, and form in deeply buried sediments. The wide range of temperature and pressure conditions is reflected in its variable chemical composition and cation substitutions in the silicate lattice.

Provenancing and Pathways

Automated petrography can be a powerful tool in fingerprinting sediment sources and establishing transport pathways. Insights into fluvial processes operating at a catchment-scale, and aeolian processes, operating at anything from local convective cells to dust plumes that travel the continent or hemisphere, can be gained by looking at the sediment composition. Sediment sources and pathways can be highly informative of former environments and circulation patterns. Sediment fingerprinting is an approach where potential source and depositional sediment samples are characterised and compared based on diagnostic physical and chemical properties. However, whole sample mineral and geochemical assays of different sediment sources can be similar. Diagnostic properties are often found in the size or shape characteristics of particular phases, or in characteristic mineral associations of constituent particles. These properties can be extracted from QEMSCAN data using iDiscover software, including the capability to classify sediments into source contributions on a particle-by-particle basis. Provenancing and pathway studies have been successfully applied in forensic soil analysis (Pirrie *et al.*, 2004; Pirrie *et al.*, 2009a) but could equally well be utilised in environmental investigations, particularly related to the identification of either diffuse or point sources of contaminants.

Chronostratigraphic studies

Automated petrography also has the potential to support chronostratigraphic studies by providing contextual data from chronostratigraphic markers such as tephra layers. Compositional mapping can reveal detailed information on the particular mineral size fractions used in numerical dating in complex sediments, e.g. luminescence dating on particular quartz size fractions.

Case study 1: Fingerprinting aeolian sediments

Sediment fingerprinting provides valuable insights into geomorphic processes operating at a range of scales and across geomorphic agents, including fluvial (Riley *et al.*, 1989), aeolian (Petherick *et al.*, 2008; Lawrence and Neff, 2009), alluvial, glacial and lacustrine transport and deposition. In aeolian sediment fingerprinting, traditional approaches compare deposited dust samples to soil samples from potential source areas through elemental composition. This so-called geochemical fingerprinting is often determined by inductively-coupled plasma mass spectroscopy (ICP-MS) (McGowan *et al.*, 2005; De Deckker *et al.*, 2010). However, geochemical comparisons are often restricted to using <30 elements due to the variable environmental stability of the elements, and the necessity to identify only elements found from distant sources. A detailed geochemical database of the potential dust source areas is also required.

Elemental composition is less representative of the natural condition of a dust sample than its mineral composition, because elements exist in a range of mixtures within minerals (McTainsh *et al.*, accepted, Shao *et al.*, 2011). Two samples which appear similar in elemental composition can therefore have contrasting mineralogy. Further, elemental variability can result from the interaction of dust particles with local gaseous air pollutants (Alastuey *et al.*, 2005). For example, the elemental composition of Saharan dust at Puerto Rico was found to be 55-65% aluminosilicates and from this it was inferred that particles could be illite, kaolinite, chlorite or montmorillonite (Reid *et al.*, 2003). This

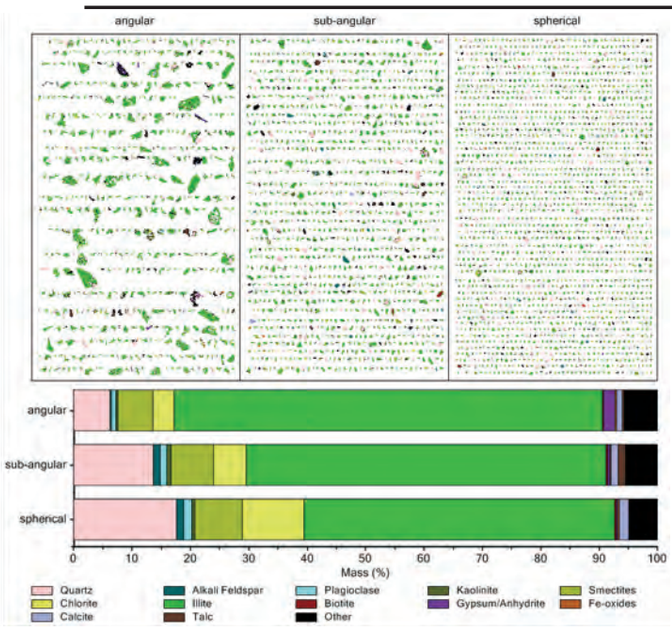


Figure 9. Particle shape characteristics and associated modal mineralogy of dust collected in Brisbane following the 'red dawn' dust storm event on 23 September 2009.

conclusion is however, of limited use in distinguishing source areas, as dusts from southern Saharan are kaolinite-rich (Whalley and Smith, 1981), while dust from north western Saharan is illite-rich (Avila *et al.*, 1997). In addition to providing the phase and mineral composition of the sample, automated petrography analysis generates detailed reports on the mineral sizes and shapes (**Figure 9**). The ability to discriminate in terms of textural, mineral and chemical properties is fundamental in characterising the potential source, transport distance, and subsequent chemical processes downwind. Particle-size reflects the source soil characteristics, entrainment processes, and distance from source. Particle shapes reflect geomorphic processes acting at formation and during subsequent transportation. Whilst in the atmosphere, the shape of the particle has been found to be important in scattering short wave radiation (Hovarth *et al.*, 2006). Automated petrography allows the detection of the presence of aggregation (**Figure 5**) and mineral coatings on particles (**Figure 6**). Identification of aggregates and mineral coatings within dust sediments aids the identification of source areas, weathering conditions at the source formation site, and can provide information on atmospheric processing whilst in transport, radiative forcing (Durant *et al.*, 2009), and any impact and alteration at the deposition site.

Recently, in both Australasia and in Europe air travel has been seriously disrupted as a result of large scale eruptions releasing ash particles into the upper atmosphere. Fingerprinting the sources of distal volcanic ashes is significant in terms of predicting the likely frequency of such events (e.g. Swindles *et al.*, 2011). In identifying source areas particle texture can be important and in contrast to XRD, automated petrography can characterise amorphous phases, such as volcanic glass. This can be a significant component of unaltered volcanic airfall ash, as demonstrated by the analysis of a sample of ash collected during the Icelandic Eyjafjallajökull eruption in 2010, which comprised 92.1% particles of volcanic glass, 4.5% plagioclase, and 3.4% pyroxene (**Figure 10**).

Case study 2: Discriminating fluvial sediments – Brisbane flood 2011

On the 11th January 2011, following a prolonged period of heavy and persistent rain, the Brisbane River in Queensland, Australia, breached its banks. Over the next 48 hours the flood level continued to rise until it peaked on the 14th January 2011. Substantial damage to the Central Business District (CBD) and nearby suburbs occurred as a result of unprecedented flooding of low lying areas.

As the flood waters receded, the damaged areas were left covered with a grey to black coloured muddy sludge. During the 14 -16 January 2011, the authors (PG, PWSKB, ARB) were able to collect samples from three different flood affected areas (**Figure 11**). At the time, the public were advised to take care in handling the mud as it was considered to be possibly toxic, having been contaminated by sewerage and industrial effluent that leaked into the river during the flooding.

Automated petrography analysis of the three samples reveals that they all quite distinctive in terms of their mineralogical composition.

The sample taken furthest upstream (**Figure 11A**) was collected at Booker Place Park in Moggill (-27.5629, 152.8938), and noted in the field to be an overbank deposit with intact ripple bed forms. It is rich in illite and fine-grained quartz and feldspars. Upstream of most of urban Brisbane, it is an example of a largely non-urban fluvial signature. The second sample (**Figure 11B**) is a sandy deposit collected from the University of Queensland car park in St Lucia (-27.4924, 153.0110). It is an example of an urban signature as it includes reworked sediments from nearby building sites (noted at the time of collection). The third sample (**Figure 11C**) is a river deposit collected right on the water's edge at Orleigh Park in West End (-27.4859,152.9973). This sample was included as an example of sediment deposited directly from the main channel downstream of the Central Business District. It has a distinctive signature presenting a mixture between the two upstream samples; comprising both coarse quartz grains similar to the CBD sample, and mud aggregates similar to the Moggill deposit. In addition, it is rich in calcareous plant fragments.

The results, although preliminary, suggest that the mud which was deposited from the Brisbane River, though appearing similar in the field at the time of collection, is in fact highly variable from site to site in terms of mineral composition and textures. Some of the variations reported here may be due to anthropogenic contamination, but clearly more work is required before any firm conclusions can be reached.

Case study 3: Anthropogenic impact on coastal sediments

Along both the south and north coast of Cornwall and Devon, in SW England, there are a series of estuary systems, such as the Camel, Gannel, Hayle, Fal, Fowey, which today are important marine habitats, but are also important areas for tourism, leisure and small-scale fisheries (**Figure 12**). The environments are of such significance that they carry various levels of environmental legislative protection. However, all of these coastal systems have been significantly affected by historic mining activity in their respective fluvial catchments. Up until the Medieval period, alluvial tin placer deposits were worked through a process known as tin streaming, whereby alluvial cassiterite was selectively winnowed from the stream sediments. The fluvial geomorphology of many of the rivers in the area was significantly modified (e.g. Thorndycraft *et al.*, 2004), and downstream, the effect was a significant increase in the rate of siltation within the estuaries. However, subsequent hard-rock mining particularly in the period 1800-1900 for Cu, Pb, Zn and Sn had a major impact on the environmental geochemistry of these estuarine sediments. This was because, during ore processing, tailings were released directly into the adjacent river courses, and these tailings were subsequently deposited within the upper reaches of all of the estuary systems (e.g. Pirrie *et al.*, 2002; Pirrie *et al.*, 2003).

Because the contaminants were released as particulate material, rather than through acid rock drainage, the mineralogy of the tailings wastes is highly important when assessing the long term environmental impact. In most cases, the metals were initially released either as unliberated sulphides such as chalcopyrite, galena, or sphalerite locked with silicates, or liberated sulphide grains which were too small to be recovered (typically <10 μm in size). In some of the estuaries, the high rates of sedimentation were such that the sulphide-rich tailings were rapidly buried. Under reducing conditions, the sulphide minerals are geochemically stable. Thus although bulk geochemical analysis shows that the sediment are exceptionally contaminated with respect to metals such as Cu, Zn and Pb, the automated petrography data show that the metals are locked within sulphides within the sediment profile and are not bioavailable (**Figure 13**). Elsewhere, where the sediments have either been physically reworked by natural processes such as channel migration, or disturbed by human activity, sulphide minerals have been allowed to oxidise with the resultant diagenetic mobility of the metals, resulting in both the growth of secondary mineral species, but also the potential biological uptake of the metals by plants, invertebrates and vertebrates (Pirrie *et al.*, 2009b). Automated petrography of these contaminate coastal sediments has proved to be an important tool in both the assessment of the point sources for the contaminants, but also importantly, in predicting the geochemical stability of the mine waste contaminants.

Summary

Automated petrography analysis can provide a micron-scale view at past and present landscape processes. The SEM-EDS based QEMSCAN solution combines fully-automated, ultra-fast data acquisition with expert software providing quantitative mineral and textural data which can be reported across multiple samples, size fractions, down to a single particle. These contextual data complement conventional bulk-sample mineral and geochemical analysis and optical petrographic microscopy. Automated petrography analysis is here discussed to be a powerful new tool in the study of transport, formation and depositional environments, weathering and diagenetic history, sediment sources and pathways, and in the characterisation of chronostratigraphic sample material. Recent advances in the QEMSCAN Spectral Analysis Engine, including the capability to identify and quantify up to 72 elements, significantly improving clay typing for environmental mineralogy applications.

In exploration geology, the ability to gain fully quantitative mineralogical data in context with high resolution imaging has proven invaluable. Similarly, Knappett *et al.* (2011) in the analysis of Bronze age ceramics from the Aegean, highlighted the significance of mineralogical and geochemical data in context with the imagery of the ceramics. Thus both larger lithic components and the fine groundmass of the ceramics could be simultaneously characterised and imaged, but reported separately. The same would hold true for the analysis of sediments of mixed provenance, or different transport and depositional processes. The potential application of automated petrography in Quaternary Science is enormous, and could revolutionise data capture by allowing the highest possible resolution analysis of records of environmental change.

Acknowledgements

We would like to thank Prof Grant H. McTainsh from Griffith University, Brisbane, Queensland for the courtesy of providing the sample for Figure 9.

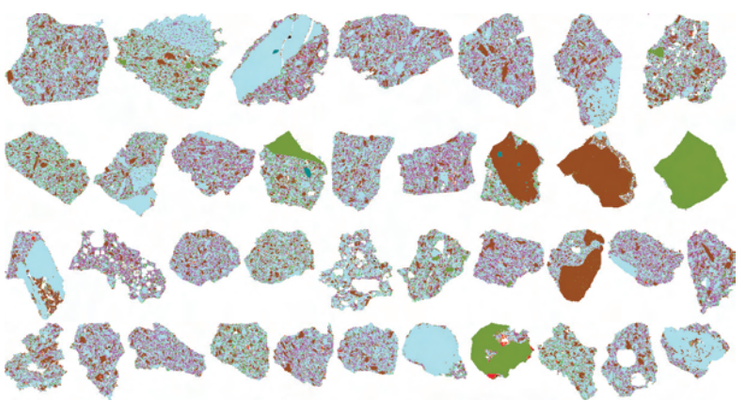


Figure 10. Particles collected in Iceland during the ash fall in 2010 by Stuart Bearhop, University of Exeter. The ash samples reflect the geology of Iceland, with the purple signature showing volcanic glass, the cyan plagioclase, the green olivine, the brown pyroxenes and amphiboles, and the red ilmenite

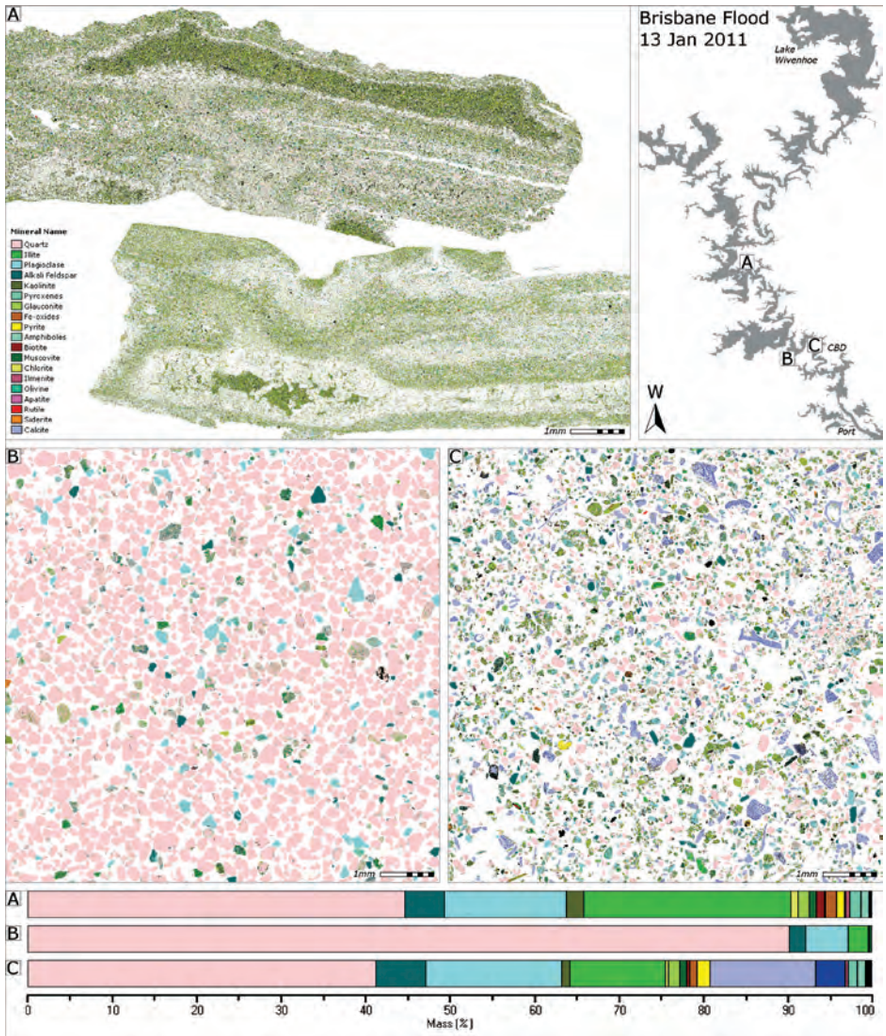


Figure 11. QEMSCAN® compositional maps of fluvial sediment samples collected at three different locations along the Brisbane River following the height of the flood peak (14-16 January 2011). The upper right image indicates the sampling positions along the Brisbane River with: A) Booker Place in Moggill; B) University of Queensland, St Lucia; and C) West End. The upper left image shows the colour-coded mineral map and legend for sample A. The central left and right images show the colour-coded mineral maps for samples B and C. The lower image compares the corresponding modal mineralogy of the samples, as expressed in mass percentages.

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Report

Basking in Bern: A Brief Overview

XVIII INQUA Congress, Bern, Switzerland, July 21st – 27th 2011

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Figure 1. The Aar River flowing past the old city, Bern. Photo: Stephen Chilcott

Introduction

From Thursday the 21st of July, 2011 at the Bern Conference Centre in Switzerland, the movers and shakers and apprentices of Quaternary science began to gather, hastily topping up on caffeinated liquids and butter pastries while conversing about their scientific purposes in life. This was a gathering of the minds and was no ordinary event; it had been four years since the last such meeting. It was the 18th International Union for Quaternary Research (INQUA) Congress. This large and prestigious event attracted over 3000 abstracts from around the globe, with over 1800 oral and 1500 poster papers presented. The next week (21st – 27th July) was filled with informative and thought-provoking Quaternary research, including one rest day devoted to excursions which presented a wide choice to explore the many natural wonders that Switzerland has to offer. The Australasian contingent had a mighty presence in attendance for this conference. Many took the opportunity to venture to the other side of the world to contribute to advancing the wonderful world of Quaternary science.

Presentation Highlights

The conference kicked off with the INQUA General Assembly which included presentations from INQUA Shackleton Medal awardees. 2011 awardee Yuki Sawai gave an excellent summary of his work on tsunami geology in Japan, discussing how evidence for events similar to the 2011 Tohoku tsunami is preserved within the geological record. 2009 awardee and Australian resident Zenobia Jacobs gave an inspiring overview of her work on the application of OSL dating to understanding the behaviour and dispersal of anatomically modern humans.

The scale of this congress meant we were spoiled for choice. The scientific program comprised up to 13 parallel sessions at any given time. Often it was hard to know where to begin and inevitably it was a tough choice deciding which sessions to attend. The distances between some of the session venues meant that it was difficult to switch between talks mid-session unless you were prepared for a quick sprint! However, all sessions were of high quality and showcased the breadth and

state of the art of Quaternary research across the world. The daily afternoon poster sessions with their good supply of coffee allowed delegates the chance to catch up and regroup amidst the latest developments in our science.

There were many sessions, possibly too many, ranging from late Quaternary records of coastal evolution through to glaciations in South America, to the use of isotope proxies as tracers of Quaternary hydrology. Since we could not attend all sessions, our overview will focus on the highlights of certain proceedings.

The first oral session began Thursday afternoon, and included a session on climate and sea level during the last 140ka in the Mediterranean during which generated some heated discussion on the proxies used to define palaeo-sea level. Another session discussed the cause and expression of late Quaternary climate trends. This session boasted a full house and was notably dominated by Australians and included excellent talks by Gerald Nanson, Joshua Larson, and Peter Kershaw.

On the second day, one highlight was the session discussing the spatio-temporal resolution of fossil proxies. Presentations explored the potential and limitations of temporal and spatial multi-site comparisons. Maarten Blaauw's presentation caught people's attention by discussing the pitfalls of tuned proxy archives and the dangers of aligning proxy archives ("wiggle-matching"). Another session which was of interest included discussions of human adaptation to climate change during the Magdalenian in Western and Central Europe, and involved integrations of multi-proxy evidence for environmental change with archaeology. An alternate session focused on the use of terrestrial and lacustrine archives to reconstruct palaeoenvironments, particularly in Europe and the Mediterranean.

Saturday morning included a session discussing the innovative use of stable isotopes to reconstruct hydrologic and climatic records from proxies including loess, ice cores, speleothems, and mammal teeth. One presentation of particular interest, by Cathy Whitlock (Montana State University), dealt with ecological responses to climatic changes at decadal to millennial timescales. This presentation elaborated on the use of palaeoecological data to provide insights across multiple scales, both temporal and spatial, as well as controls of fire-regimes.

After a well earned break on Sunday, which provided the opportunity to explore the sights of Bern and beyond, it was back to the intensity of parallel sessions on Monday. The session on Geoarchaeology showed off the breadth of geoarchaeological studies being carried out from Rajasthan to the High Andes. These studies integrated evidence obtained from different fields such as remote sensing, geomorphology and soil micromorphology with archaeological studies.

As the conference drew to a close, the sessions continued to sustain interest. An interesting session explored the interaction of climate change and cultural dynamics in Western and Central Europe during the Upper Pleistocene. In this session, presentations integrated palaeoenvironmental evidence, for example from molluscs, stable isotopes and loess. The session on Quaternary records of rapid coastal change showcased this rapidly advancing field including studies on co-seismic coastal changes, tsunami deposits and storm deposits, accompanied by a well attended poster session. For those of us who made it to the end of the congress, there was no better way to conclude a great week than with beer and giant pretzels.

Bern, a beautiful city

The host city for INQUA 2011 was a great choice. The old town is small enough to facilitate meeting colleagues after hours, as well as being incredibly beautiful. It seemed quite surreal to be in Bern, and every evening after the progressions was spent enjoying some of the many different sights Bern has to offer. It was especially nice to sit at the brewery enjoying a cold beer amongst new and old friends with a picturesque view over the bear pit, the Aar River and the old town. It certainly was a pleasant change from the hustle and bustle of university life back in Australia. Bern's trams, trains and buses did a great job of taking us to the sessions on time and around town for a bit of sightseeing, and included in our registration pack was a weekly pass for public transport.

Housekeeping

There are always some formalities when these events occur, and the meeting included elections by representatives of each country for the next INQUA President and the location of the next (IXXth) INQUA Congress. I would like congratulate Margaret Avery (Iziko South African Museum) on being elected the new President of INQUA, and its first female president. The city of Nagoya, Japan, was elected to host the 2015 INQUA Congress. I'm looking forward to attending again in 2015, which promises to be another outstanding conference.

Conclusion

As a recent honours graduate, I am pleased to say that this conference was of highest quality and was for me a very educational, well-organised and enjoyable experience. Not only was there a plethora of high quality research, there were plenty of opportunities to catch up with other presenters and discuss their research and applications in greater detail. While less academic - but just as important - the quality and supply of coffee and food for morning and afternoon teas and lunch was excellent and provided sustenance for long hours of concentration and rumination! The helpfulness of all staff involved was exceptional. At a large conference with so many parallel sessions which sometimes required a sprint between conference rooms, their assistance in answering a range of enquiries and providing directions ensured that all sessions ran smoothly. I do also believe that every Australasian oral and poster presented was more than outstanding! It makes me feel that we do great things down in this part of the world. Till 2015, keep up the good work and hope to see you all in Japan.

INQUA2011 Mid-congress field trip:

The Last Glacial Maximum (LGM) and late glacial ice extents in the Rhone Valley, with a focus on the Aletsch Glacier

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On Sunday 24th of July a number of mid-congress field trips were offered by the INQUA2011 Congress organisers, allowing a break from the conference proceedings and an opportunity to experience the amazing glacial landscapes of Switzerland and learn about their Quaternary origins. One of the most appealing for several AQUA members was the opportunity to visit the Aletsch Glacier in the Swiss Alps and learn about glacial periods in an area of active glaciation.

The field trip began with a bus trip from Bern into the Alps, following the course of the River Aare past the scenic lakes of Thun and Brienz. At the head of the valley of the Aare the bus followed the Grimsel Pass road, winding up into the mountains and fresh snow. This road took us past the Räterichsbodensee and Grimselsee, reservoirs of a large alpine hydroelectricity network, to our first stop at Grimsel Pass, at an elevation of 2165 m. Here field trip organiser Meredith Kelly ushered participants off the bus and into the falling

Figure 1. A. The group braves the snowy conditions of Grimsel Pass to discuss the LGM ice extent. B. The gondelbahn ferries participants from the Rhône Valley to Riederalp. C. LGM glacial trimlines carved into the Sparrhorn across the Aletsch Valley. D. The crest of the left-lateral Egesen moraine of the Aletsch Glacier.

snow, an appropriately chilly setting for a discussion of the extent of LGM ice cover in the central Alps. The Rhône ice dome, source of the LGM Rhône and Aare glaciers, was located just to the south of this pass, which was itself covered by around 600 metres of ice. Cosmogenic surface exposure dating has indicated that this ice cover had retreated from the Grimsel Pass region by 14 000-11 300 yr BP (Kelly *et al.*, 2006). Despite the presence of numerous interesting glacial erosional features here, the warmth of the bus was too enticing for an extended examination and the tour soon recommenced.

The current terminus of the Rhône glacier was visible as the bus again navigated the winding alpine roads to descend into the sunny and warm upper Rhône valley. After following the Rhône down to the town of Mörel participants then rode the gondelbahn from the valley floor up to the town of Riederalp, an ascent of 1166 metres. After admiring the magnificent views south across the Rhône Valley to the mountains of Valais, a brief walk brought us to Riederfurka, atop the ridge between the Rhône and Aletsch valleys. This was the picturesque location for a picnic lunch accompanied by the clinking of Swiss cow bells, and the starting point for an afternoon in the Aletsch forest.

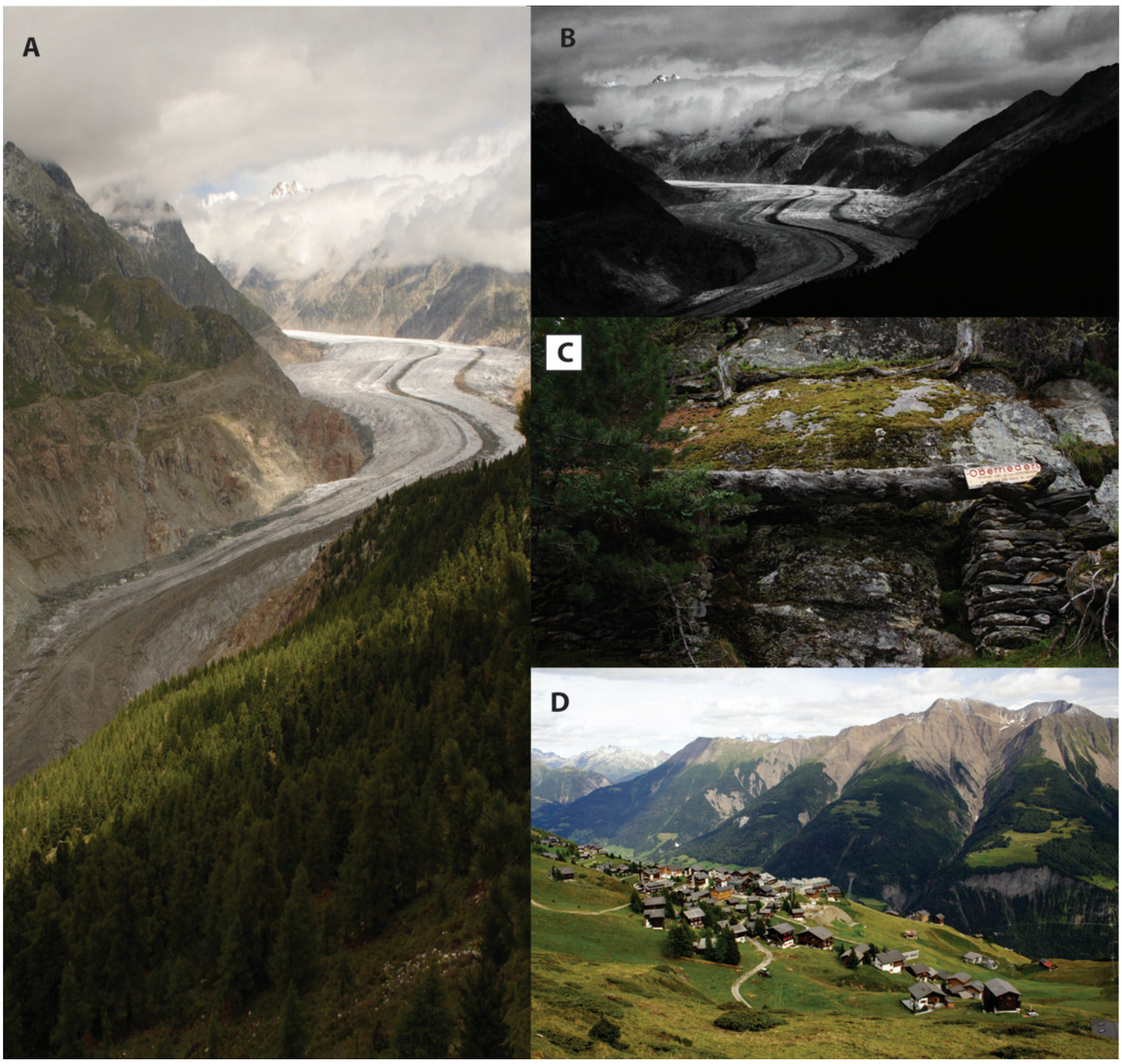

Figure 2. A. The lower extent of the Aletsch Glacier and the Aletsch forest. B. Aletsch Glacier below the Gross Wannenhorn. C. Remains of an 11th-13th century aqueduct. D. Returning to Riederalp and the Rhône Valley.

After lunch participants set off along the Moränenweg, a track traversing the left-lateral moraines of the Aletsch Glacier. Glacial trimlines indicating the LGM ice extent were visible high on the mountains across the Aletsch Valley, clearly preserved in the crystalline bedrock of the central Alps. These and other glacial erosional features in the area indicate that ice flow from the Aletsch region was into the Rhône Valley to the south during the LGM. The Moränenweg followed the crest of a moraine of the Aletsch Glacier deposited during the Egesen stage, a regionally identified period of glacial advance correlated with the Younger Dryas. This period of advance has been dated both by surface exposure dating of boulders on the moraine crest using the cosmogenic nuclide ^{10}Be, and by radiocarbon dating of organic sediments deposited subsequent to deglaciation (Kelly *et al.*, 2004).

Further up the valley the pine and larch forest soon thinned to reveal stunning views of the Aletsch Glacier. At 23 km long and with an ice surface of 86 km^2 it is the longest and largest glacier in continental Europe. The sheer volume of ice contained is staggering, with a depth of 900 metres of ice measured at Concordia, the area of convergence of the three source glaciers, the Great Aletschfirn, Jungfraufirn, and Ewigschneefeld. Perhaps even more remarkable, however, was the evidence of the glacier's former extent in recent periods of glacial advance. In addition to the high LGM glacial trimlines and the Egesen/Younger Dryas moraine, evidence of a greater glacial extent in more recent periods was observed as the group descended to an inner moraine at Chalchofu. This inner lateral moraine was deposited by a series of glacial advances during the Little Ice Age. In the 19th century the glacier reached a maximum of around 3km longer and several hundred metres higher than its current extent.

More evidence of historical glacial retreat was witnessed on the return to Riederfurka, with the remains of an aqueduct situated on the crest of the Little Ice Age moraine. This structure was built between the 11th and 13th centuries and operated until the 16th century, draining water directly from the glacier. Its location high above the current glacier terminus is testament to significant recent glacial retreat. Other human activities were also influenced by the dynamic nature of the glacier in historic times. Access to alpine meadows adjacent to the glacier was formerly facilitated by a route directly across the ice. Glacial retreat after 1860 forced the identification of alternative routes to these pastures, and by the 1940s further retreat had made access impossible (Holzhauser and Zumbühl, 1999).

Continuing along the Little Ice Age moraine and again through the pine and larch of the Aletsch forest, the group soon returned to Riederfurka and spent the remainder of the afternoon enjoying the views and some local beverages in the alpine sunshine. Soon, however, it was time to return to Bern and the group shuffled into the gondelbahn to descend to the Rhône Valley. A short bus journey further down the valley brought us to the shores of Lake Geneva, where we turned east to return to Bern with a new appreciation of late Quaternary glacial landforms in the Swiss Alps.

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Report

INTIMATE meetings at INQUA

Jessica Reeves, Peter Almond, Tim Cohen, Drew Lorrey

Jessica Reeves: SCECE, RMIT University
Peter Almond: Department of Soil and Physical Sciences, Lincoln University
Tim Cohen, School of Earth and Environmental Sciences, University of Wollongong
Drew Lorrey, NIWA

The INQUA congress provided a great opportunity to showcase the advances in the Quaternary science of our region in the session, "Linking Southern Hemisphere multiproxy records and past circulation patterns: AUS-INTIMATE and wider Southern Connections". Saving the best 'til last, the session was on the final day of the congress, in the rather remote "Kaserne Room", part of the Swiss military training academy, with a poster session on the previous day. The session was well attended by both the strong Australasian contingency and our colleagues from the Northern Hemisphere COST-INTIMATE, many of whom we met at their social night on the previous Saturday.

The session comprised 12 oral and 11 poster presentations, by an even mix of Australian and New Zealand researchers. Conditions during the Last Glacial Maximum were featured in several presentations, including New Zealand vegetation, by Rewi Newnham, east Australian dust and vegetation by Lynda Petherick and temperature estimates of New Zealand's South Island from palaeo-glacier modelling by Alice Doughty and pollen and chironomid studies by Marcus Vandergoes and Louise Callard. More broad studies on the last glacial cycle included presentations on alluvial palaeosols of the Flinders Ranges, by Jan-Hendrick May, a synthesis of records from the arid interior from Kat Fitzsimmons and pollen records from east-coast Tasmania, by Lydia Mackenzie and maar lakes near Auckland by Paul Augustinus.

Peter Almond provided an update of the conditions of the critical Kawakawa tephra time slice, from the revised NZ climate event stratigraphy and Steven Phipps provided a road map forward of how modelling can play a more integrative role in the future of the AUS-INTIMATE project. The session ended with a thought provoking paper by Tim Barrows, which looked to link some of the New Zealand,Southern Ocean and Antarctic ice core records as the basis of a more regional event stratigraphy.

Following the talks, many people stayed behind for a discussion on the future of the AUS-INTIMATE project, after a week of disparate coffee break conversations. Drew Lorrey proposed the idea of a new look SHAPE (Southern Hemisphere Assessment of Palaeo Environments) for our third iteration. Details of SHAPE will be further refined at the OZ-INTIMATE meeting at AINSE this month.

An engrossed audience at the AUS-INTIMATE session at INQUA. Image credit: Henk Heijnis.

American Geophysical Union (AGU) Chapman Conference on Climates, Past Landscapes and Civilizations

Santa Fe, New Mexico, USA

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The AGU Chapman Conference on Climates, Past Landscapes and Civilizations took place between March 21st to 25th at the Eldorado Hotel and Spa in Santa Fe, New Mexico, USA. Santa Fe is the capital city of New Mexico and is the third oldest surviving American city founded by European settlers (founded in 1608). There is also evidence of Native American Pueblo villages within the downtown area of Santa Fe dating to 900 AD, making this a highly appropriate setting for the conference. Furthermore, at 2,134 m above sea level, Santa Fe is also the highest capital city within the United States and occurs within a cool semi-arid climate zone, which was readily apparent during the conference, with temperatures ranging from around 0° to 15°C and even some light snow on the second evening of the meeting.

The conference kicked-off with a welcome reception on Monday March 21st, with drinks and nibbles. Most conference delegates were from North America and Europe, with myself and Lincoln Steinberger (PhD student – University of Queensland) being the sole representatives of Australasian institutions. The formal meeting then began early on Tuesday morning with the official welcome and then a session focusing on global perspectives for climate, environmental and societal interactions, including an invited talk by Bill Ruddiman (University of Virginia), who presented a highly topical seminar focussing on whether increase in late Holocene carbon dioxide and methane values were driven by natural or anthropogenic processes. This was followed by presentations examining the role of climate change in agricultural development, sediment response to anthropogenic activity and natural climate change and whether mega-droughts in Asia and North America were synchronous over the last 1,000 years. This was then followed by the poster session, which provided a range of topics and geographic locations, in this session Lincoln presented his research on recent human interactions with the north Queensland rainforest mosaic and Amy Prendergast (Cambridge) provided a palaeoclimatic framework for late Quaternary occupation of North Africa. The next session continued with the global perspectives and included an invited talk by Brian Fagan (University of California, Santa Barbara) that provided an archaeological perspective of 21st century anthropogenic climate change. After lunch the sessions then shifted to specific regional locations,

Figure 1. Conference venue: Eldorado Hotel and Spa in Santa Fe, New Mexico

Figure 2. Pueblo remains at Bandelier National Monument

starting with Africa, with the majority of talks examining late Quaternary change in the Saharan region and then the final session of the day moved to Europe and North Atlantic, with talks focussing on central Europe, Ireland and Greenland.

The second day of the conference began with an invited talk by Harvey Weiss (Yale), who examined the complexity associated with quantifying the collapse of civilizations using examples drawn from the Middle East and the eastern Mediterranean. This was followed by two more presentations focussing on this region and then shifted to East Asia, with six talks examining climate, environmental and societal interactions for this region, including an invited talk by Robert Bettinger (University of California, Davis) looking at the relationship between climate and human behavioural changes on the Loess Plateau of North China for the last 100,000 years. Post lunch there were nine talks examining South Asia, many of the presentations focussed on the Indus River region, the 4.2 ka event and its relationship to the Indus civilization and the Indian monsoon. Wednesday concluded with the conference banquet which was held in the aptly titled Ana Sazi North function room in the Eldorado Hotel.

Thursday incorporated the conference field-trip that was held at the Bandelier National Monument in New Mexico. This was located about one hour's drive north-west of Santa Fe and preserves 10,000 years of human history, including artefacts from nomadic hunter-gatherers who followed game into the mesas and canyons of the reserve and the Ancestral Pueblo people who occupied the region from 1150 to 1550 AD. The most conspicuous vestiges of this occupation are the extensive pueblo remains that occur across Frijoles Canyon. The Pueblos were built from volcanic tuff and the Pueblo people dry farmed maize, beans and squash on nearby mesa tops, which they supplemented with a variety of wild foods. A number of Pueblos are still occupied to the present day within New Mexico and the Ancestral Pueblo people of Bandelier may have moved to these locations from 1550 AD. There is still some debate over why they abandoned the region around the mid-16th century but was probably linked to a combination of overpopulation, resource depletion and climate change – central themes of the conference.

The final day of the conference shifted to Australasia-Pacific, South/Central America and Western North America, with two presentations examining the sub-tropics of eastern Australia and the tropical environments of the Gulf of Carpentaria. The conference ended with a discussion session that examined many of the issues that had been identified over the course of the conference. This included the complexity associated with disentangling the impact of people and climate on landscapes, as well as examining how archaeologists and physical scientists can be brought together to examine this issue. This has not been the first Chapman conference on the themes of climates, past landscapes and people, with more planned in the future, and I would strongly recommend that AQUA members consider attending upcoming Chapman conferences as it provides the opportunity to discuss similar issues we are facing in the Australasian Quaternary community in a small conference setting with like-minded colleagues from across the globe. I would also like to thank the conference convenors, particularly Peter Clift and Liviu Giosan, and the American Geophysical Union for organizing such as interesting and thought-provoking conference.

AQUA Early Career Scientists attend 'Science meets Parliament'

Lydia Mackenzie, Kirsty Wilkes

Lydia Mackenzie: School of Geography, Planning and Environmental Management
University of Queensland
Brisbane, Australia.
Kirsty Wilkes: The School of Behavioural, Cognitive and Social Sciences
University of New England.

During the 2010 AQUA conference held at North Stradbroke Island, Lydia Mackenzie and Kirsty Wilkes presented on their honours research and were awarded attendance to the annual Science meets Parliament (SmP) event held in Canberra. Run by the Federation of Australian Scientific and Technological Societies (FASTS), the two day event brings together scientists from a range of research backgrounds and encourages them to think about the importance of their work within the current economic, political and social context.

On 20 June 2011, over 200 science delegates braved the blustery Canberra weather for Day 1 of SmP held at Old Parliament House. The event was kicked off with a welcome by the FASTS president Dr Cathy Foley. In no time at all Anna-Maria Arabia, CEO of FASTS had the participants energetically discussing and debating the influence of the media, society and political advisers on the Australian political system. This highlighted the key role of the media in broadcasting scientific research to the wider community. John Flannery, Director of Public Affairs and Media (Australian Medical Association) further enlightened the crowd with comments on the current (and difficult) political environment where, in particular, the credibility of climate research has been brought into question. He encouraged scientists to 'make the science local', use simple but catchy arguments and continue working to keep the science in the climate change debate.

For the remainder of the morning prominent journalists and science communicators including Lyndal Curtis (Australian Broadcasting Corporation), James Massola (The Australian), Alex Hart (Channel 7) and Phil Coorey (Sydney Morning Herald) presented ideas on 'turning science into news' and how to promote research outcomes 'in the time it takes a sparkler to burn'. Delegates learnt about the importance of conveying a message 'in the first two lines' and keeping stories 'human' (i.e. what is the real, on-the-ground impact for everyday Australians?). These informative sessions were put into practice after morning tea and coffee in the beautiful Old Parliament House courtyard, with each delegate asked to develop a persuasive and catchy one-minute presentation on the importance of their research to a politician or journalist. This (rather challenging!) exercise taught Lydia and Kirsty how to convey a sharp and snappy summary of their research and to think about the relevance of their work for a political or public audience.

The afternoon session continued this theme with presenters taking the scientific audience through the do's and don'ts of conveying a message to politicians. Just to name a few... *don't* visit a politician for the purpose of giving a lecture, highlighting the lack of funding or discussing the complexity of the research.

Lydia Mackenzie and Kirsty Wilkes at Parliament House on day 2 of SmP. Image credit: Patrick Moss

Do approach a politician with enthusiasm, bold predictions, a friendly attitude and quotable references in hand (Kylie Walker, Australian Academy of Science). Talk in stories not numbers (Dr Richard Denniss, The Australia Institute) and try to emphasise the value for money, cost effectiveness and benefit of early action (Ashley Wells, Director of Hawker Britton Group). This session provided essential tips for the following day, when all delegates would be given the opportunity to attend face-to-face meetings with local MPs and Senators – a real highlight of the SmP event.

Armed with a much improved understanding of science in the political world, delegates ended Day 1 by attending the Gala Dinner held in the Great Hall of Parliament House. During the dinner, the new 'Respect the Science' campaign was launched (www.respectthescience.org.au). The campaign urges Australians to acknowledge the hard work of Australian scientists, to trust the credibility of their scientific research and its ability to inform decision making. An announcement was also made that FASTS would be transforming its name to the new and improved Science and Technology Australia (STA) (www.sta.org.au). "Above all, we rely upon science to inform some of our most critical policy decisions such as the need to tackle dangerous climate change," wrote Prime Minister Julia Gillard PM in response to this year's SmP event and the 'Respect the Science' campaign. "My strongest support for Australia's scientific community and its peak body Science and Technology Australia." The dinner was attended by over 200 people, including 80 MPs and Senators, providing a unique networking opportunity and the chance to fill up on scrumptious food and wine whilst listening to the likes of Annabel Crabb (the lively MC for the evening), Senator Christine Milne, Professor Ian Chubb, The Hon Kim Carr and the Hon John Brumby (keynote speaker).

After a long night of networking it was back to the University House to make some final preparations for the next day's activities and meeting. Day 2 of the SmP event began at New Parliament House with some final tips from the Hon Kim Carr on 'Meeting the Ministers'. Lydia Mackenzie had the opportunity of meeting with her local MP Graham Perret, ALP member for Moreton.

Lydia Mackenzie and Patrick Moss (2nd and 3rd from right) with fellow scientists at the SmP Gala Dinner, Parliament House. Image credit: Lorna Sim / Science & Technology Australia.

The meeting, while briefly interrupted by a call to the chambers, was enjoyable and productive, and gave Lydia a chance to practice the science communication lessons from Day 1. While most interested in scientific research directly relating to his electorate, Mr Perret acknowledged the importance of Quaternary research for the future of Australia. With a steadily growing community in the Moreton region, questions about the impact of climate change on coastal stability, environmental management and effective planning for the future were of specific interest to him. The opportunity to talk with a local MP and discuss her scientific research was one of the main highlights of the SmP event for Lydia.

After the morning meetings, SmP delegates were able to attend the address to the National Press Club by Chief Scientist of Australia, Professor Ian Chubb. During his speech Professor Chubb stressed the value of science to Australia in tackling future 'big issues'. Professor Chubb touched on a key topic raised during the SmP event when he commented that scientific research struggles to enter into mainstream debate around the daily sensationalist news headlines. Not only is scientific communication difficult for the average researcher, it also has to compete with MasterChef finalist updates and celebrities' latest love lives. "My goal is to ensure they [politicians] have no excuses for not having the relevant scientific advice in front of them." Professor Ian Chubb lamented during his address that "too often the scientific discussion gets mixed up with the political debate – or with the political response to the scientific evidence." Delegates were reminded that making science accessible to the broader community through effective communication of research outcomes is important, and that the research community needs to take control of this. After the second day of SmP, attendees were better prepared to take on this challenge.
The final afternoon of SmP gave delegates the opportunity to attend question time and experience politicians in action. Witnessing scientific outcomes being discussed as part of the political debate is one of the outcomes of successful science communication. As Ms Gillard stated, "national leadership requires us to tackle climate change." Seeing scientific advice from a large body of research influencing current policy decisions within the Chamber was another excellent opportunity provided by SmP. To conclude the final day, Senator Christine Milne, Green spokesperson for Climate Change, Innovation, Industry, Science and Research, joined delegates for cocktails in the Parliament Theatre and discussed the importance of 'climate science' in current political debate.

Scientists can benefit significantly from the skills and information provided by the annual SmP event, since scientific communication is the key link between research outcomes and real action. Lydia and Kirsty were thrilled to be granted this opportunity of interacting with fellow scientists, meeting politicians, journalists and policy makers, and being taught how to communicate science in a way that is concise and relevant. A very sincere thank you to AQUA for making it possible.

Report

Australian Research Council outcomes for 2012

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Archaeology was the star performer in the ARC Discovery round DP12. Geochemistry also did rather well in the LIEF grants and Future Fellowships. Congratulations to all the successful applicants, especially those receiving the inaugural DECRA's.

DISCOVERY GRANTS

The Flinders University of South Australia

DP120104435: Prideaux, Dr Gavin J; Bunce, Dr Michael; Ungar, Prof Dr Peter S; van der Kaars, Dr Willem A

Project Title: Faunal responses to environmental change and isolation on an Australian land-bridge island.

Project Summary: Establishing how faunas responded to past isolation and environmental changes offers great potential for predicting long-term impacts of habitat fragmentation. By combining novel methods we will track extinction rates, diet and bodysize shifts on Kangaroo Island, the only known land-bridge island with a fossil record spanning the past 100,000 years.

Total $380,000.00; Primary FoR 0603 Evolutionary Biology

James Cook University

DP120103179: Ulm, Dr Sean G; Wallis, Dr Lynley A; Moss, Dr Patrick T; Sloss, Dr Craig R

Project Title: Naïve island landscapes: people and environmental change in tropical sclerophyll landscapes.

Project Summary: A detailed history of how people in tropical island environments have managed environmental change will be produced for the South Wellesley Archipelago in the Gulf of Carpentaria. The outcomes will provide new insights into the dynamic relationship between people and environment during periods of climate change.

Total $450,000.00; Primary FoR 2101 Archaeology

La Trobe University

DP120100580: Cosgrove, Dr Richard F; Smith, Dr Colin; Roebroeks, Prof Wil; Pike-Tay, Prof Anne

Project Title: Forty-two degrees of latitude: comparative archaeologies of southwest Tasmania and southwest France during the last Ice Age.

Project Summary: The late Pleistocene archaeology of each region represents the end journeys of behaviourally modern humans after leaving Africa at least 70,000 years before. They are similar in age,

preservation and are important in understanding our species' adaptation to climate perturbations and the different cultural responses to these.

Total $232,500.00; Primary FoR 2101 Archaeology

Macquarie University

DP120103519; Sheedy, Dr Kenneth A; Gore, A/Prof Damian B

Project Title: A spring of silver, a treasury in the earth: coinage and wealth in archaic Athens.

Project Summary: The purpose of the project is to study the impact of locally mined silver on the public treasury of the Athenians, and thus on the developing political economy of this important city-state during

the years c.550-480 BC, by examining its employment for the minting of coins.

Total $150,000.00; Primary FoR 2101 Archaeology

DP120103665: Harrison, Prof Sandra P

Project Title: Quantitative reconstructions of Australian climates since the last Interglacial.

Project Summary: A crucial test of the models used to project future climate is how well they reproduce past climates. The project will reconstruct Australian regional climates, from vegetation, fire and runoff records, and use these for climate-model evaluation - helping to provide a more solid basis for management of Australian resources in the future.

Total $500,000.00; Primary FoR 0406 Physical Geography and Environmental Geoscience

Murdoch University

DP120103725: Bunce, Dr Michael; Dortch, Dr Joseph C; Haile, Dr James; Gilbert, A/Prof Marcus T

Project Title: Ancient DNA from cave sediments: a new horizon in the archaeology of Aboriginal Australia.

Project Summary: Archaeological cave deposits at Devil's Lair and nearby sites in south-west Western Australia document 48,000 years of occupation by the

first Australians. Using ancient DNA isolated from cave sediment the project will identify the diversity of plants and animals, thereby providing new insights into past environments and Aboriginal hunter-gatherer practices.

Total $152,000.00; Primary FoR 2101 Archaeology

The Australian National University

DP120100512: Brockwell, Dr Celia J

Project Title: Earth mounds in Northern Australia: archaeological and environmental archives of the mid to late Holocene.

Project Summary: Earth mounds, created and occupied by humans, are a common feature of Australia's northern coastal plains. They can offer unique insights into the formation of this recent landscape, and shed

light on climatic and environmental change, and human/environmental interaction. This study will provide important new data for climate change models.

Total $176,500.00; Primary FoR 2101 Archaeology

DP120103202: Clark, A/Prof Geoffrey R; Reepmeyer, Dr Christian H; Haberle, Dr Simon G; Sachs, A/Prof Julian P; Nero, Prof Karen L

Project Title: Climate change in the abandonment of islands: a high-resolution case study from the tropical Pacific.

Project Summary: Climate change in the last 1000 years is thought to have had negative environmental and societal consequences in the Pacific, particularly in Palau through the occupation and abandonment of

limestone islands. This project uses highresolution data to establish the palaeoclimate and the cultural mechanisms used to cope with climate events.

Total $335,000.00; Primary FoR 2101 Archaeology

DP120102772: Kerr, Dr Ross C; Hughes, Dr Graham O

Project Title: Melting and circulation in Antarctic ice shelf cavities.

Project Summary: This project will explore and model the mechanisms causing the observed increased rate of melting of Antarctica's ice shelves. This understanding is essential for accurate predictions of sea level rise and global thermohaline circulation over the next century, so that their impact on society can be planned for and mitigated.

Total $380,000.00; Primary FoR 0405 Oceanography

The University of Melbourne

DP120103142 Sagona, Prof Antonio G; Lordkipanidze, Prof Dr David

Project Title: Archaeology in the central Caucasus: investigations at Samatvro and Tchkantiskedi.

Project Summary: This archaeological project is the strongest Australian cultural link with the Republic of Georgia, a developing country of considerable strategic importance that borders Russia. A study of Georgia's past heritage will provide a deeper understanding of its contemporary social diversity and complex geographical situation.

Total $253,000.00; Primary FoR 2101 Archaeology

The University of New England

DP120102316: Beck, A/Prof Wendy E; Fullagar, Dr Richard L; Burns, Dr Judith; Kiernan, Dr Kevin W

Project Title: Indigenous heritage: working ancient wetlands for social benefit and cultural understanding.

Project Summary: This research will answer important theoretical and practical questions about Aboriginal community engagement with Heritage research. It will generate significant archaeological outcomes on the

nature of Indigenous occupation in ancient eastern Australian landscapes, and this research will also improve the employability of young Aboriginal people.

Total $575,000.00; Primary FoR 2101 Archaeology

DP120103993: Grave, Dr Peter R; Attenbrow, Dr Valerie J

Project Title: Axes, exchange, social change: new perspectives on Australian hunter-gatherers.

Project Summary: This project refocuses attention on the importance of South East Australia for understanding the role of exchange in social change amongst hunter-gatherers. Our study will develop new perspectives on Aboriginal hunter-gatherer societies by tracing changing patterns of stone axe exchange over time using a new non-destructive provenancing technique (PXRF).

Total $305,000.00; Primary FoR 2101 Archaeology

The University of Queensland

DP120100969: Fairbairn, Dr Andrew S; Baird, Dr Douglas D

Project Title: The emergence of farming beyond the Fertile Crescent at Boncuklu Hoyuk, Central Turkey.

Project Summary: International collaborative research at Boncuklu Hoyuk will identify when farming first spread beyond Asia's Fertile Crescent 10,500 years ago. In answering whether migrating farmers caused this key event in global history it will refine our knowledge of the link between migration and culture change relevant to understanding both past and present.

Total $245,000.00; Primary FoR 2101 Archaeology

DP120101752: Price, Dr Gilbert J; Feng, Dr Yuexing; Joannes-Boyau, Dr Renaud

Project Title: Developing reliable chronologies for extinct Australian Pleistocene megafauna from museum fossil collections.

Project Summary: Our ability to understand the timing of prehistoric extinction events is critical, but can only be achieved by reliable dating methods. This project will adopt several new and exciting methodologies in the direct dating of fossils to determine the chronological sequence and the timing of extinction of the Pleistocene megafauna.

Total $115,000.00; Primary FoR 0403 Geology

DP120101793: Webb, Prof Gregory E; Webster, Dr Jody M; Nothdurft, Dr Luke D; Zhao, Prof Jian-xin; Braga, Prof Dr Juan C; Tudhope, Prof Alexander W

Project Title: Geomorphological development of coral reefs, southern Great Barrier Reef: an integrated record of Holocene palaeoecology and palaeoclimate from cores.

Project Summary: Very little is known about how the Great Barrier Reef (GBR) has responded or may respond to predicted environmental change and/or degradation. The project will reconstruct the recent biological and physical history of reefs in the southern GBR in order to better understand how they may react to future environmental changes.

Total $490,000.00; Primary FoR 0406 Physical Geography and Environmental Geoscience

The University of Sydney

DP120102257: Miller, Prof Margaret C; Beaumont, Dr Lesley A; Paspalas, Dr Stavros A

Project Title: Settlement sustainability and societal change in the ancient Mediterranean: the case of Zagora.

Project Summary: A settlement becomes a community when its physical design supports its social structure and thrives when diversity secures its economic base. Probing the failure of once-prosperous centers like

8th-century BC Zagora will illuminate past approaches to issues of settlement sustainability in the face of environmental, social and economic challenge.

Total $450,000.00; Primary FoR 2101 Archaeology

Monash University

DP120104320: Baker, Dr Patrick J; Cook, Dr Edward R; Palmer, Dr Jonathan G

Project Title: The divergence phenomenon in tree-ring-reconstructed temperatures: global problem or Northern Hemisphere anomaly?

Project Summary: Concerns about recent global warming derive from comparisons of current temperatures and past temperatures reconstructed mainly from tree-rings. There is some evidence that tree-rings are

becoming less sensitive to temperature at some high-latitude sites. The project will determine the scale and extent of this problem across the Southern Hemisphere.

Total $540,000.00; Primary FoR 0406 Physical Geography and Environmental Geoscience

DP120104322: Baker, Dr Patrick J; Mooney, Dr Scott D

Project Title: Has Twentieth Century warming changed southeastern Australia's fire regimes?

Project Summary: This project will reconstruct extreme fire seasons and fire events for the past 500 years in three temperate regions of southeastern Australia. This baseline information will extend our historic records of fire, quantify the controls on fire in our landscapes and place recent catastrophic fire events in historical context.

Total $310,000.00; Primary FoR 0501 Ecological Applications

LIEF

Southern Cross University

LE120100201: Bush, Prof Richard T; Burton, A/Prof Edward D; Scheffers, Dr Sander R; Scheffers, A/Prof Anja M; Rose, A/Prof Andrew L

Project Title: High-resolution laser ablation inductively coupled plasma mass spectrometer for cutting edge geochemistry research.

Project Summary: The new-generation laser ablation inductively coupled plasma mass spectrometer is a highly versatile precise analytical instrument for palaeo-environmental, palaeoclimate, archaeological and geochemical studies. With this instrument Australia will continue to lead the way in cutting-edge geoscience research.

Total $200,000.00; Primary FoR 0402 Geochemistry

The University of Melbourne

LE120100180: Drysdale, Dr Russell N; Woodhead, Prof Jonathan D; Hellstrom, Dr John C; Treble, Dr Pauline C; Baker, Prof Andrew

Project Title: An Australian fluid-inclusion facility for climate-change science

Project Summary: Understanding past temperature and rainfall changes is essential for improving climate projections. The proposed facility will generate new palaeotemperature and palaeorainfall information from cave deposits, leading to a better understanding of natural climate variability and change.

Total $150,000.00; Primary FoR 0402 Geochemistry; Partner/Collaborating Eligible Organisation(s): Australian Nuclear Science and Technology Organisation, The University of New South Wales

The University of Adelaide

LE120100054: Gillanders, Prof Bronwyn M; Robinson, Prof Sharon A; Walker, A/Prof Stewart; Kennedy, Prof Martin J; Watling, A/Prof Jennifer R; Soole, A/Prof Kathleen L; Tibby, Dr John; Guan, Dr Huade W; Cooper, Prof Alan; Ball, Prof Andrew S

Project Title: Stable isotope analysis of environmental and physiological samples.

Project Summary: Mass spectrometers capable of isotope analysis are essential tools for the earth and environmental sciences, physiology and palaeoecology. This project will provide mass spectrometers for both

laboratory and field conditions which will ensure Australia remains at the forefront of international research, attract collaborations and lead to outcomes of global significance.

Total $420,000.00; Primary FoR 0402 Geochemistry; Partner/Collaborating Eligible Organisation(s): Bio Innovation SA, The Flinders University of South Australia, University of Wollongong

Curtin University of Technology

LE120100077: Grice, Prof Kliti; Oliver, Prof Richard P; Charrois, A/Prof Jeffrey W; Greenwood, Dr Paul F; Linge, Dr Kathryn L; Flematti, Dr Gavin R; Tan, Dr Kar-Chun; Dodson, Prof John R

Project Title: Automated preparative gas chromatograph for isolating unique and important organic components for structural identification.

Project Summary: The rapid capability to purify and identify significant and important organic compounds, present at low levels within complex mixtures, is fundamental to geochemistry, plant biology, chemistry, and environmental science. This facility's automated gas chromatograph will assist in isolating and purifying new compounds from microbes, plants, humans, animals, and environmental and geological samples.

Total $150,000.00; Primary FoR 0402 Geochemistry; Partner/Collaborating Eligible Organisation(s): Australian Nuclear Science and Technology Organisation, The University of Western Australia

The Australian National University

LE120100181: Botten, Prof Lindsay C; Leinweber, Prof Derek B; Radom, Prof Leo; Gready, Prof Jill E; England, Prof Matthew H; Mark, Prof Alan E; Blackburn, Prof Hugh M; Hogg, Dr Andrew M; Jakob, Prof Christian; Pitman, Prof Andrew J; Powell, A/Prof Benjamin J; Rasmussen, Prof Kim J; Moresi, Prof Louis N; Yu, Prof Aibing B; Knackstedt, Prof Mark A; Bilek, Prof Marcela M; Ragan, Prof Mark A; Schmidt, Prof Brian P; Muller, Prof Dietmar; Pukala, Dr Tara L; Soria, Prof Julio; Turney, Prof Chris S; Hourigan, Prof Kerry; Adelson, Prof David L; Khanna, A/Prof Rita; Denier, A/Prof Jim; Pailthorpe, Prof Bernard A

Project Title: Strengthening merit-based access and support at the new National Computing Infrastructure petascale supercomputing facility.

Project Summary: World-leading high-performance computing is fundamental to Australia's international research success. This facility will provide access to the new National Computational Infrastructure facility

by world-leading researchers from six research universities, and sustain ground-breaking work in an increasingly competitive environment.

Total $650,000.00; Primary FoR 0401 Atmospheric Sciences; Partner/Collaborating Eligible Organisation(s): Monash University, The University of Adelaide, The University of New South Wales, The University of Queensland, The University of Sydney

LE120100218: Roberts, Prof Andrew P; Heslop, Dr David C; Pillans, Prof Bradley J; De Deckker, Prof Patrick; Lister, Prof Gordon S; Li, Prof Zheng-Xiang; Rosenbaum, Dr Gideon; Vasconcelos, Prof Paulo M; Aitchison, Prof Jonathan C; Pisarevsky, Dr Sergei A; Tohver, Dr Eric; Schmidt, Dr Phillip W; McWilliams, Prof Michael O

Project Title: A world-class rock magnetic facility to support Australian palaeomagnetic and environmental research.

Project Summary: Magnetic properties of rocks and environmental particles provide information about a vast range of geological and environmental processes. We propose to develop a facility that will enable detection and interpretation of these magnetic signals to aid understanding of climate change, mineral exploration, and the geological development of Australia.

Total $254,078.00; Primary FoR 0403 Geology; Partner/Collaborating Eligible Organisation(s): Commonwealth Scientific and Industrial Research Organisation, Curtin University of Technology, The University of Queensland, The University of Sydney, The University of Western Australia

LINKAGE

The University of Western Australia

LP120100310: Grierson, A/Prof Pauline F; Skrzypek, Dr Grzegorz D; Turney, Prof Chris S; Greenwood, Dr Paul F; Cook, Dr Charlotte G; Dogramaci, Dr Shawan

Project Title: Climate-related regime shifts in inland semi-arid ecosystems through ecohydrological proxies.

Project Summary: This project will investigate the dynamics of climate, especially rainfall, of the northwest of Australia over the last few thousand years. Our findings will increase understanding of climate variability and contribute to sustainable management of water and biodiversity in semi-arid Australia.

Total $330,000.00; Primary FoR 0406 Physical Geography and Environmental Geoscience; Partner Organisation(s): Rio Tinto

FUTURE FELLOWSHIPS

The University of Adelaide

FT110100793: McInerney, Asst Prof Francesca A

Project Title: Palaeoclimate reconstructions from the isotopic signatures of fossilised leaf waxes.

Project Summary: This project develops a method for using the chemical signature of fossilised leaf waxes to reconstruct hydrologic change in south-eastern Australia during the Holocene (last 10,000 years) and

Eocene (56-34 million years ago). Understanding climate in the geologic past is essential for testing models and projecting future climate with rising carbon dioxide.

Total $714,418.00; Primary FoR 0402 Geochemistry

The University of Western Australia

FT110100352: Skrzypek, Dr Grzegorz D

Project Title: How warm and how wet? New perspectives on paleoclimate records and hydrological regimes in arid zones of Australia

Project Summary: This project will develop a new and precise palaeotemperature record for southern Australia, and will investigate the hydrologic dynamics of inland Australia. Together, this research will lead

to new discoveries in the way Australian ecosystems respond to climate variability and will enable better understanding of its impacts.

Total $706,128.00; Primary FoR 0402 Geochemistry

DECRA

The University of Melbourne

DE120102504: Pickering, Dr Robyn

Project Title: Old stalagmites, new techniques: South African palaeoclimate records linked to early human evolution.

Project Summary: Caves in South Africa preserve a rich hominin (early human) fossil and archaeological record dating back over two million years. This project uses stalagmites from various South African caves to

provide a new, detailed record of the palaeoclimate, forming the backdrop to the evolutionary changes that took place during this period.

Total $375,000.00; Primary FoR 0402 Geochemistry

The University of Queensland

DE120101533: Price, Dr Gilbert J

Project Title: Understanding faunal responses to climate change and environmental perturbations through the Quaternary in north-eastern Australia.

Project Summary: To understand life, it is essential to know its history; and to conserve biodiversity into the future, it is essential to learn lessons from the past. This project will use information from the fossil record to identify climate- and human-forced threats to the environment and fully understand the adaptive response of native fauna to climate change.

Total $375,000.00; Primary FoR 0403 Geology

The University of Melbourne

DE120102530: Sniderman, Dr J.M. Kale

Project Title: Are northern- and southern-hemisphere climates synchronised on orbital timescales? New insight into Earth's climate history.

Project Summary: This project will generate a very high (1-100 year) resolution palaeoclimate record in order to test whether southern hemisphere ice age climate changes 1.5 million years ago were synchronised with the northern hemisphere. This will provide a critical test of theories on the mechanisms driving glacial-interglacial climate changes.

Total $375,000.00; Primary FoR 0406 Physical Geography and Environmental Geoscience

University of Wollongong

DE120103033: May, Dr Jan-Hendrik

Project Title: The wet and dry of tropical Australia: past, present and future.

Project Summary: This project investigates rivers in the tropical 'Top End' of Australia and how flooding and long-term flow have changed over the recent geologic past. Such knowledge adds important components to our understanding of past climate in Australia, and is crucial in assessing the impacts of future global change on the continent's water resources.

Total $375,000.00; Primary FoR 0406 Physical Geography and Environmental Geoscience

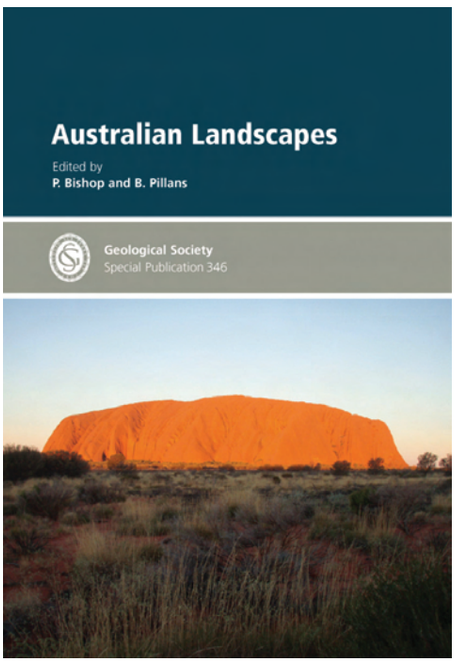
The Australian National University

DE120100069: Calo, Dr Ambra

Project Title: The archaeology of the north coast of Bali: a strategic crossroads in early trans-Asiatic exchange.

Project Summary: New archaeological excavations on the north coast of Bali and a comparative study of materials across Southeast Asia aim to document the growth of Trans-Asiatic exchange networks during the Late Metal Age, and particularly the strategic significance of Bali and eastern Indonesia for the trade in spices that linked Asia with the Mediterranean.

Total $375,000.00; Primary FoR 2101 Archaeology



Australian Landscapes

Paul Bishop and Brad Pillans (Editors)
Geological Society Special Publication 346
The Geological Society, London 2010
ISBN 978 1 86239 314 1
Hardcover GBP90.00
Available online: http://sp.lyellcollection.org/content/346/1.toc

Just as Dorothea Mackellar in the early twentieth century evoked sentiments of wonder at her "land of sweeping plains", so too do the contributors to Paul Bishop and Brad Pillans' edited volume express a boundless scientific curiosity for the Australian landscape. This 328-page volume represents the third publication devoted to understanding the vagaries of geomorphology in the driest inhabited continent. It arrives more 30 years since the most recently published book on the topic (Davies and Williams, 1978), and over 40 years since the publication of the first (Jennings and Mabbutt, 1967). The intervening period has seen substantial advances in scientific techniques including geochronology and remote sensing, which have enabled more quantifiable understanding of the age of landscapes, and rates of erosion and denudation responsible for geomorphic change. However, as the editors are firm in pointing out, despite increasingly routine applications of these techniques, the enduring themes which confronted early workers often remain the driving issues. Bishop and Pillans make the link between the old and the recent by highlighting confirmation by recent work of the antiquity of the Australian landscape, hypotheses put forward many decades ago by Joe Jennings and his academic descendants. It is fitting, then, that the volume is dedicated to Martin Williams and John Chappell, academic descendants of Jennings and "twin towers in Australian geomorphology", as Jim Bowler describes them in his dedication.

The book does not aspire to cover all aspects of Australian geomorphology, but it achieves an excellent coverage of many of the key issues in the discipline. It is divided into 15 thematic chapters by authors who are experts in their fields. The chapters cover various aspects of Australian geomorphology, from modern coastal processes to reviews on the application of geochronological techniques to investigate the antiquity of the Australian continent. The fact that many of the chapters are collaborative efforts ensures a solid and in-depth investigation of each topic.

The majority of chapters incorporate geochronological data as a means to understand landscape evolution and change, further highlighting the advance of the geomorphic discipline through the use of such techniques. These chapters address a variety of landscape questions. In particular, the versatility of cosmogenic nuclides as a suite of geochronologic techniques is apparent in their application to address the level of tectonic activity and uplift on the continent (Quigley et al.), the influence of glaciations in Tasmania (Colhoun et al.), and erosion rates across the mainland (Heimsath et al.). Cosmogenic nuclides, in combination with luminescence dating techniques, have also proven useful for understanding the formation and development of the dunefields and stony deserts of the extensive arid zone (Fujioka and Chappell). Other geochronologic techniques are applied to investigate the formation of caves (Osborne), the antiquity of the western Australian cratons (Chivas and Atlhopheng), and the response of subaerial landscapes to climatic fluctuations in the semi-arid Flinders Ranges (Haberlah et al.). Geochronology has also proven useful in elucidating the interaction between humans and their environment, enabling attempts to quantify the nature and timing of archaeological site occupation (Holdaway and Fanning).

The development of remote sensing techniques, and the advent of Google Earth, have allowed for innovative investigations into landscape formation on large scales. This has been achieved for new mapping of morphologic variability in the desert dunefields (Hesse), as well as submarine investigations of the offshore Murray River mouth (Schmidt et al.), and of the planated bedrock surface which dominates offshore New South Wales (Thom et al.). The volume also includes chapters on modern process geomorphology, addressing fluvial (Bishop and Goldrick), semi-arid (Dunkerley) and coastal (Nott; Travers et al.) landscapes.

Although the volume does not cover all environments or timescales, it provides a broad overview of current issues in geomorphology in Australia. The chapters provide new perspectives and approaches to long-standing questions, while also generating new issues and challenging our understanding of the nature of the Australian landscape. As such, it is a highly useful and timely book for researchers, teachers and students alike.

The book is fully indexed. It may be purchased through the Geological Society and Amazon, and individual chapters are available online for a smaller fee (USD30.00).

- Davies JL, Williams MAJ (eds) 1978. Landform evolution in Australasia. Australian National University Press, Canberra.
- Jennings JN, Mabbutt JA (eds) 1967. Landform studies from Australia and New Guinea. Australian National University Press, Canberra.

Review by Kathryn Fitzsimmons
Department of Human Evolution
Max Planck Institute for Evolutionary Anthropology
Leipzig, Germany

A study of molluscs applied to the palaeoenvironmental reconstruction of the Gulf of Carpentaria, Australia, and phylogeny of the Corbulidae (Bivalvia)

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There are three integral components to this thesis. One part, published as an article, contains the formal species description of two new bivalves of the family Corbulidae. The taxon *Lentidium dalyfluvialis* is a freshwater species whose known distribution is restricted to the Daly River in the Northern Territory, northern Australia. The other taxon, *Lentidium origolacus*, was the dominant mollusc in the Gulf of Carpentaria, also in northern Australia, in lower sea-levels than those of the present (~80–12 ka), during which the environment was largely non-marine. This species still occurs in the modern Gulf of Carpentaria, with its known current distribution in the south-eastern estuaries of the region. No non-marine corbulids have previously been described from Australia.

This study also presents a molecular phylogenetic study of the family Corbulidae, using the ribosomal genes 18S rRNA, 28S rRNA, and a dataset merging the two. This analysis distinguishes, for the first time, a non-marine clade of corbulids (of which the two above-mentioned species form a part) comprising the genera *Lentidium* and *Potamocorbula*, as well as the genus *Erodona*, the latter currently, and inappropriately, belonging to the family Erodonidae. These findings have implications for the taxonomy of the family. It is suggested herein that the subfamilies Lentidiinae and Potamocorbulinae, in addition to the family Erodonidae, are taxonomically redundant, and that these three genera ought to be placed within the same subfamily (alternatively family, although this is only briefly discussed in this study). Additionally, shell morphological comparisons between these non-marine taxa and selected marine species of the same family consolidate the hypothesis that this non-marine clade is a distinct group of Corbulidae *sensu lato*. These molecular/morphological results are also important in that this non-marine group comprises species that are ecologically significant and, in certain environments, extremely abundant. In the palaeo-record this has been shown for instance in the Gulf of Carpentaria with *L. origolacus*, whereas other species have proven highly invasive in the modern environment. The recognition of such an ecologically important group may therefore provide direction in future studies applicable to palaeocological- and palaeoenvironmental reconstruction, invasive species ecology- and management, and further phylogenetic investigation of bivalves.

Another integral component of this study is the palaeoenvironmental reconstruction of the Gulf of Carpentaria throughout the Last Interglacial period (~130 ka), based on the molluscan fauna obtained from six sediment cores, MD-28 to MD-33, with a focus on core MD-32. A chronological account of molluscs obtained from these cores provides a palaeohistory of the gulf, which is accompanied by cluster analysis of MD-32. This analysis defines seven assemblage zones, three of which are decidedly non-marine, one that is arguably non-marine, and three zones that are marine in species composition. Ultimately, a trace-element analysis of shells of *L. origolacus* provides an additional independent interpretation of the non-marine environmental conditions in the gulf. These results, based on Ba/Ca, Sr/Ca, Mg/Ca, Fe/Ca, Mn/Ca, U/Ca and Na/Ca, show that these environments fluctuated considerably with regards to for example continental input, oxygen levels and salinity levels in the non-marine lake systems. These analyses, comprising palaeoecology and geochemistry, are the first to investigate molluscs from the Gulf of Carpentaria in order to elucidate the palaeoenvironments of the region.

Pointless Spinifex? An Investigation of Indigenous Use of Spinifex throughout Australia

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European settlement had substantive impacts on much of Indigenous Australia, resulting in the loss of knowledge about certain technologies and practices: this is especially true in relation to the use of plants. Despite its distribution across more than one-quarter of the Australian continent and its widespread use by Indigenous peoples, relatively little research has been undertaken on spinifex grasses and their associated technologies. While aware of the inherent limitations of ethnographic literature and museum based collections, this thesis investigates Indigenous uses of spinifex, reaffirming some existing knowledge and bringing to light new information. Particular emphasis is given to lesser known uses of spinifex, focusing on building narratives based on ethnographic records including photographs and objects in the South Australian Museum and Melbourne Museum collections.

Traditionally the two dominant and most widely known uses of spinifex were the production of resin, which was employed for hafting and repairing, and as cladding in shelter construction. This research reveals that spinifex resin was also used for ornament manufacture, ceremonial and sorcery objects, healing and possibly even in rock-art production. Other uses of spinifex included fishing and trapping, fibre-work, medicinal purposes, as a food source, in games, fuel for fire and subsequently for hunting, light, heat and communication, minimising water loss in water carriers, wrapping objects and shoring wells. Prior to this research, these uses had received little, if any, attention in the published literature. Specifically, our understanding of material culture objects such as spinifex nets and resin figurines have greatly benefited from the study of these objects within museum collections. In conjunction to this positive, museum information has been improved by being added to and/or corrected by findings through this study.

Although time consuming to collect and process, spinifex resin was widely used probably owing to its highly desirable properties. A number of common processing techniques were employed throughout Australia and contrary to the majority of recorded accounts, several factors suggest that women played an important role in these processes. Resin obtained from ant nests rather than threshing the plants themselves does not appear to have been commonly used and is likely to be a method which developed after European settlement. The analysis of adhesive specimens held in museums has provided a framework for the visual non-invasive identification of spinifex resin.

This research has revealed substantive new information regarding Indigenous use of spinifex. Spinifex grasses were highly valued in Indigenous societies and as traditional Indigenous knowledge coupled with Western science of the broader Australian Research Council Spinifex Project demonstrates, spinifex has many potential applications worthy of future investigation.

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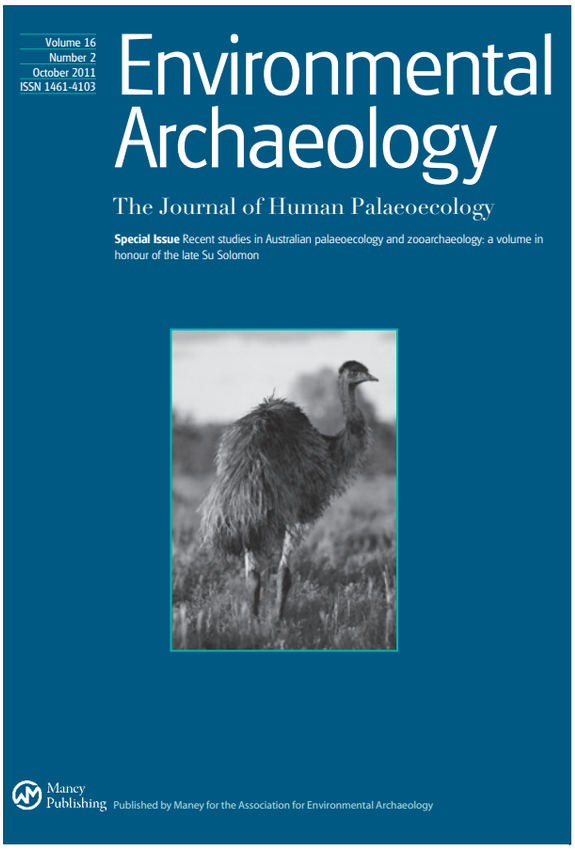

2011 Journal Special Issue

Environmental Archaeology: The Journal of Human Palaeoecology
Special Issue: Recent studies in Australian palaeoecology and zooarchaeology: a volume in honour of the late Su Solomon
Volume 16, Issue 2
October 2011
ISSN 1461-4103
Guest Editors: Jillian Garvey and Judith Field

Recent studies in Australian palaeoecology and zooarchaeology: A volume in honour of the late Su Solomon
Jillian Garvey and Judith Field

Diet and health at Chinikihá, Chiapas, Mexico: some preliminary results
Coral Montero López, Luis Fernando Núñez, Pedro Morales, Edith Cienfuegos and Francisco Otero

Modern emu (*Dromaius novaehollandiae*) butchery, economic utility and analogues for the Australian archaeological record
Jillian Garvey, Brett Cochrane, Judith Field and Chris Boney

Testing the impact of environmental zone on experimental taphonomic faunal models
Melanie Fillios

Crocodile ecology and the taphonomy of early Australasian sites
Michael C. Westaway, Jessica C. Thompson, Walter B. Wood and Jackson Njau

Late Holocene mollusc exploitation and changing near-shore environments, a case study from the coastal margin of Blue Mud Bay, northern Australia
Patrick Faulkner

The antics of ants: ants as agents of bioturbation in a midden deposit in South-east Queensland
Richard Robins and Andrew Robins

Palaeoecological evidence associated with earth mounds of the Murray Riverine Plain, south-eastern Australia
Sarah Martin

Instructions To Authors

Research papers, conference reports, book reviews and other articles

Preparation of the text

- The manuscript should be prepared using a word processor, with double spacing, wide margins and text in 12 point Ariel font, and preferably as a Word document. Please limit the word limit of the manuscript to 6000 words; shorter papers will also be considered.
- Please provide an abstract of no more than 200 words.
- Structure the article as you would any scientific paper, including introduction, methods, results, discussion and conclusion sections. Subheadings can be included.
- Please include a title page, including the title of the paper and author details: the name(s) of the author(s), their affiliations, fax numbers and email addresses. In the case of more than one author, please indicate to whom the correspondence should be addressed.
- Present table and figure captions on separate pages at the end of the manuscript. Do NOT embed figures and tables in the document.

References

- Please ensure that the references cited in the text are consistent with those in the reference list. It is preferable not to refer to references within the abstract. Unpublished results and personal communications should be acknowledged in the text but not in the reference list. References cited as "in press" imply that the paper has been accepted for publication.
- Citations in the text should consist of the surname of the author(s) followed by a comma then the year of the publication in parentheses. eg. (Quaternarist, 2000) (Quaternarist and Palynology, 2000) (Quaternarist *et al.*, 2000). Do not use italics.
- The reference list should contain all authors of a paper, the year of publication, the title of the article/chapter, the full name of the journal or book (if relevant) italicised, the editors of any books, volume and page numbers. See examples below.

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Quaternarist, A.B., Palynologist, C.D. and Geomorphologist, E.F., 2000. *A Guide to Happy Quaternary Studies*. Fun Book Company, Sydney. 300 pp.

Tables and figures

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