VOLUME 34 | NUMBER 1 | JULY 2017

Quaternary AUSTRALASIA

AQUA Auckland conference

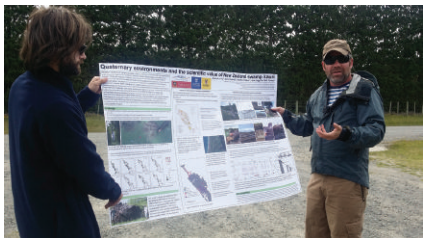
Science communication

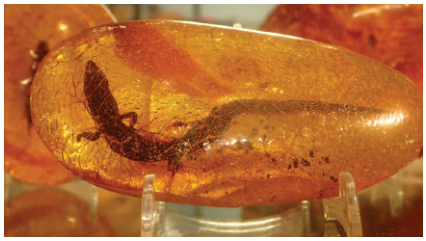
Vale Ignacio Martinez

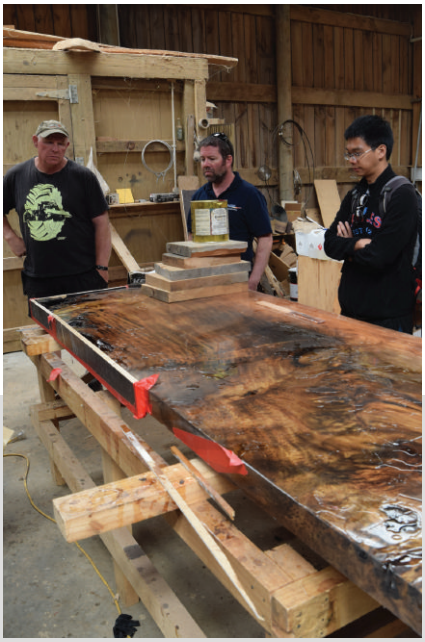
AQUA BIENNIAL MEETING:
Quaternary perspectives from the City of Sails

POST CONFERENCE FIELD TRIP: KAURI AND THE QUATERNARY OF NORTHLAND

All photos Allen Gontz







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Front cover photo:

The majestic Tane Mahuta (*Agathis australis*) in the Waipoua Forest, Northland. (Photo credit: Allen Gontz).

Coring the Lagoon at Hazards. See Notes from the Field. (Photo credit: Michael-Shawn Fletcher).

EDITORIAL

Dear fellow Quaternarists,

Many of you will have followed the recent political events which prompted the world-wide 'March for Science' protests, and incredulity at the US government's choice of a 'proud' climate-change denier as their Secretary of the Interior.

Never before has the gap between scientists and non-scientists been so publicised and scrutinised.

Lynda Petherick and Erin Hall, in their contribution to this edition of QA: 'Is science silent if it stays in the lab' have outlined a history of scientific communication and the loss of 'recognition of the expertise and authority of scientists'. Their article discusses that, as scientists, we need to develop skills to 'effectively communicate to the layperson', not only in ways the non-scientist can comprehend, but also via the medium the non-scientist prefers to access; be it Twitter, YouTube or independent media outlets such as The Conversation.

Emily Field's report on 'Science meets Parliament' also discusses the demise of scientific authority. The presenters at 'Science meets Parliament' urged participants to recognise that science must develop as a form of entertainment; to be popularised and made 'interesting' for it to have impact (in media-speak; 'clickbait'). Many of us will bemoan the perceived 'dumbing down' of our work, but it is up to all of us to develop our own happy medium between authentic science and popular communication.

This edition of Quaternary Australasia includes a series of reports on the 2016 Auckland AQUA Conference. The conference was huge success, both professionally and socially. All the AQUA conference articles in this issue have been penned by the AQUA 2016 student travel prize recipients. Their reports outline not only the conference events, but also reflect the impact the conference and the associated field trips had on these students.

A big congratulations to our student travel prize recipients, Deidre Ryan, Lydia Mckenzie, Emily Field, Briony Chamberlayne. Elyssa De Carli and Matt Ryan. Each of the above recipients, as well as many other students, presented at the conference. This provided a wonderful opportunity for these students, as early career scientists, to hone their communication skills.

The student presentation awards committee were given the difficult task of selecting the best student presentations. The eventual winners were Emily Field (Scientist meets Parliament), Briony Chamberlayne (GNS Quaternary Techniques), Ellen Corrick (best student talk) and Martin Ankor (best poster).

Scott Mooney, in his Presidents Pen, refers to the labour intensive effort of applying for research funding (I am sure many of us have been here). Needless to say, for many researchers the continuation of current, or the initiation of future research projects is heavily dependent on funding success. The need for clear, concise, written communication in everyday language is vital in these applications. Successful funding also provides the means for researchers to offer research and travel opportunities to students, and so encourages our next generation of scientists.

So, it is with great delight the AQUA community thanks the anonymous benefactor of a significant donation. These funds will be used to support young AQUA researchers as they develop their communication skills and meet with like-minded scientists at conferences. Never to forget, today's students will be tomorrow's great scientists. Importantly, our young scientists regularly (and proficiently) use social media when communicating with their peers (hence potential increases in 'clickbait'). With this in mind, I echo the words of Hon. Kim Carr ('Scientist meets Parliament') ... " I am staying 'optimistic".

Yours Quaternarily,

Carol Smith and Sanja van Huet

Editors

PRESIDENT'S PEN

Firstly, thank you to Drew Lorrey, Paul Augustinus and their team for organising the 2016 AQUA Auckland Conference; it was a great meeting and I am sure we were all re-energised by the great science happening across Australasia.

Wow: hasn't the year flown by! As I write this a third of the year has gone, and I suspect that by the time you read this, almost a half of it will have disappeared. My first half of the year is teaching-light and I always start with grand plans for finishing projects and writing... and then I am astonished by how much time the ARC DP process takes (ditto DECRA, LIEF or in the case of New Zealanders – the Marsden Fund). In Australia, late April is the time of the year when ARC 'assignments' trickle in. Although I suspect the Council doesn't take much notice of the reviews I labour over, I will continue my participation, but grudgingly. (I don't think any of the 176 members of the ARC College of Experts publish within our field, but I could be wrong.) I suspect research funding in New Zealand is equally laborious, frustrating and career defining (or limiting). Good luck to everyone who has submitted a proposal.

To much happier things: AQUA was recently the recipient of a (substantial cash) donation. The donors, luminaries in the Australian Quaternary world, want to remain anonymous and I will respect their wishes. This money will be added to our (relatively healthy) accounts so that we can continue to support young researchers to attend conferences. We are grateful to receive donations, so if you were wondering how you might contribute to the Australasian Quaternary community, we'd love to hear from you.

There has been lots of change in the AQUA Exec Committee lately. Duanne White (who was Secretary for longer than I can remember) and Lydia Mackenzie (Treasurer since 2015) have recently moved on. I should also acknowledge that our immediate past President, Helen Bostock, was our Communications and IT Co-ordinator until recently. My sincere thanks to all of them. We have recruited new people to replace all of these positions. I'd like to welcome Emily Field (Secretary), Georgy Falster (Treasurer) and Haidee Cadd (Information Technology Editor). It is great to have some young researchers to energise the Committee.

As you probably know, AQUA acknowledges outstanding contributions to Australasian Quaternary science or to our Association with Life Membership. At the 2016 Biennial Meeting in Auckland we announced that Matt McGlone has been added to our list of luminaries. Matt's career was eloquently summarized by Belinda Jeursen in the last QA (vol. 33(2), December 2016) and so I won't repeat anything beyond adding my personal congratulations and fervent hope that I get to hear more of his limericks one day.

Finally: we will work on getting our www page (http://aqua.org.au) back up to date ASAP. In the meantime, don't forget that the AQUA Facebook page (www.facebook.com/groups/435804017 38/) is a great way to communicate with our community.

Scott Mooney *AQUA President*

MEET A MEMBER OF THE AQUA EXECUTIVE COMMITTEE

GEORGINA FALSTER, AQUA TREASURER

I am in the third and (hopefully) final year of my PhD studies at the University of Adelaide. A lifetime love of science led me to complete a B.Sc of Science – also at Adelaide Uni – with an Honours year spent investigating the sedimentology and carbonate isotope stratigraphy of a Precambrian basin in southern India. After graduation, I spent two years in the petroleum industry, where I did stints in the sedimentology and unconventional resources teams, as well as working as a wellsite geologist in the Cooper Basin. However, I fairly soon realised that the life of a petroleum geologist was not for me, and returned with relief to university to commence a PhD in palaeoclimate with Dr. Jonathan Tyler.

For my PhD research, I am investigating climate variation in southern Australia around the Last Glacial Maximum. I am particularly interested in the production and analysis of high-resolution time series, as well as the use of various carbonate isotope geochemical proxies to try to disentangle past temperature and hydrological change.

I like to spend as much of my spare time as possible in the outdoors – I love trail running, open water swimming, surf lifesaving, skiing, and hiking, and am lucky enough to live in a state where it is possible to do all of these (except one) in such beautiful natural surroundings! During the week I am also a very enthusiastic cook, and frequently inflict vegan cooking/baking experiments on my long-suffering family and friends.

NEWS

ENVIRONMENTAL RECONSTRUCTION WORKSHOP, UNIVERSITY OF MELBOURNE, MARCH 2017

Michael-Shawn Fletcher, School of Geography, Melbourne University.

A BRIGHT FUTURE

In March, 2017, around 40 academics and students gathered at the University of Melbourne for an Environmental Reconstruction workshop. This workshop was aimed at drawing together people working in this space who were in and around Melbourne at the time. The workshop was attended by a very diverse array of people working on topics such as climate modelling, archaeology, human-environment interactions, sclerochronology, palaeofire, vegetation change, palaeoclimate archives (speleothems, lake sediments, etc), landscape evolution, aquatic ecosystem dynamics, ecological change in the Tertiary, landscape animations and simulations, and a range of other topics. It truly was an impressive collection of people working on environmental change and I am excited by what is in store for the future of our sciences. The day also provided the opportunity for networking and, with hope, has sparked some new and exciting collaborations.

A CALL FOR BETTER DATA AVAILABILITY AND CONSOLIDATED ONLINE RESOURCE

The latter part of the day was spent discussing the needs of the community, which resoundingly focussed on data availability and sharing. From this, we hope to spark a discussion and, perhaps some action. The general consensus was that, despite the explicit requirement of many funding schemes, data availability was worryingly poor in Australia. This is also despite there being a plethora of existing platforms for data sharing, such as NEOTOMA, NOAA, Global Charcoal Database, etc. Further, there are a host of online and freely available platforms for analysis and data mining that are scattered and often hard to locate. The group was unanimous in their desire for a consolidated platform where these options can be accessed. Various options were discussed, including the AQUA landing page as a portal for the various data sharing platforms and analysis tools.

Figure 1: Participants at the recent Environmental Reconstruction Workshop enjoy a well-earned (and large) meal.

A CRIPPLING LACK OF COMPLIANCE – A PERSONAL VIEW

Here I venture a personal view on what I see as the reticence of Australian data producers to make their data freely available. I know the ARC explicitly requires applicants to state that data generated in funded projects be made available once published, yet a search through some of the data share platforms highlights our region as a relatively barren datascape. This contrasts with the seeming overabundance of data available in the northern hemisphere. This dearth of data in our region cripples attempts to synthesise data from across regions and has real implications for our sciences. Meta analyses are revealing new insights about processes that operate at various spatial and temporal scales that are often invisible to localised datasets. Historical and geographic reasons aside (e.g. longevity, population size), my personal view is that this is largely cultural. It's just not in our makeup to get our data online for others to use after we publish. Often (myself included) it is not even a thought after publishing a paper, as I've moved on to the next question, or I have the data in so many fragmented files that only true immersion back in to that headspace would allow successful extraction of the data and configuration for whatever idiosyncrasies are inherent in the platform I chose to use. So much so, I've only managed to put one dataset on NEOTOMA thus far! I think it's time for a shift. I will endeavour to put all my published data online and I urge others to do the same. If not for the betterment of scientific knowledge, then to satisfy the legal requirements of many of our funders.

THERMOLUMINESCENCE LABORATORY AT UNIVERSITY OF WOLLONGONG TO CLOSE

David Price (Principle Research Fellow) informs us that the thermoluminescence (TL) laboratory which has operated in the School of Earth & Environmental Sciences at The University of Wollongong for over 31 years will be cease to operate at the end of this year. During this time the laboratory has analysed over 5000 samples contributing to more than 130 refereed publications. Apart from anything else this will leave numerous electrons in their trapped states just waiting to receive the energy to escape and return to their ground states.

VALE IGNACIO MARTINEZ

Helen Bostock

Jose Ignacio Martinez was born in Bogota on May 15, 1956. His parents were Don Jose Martinez and Dona Narcisa Rodriguez. Ignacio received his Degree in Geology in 1982 from the National University of Colombia. He was then awarded a British Government scholarship to undertake an MSc in micropalaeontology at Hull University under the supervision of Professor Martin Brazier. His thesis was completed in 1987. Ignacio then returned to Colombia to work at Ingeominas (Geological Survey Columbia) as a micropalaeontological consultant for the petroleum industry.

In 1989, he obtained an Australian Government postgraduate scholarship to study at the Australian National University, and completed his PhD in 1994. The common theme of his doctoral work was to examine a north-south transect in the Tasman Sea and he used foraminifera to determine oceanographic changes during the late Quaternary. He quickly gained much insight into modern oceanographic processes in the Australian region and used foraminifera to determine past movements of oceanographic fronts and water masses through time. Ignacio was the first researcher to clearly document the latitudinal shift of the Tasman Front.

His studies at ANU coincided with the commencement of Quaternary marine research, and numerous students, postdoctoral fellows and international visitors came to the Geology Department. It was an exciting time and Ignacio was part of the research group and a successful participant in the new research. International dinners and excursions were enjoyable activities in which Ignacio and his family took part.

Ignacio was a very productive worker. He would identify and count up to 300 planktic foraminifera per sample in 20 minutes, a feat rarely achieved by others. He also had a collegial attitude that animated activities in the laboratory.

He gained a broad knowledge of Quaternary issues and was able to define the 'big picture' concerning changes in the Tasman Sea over time [during his PhD]. He did the same for the eastern Indian Ocean during his post-doctoral fellowship, also held at ANU.

Ignacio participated in the ODP Leg 132 near Vanuatu and produced a significant paper on an extraordinary high-resolution sequence that covered the last glacial/interglacial cycle over >40m of sedimentation. The surprise was that the sediments were coloured a deep chocolate brown due to the high input of terrigenous material at sea.

Figure 1: Ignacio Martinez with his son Daniel at EAFIT University late September 2016, examining coral samples in a geology teaching laboratory.
(Photo credit: Martinez family).

In 1998, Ignacio returned to Colombia with his family and took a Professorship with the University of EAFIT in Medellin. He taught geology and his field of specialization, micropalaeontology and biostratigraphy. He also continued his ocean research and participated in scientific cruises in equatorial Pacific and Panama.

After his return to Colombia, Ignacio received a number of awards: in 1999, he was honoured by the Alejandro Angel Escobar Fundacion; in 2002 he received a research award from the EAFIT University; in 2008, he was elected as corresponding member of the Colombian Academy of Sciences; and in 2013 he received an award from the Colombian Geological Society entitled: 'Distinction Fundadores Luis Guillermo Duran – Padre Jesus Emilio Ramirez'

Ignacio was one of the leaders in his field throughout Latin America. He used his expertise of foraminifera in studies on the upper Cretaceous of the Colombian region. He was frequently consulted on these microorganisms which were used as biostratigraphic and palaeoecological tools that spanned various times; from the upper Cretaceous of eastern Colombia to the Cenozoic of the Colombian-Caribbean region. He authored over 60 scientific papers, which are valuable for their clarity and innovation. More recently, he commenced working on Holocene climate change records in sedimentary terraces of Ro Cauca in Colombia, this time looking at a fluvial environment.

Due to his broad knowledge of South American geology and palaeontology, Ignacio Martinez served for many years on the board of the international multidisciplinary journal *Palaeogeography, Palaeoclimatology, Palaeoecology*. He was also a member of the PAGES Scientific Committee for several years and was highly regarded for his services and advice concerning the South American Quaternary.

Ten years ago, Ignacio was diagnosed with a brain tumour but retained his good sense of humour and returned to work after treatment. Eventually, the disease returned and Ignacio died at age 60, in December 2016.

Ignacio is sadly missed, not only by his Australian colleagues, but by all those who were taught by him and worked with him in Colombia. He leaves behind an enormous legacy in the Colombian geological sciences.

Our sympathy goes to his wife Ingrid and his two children Luisa and Daniel. The latter is completing a BSc (Hons) at ANU, following in the footsteps of his father.

CORING TRIP TO HAZARDS LAGOON, FREYCINET PENINSULA, TASMANIA

Michael-Shawn Fletcher

School of Geography, Melbourne University.

In May 2017 the palaeoecology research team at the University of Melbourne ventured to Freycinet National Park, Tasmania, to core Hazards Lagoon (Figure 1). This site had been previously cored and analysed by Lydia Mackenzie and Patrick Moss, revealing around 24,000 years of deposition at the site.

This new study is the basis for Joseph Alexander's Masters research project in the School of Geography, University of Melbourne, which seeks to understand the spatial pattern and ecological impacts of rapid climate change in Tasmania during the Antarctic Cold Reversal (ACR). Joe is analysing two cores that span this intriguing interval: one from Hazards Lagoon and one from Lake Rolleston in Tasmania's West Coast Range. Given the relative remoteness of Hazards Lagoon, we employed a water taxi to transport our platform and coring gear to Hazard's Beach, which, in the 30 kmph winds, resulted in a few wet salty bodies and plenty to laugh about (Figure 2).

From the beach, we had to portage the gear 1 km to the site (multiple trips required) and, after probing extensively across the area proximal to the previous core site, we settled on a ca. 4m deep section of sediment and set to work in the beautiful surrounds.

Between muddy wading, swimming in Wineglass Bay, surveying the area with our new drone (for science of course) and around 15-20 km walking per day through the lovely national park to and from our core site, we successfully retrieved 3.7 m of beautiful sediment from Hazards Lagoon.

We even managed a 2.5 m core from a dune-bound swamp behind the Hazards Beach dune system on our way out.

Next stop is ANSTO for Joe, where the cores will be ITRAX scanned before subsampling and plenty of lab work that will help unravel the mysteries of the ACR in southeast Australia!

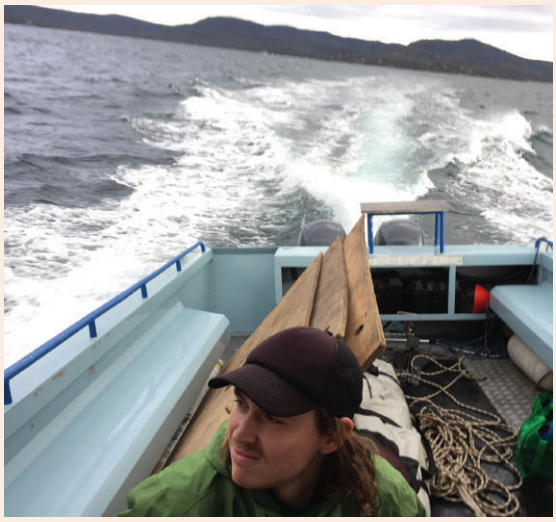
Top: Figure 1: Aerial view of Hazards Lagoon, Wineglass Bay.

Middle left: Figure 2: En-route to Hazards Beach.

Middle: Figure 3: Coring the Lagoon at Hazards.

Middle right: Figure 4: Core from Hazards Lagoon.

Bottom: Figure 5: Coring the dune-bound swamp in the Hazards dune system. (All photos Michael-Shawn Fletcher).



IS SCIENCE SILENT IF IT STAYS IN THE LAB?

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ABSTRACT

Clear communication of scientific findings is crucial for increasing public awareness and for reaching policy-makers. Here we provide a brief overview of the history of scientific communication to provide the context for how and why we should be thinking about communicating our research to the general public. The article contains a series of links for inspiration and further information.

1. A VERY BRIEF HISTORY OF SCIENCE COMMUNICATION

"We live in a society exquisitely dependent on science and technology, in which hardly anyone knows anything about science and technology" (Sagan, 1990).

The concept of communicating scientific ideas to the general public is not a new one. Technological advances and relaxed legislation in England and France during the early-/mid-19th century initiated the publication of popular scientific periodicals to an increasingly educated public (Sheets-Pyenson, 1985). Early popular science periodicals recognized the importance of using diagrams and figures to support scientific text (Sheets-Pyenson, 1985). "Also, to aid their reader's comprehension, periodicals often tried to eliminate technical language. The *London Journal of Arts and Sciences*, for example, contended that technical terminology 'precludes both perspicacity and common sense'." (Sheets-Pyenson, 1985 p. 551). The periodicals published a mixture of scientific reports and findings, and encouraged their non-expert subscribers to conduct their own scientific experiments with day-to-day materials (Sheets-Pyenson, 1985). In the early 20th century there was an "almost-missionary zeal of a few leading scientists" (Logan, 2001 p.137) in America, towards increasing the public understanding to apply to municipal affairs and to improve quality of life (Logan, 2001). As the 20th century progressed, so did the idea that scientific understanding raised the individual's confidence (Bronowski, 1973; Holton, 1993; Silver, 1998) and provided the "capacity to create a modern, industrial, self-critical, tolerant and democratic society" (Logan, 2001 p.138). Technological developments in the late 20th century provided a platform to disseminate scientific ideas to the general public. Books, television series, documentaries and televised public debates involving prominent scientists such as Carl Sagan, Stephen Hawking, Richard Dawkins, Brian Cox and Neil deGrasse Tyson stimulated a wider interest in the natural world. Carl Sagan's 1980 *Cosmos: A Personal Voyage* is one of the most widely watched TV series in the world ever, viewed by hundreds of millions of people (Achenbach, 2014).

By the early 21st century it had become increasingly apparent that public understanding of science is "critical for a society increasingly affected by scientific developments and policies influenced by scientific expertise" (Corbett and Durfee, 2004 p.130). Despite this, in recent years, there has been an apparent divorce of science from society, which has been largely attributed to four factors (Benneworth, 2009):

- Loss of recognition of the expertise and authority of scientists,
- Changes in the way scientific research is conducted i.e. increased interdisciplinary research,
- Advances in communication methods (e.g. social media), and,
- The so-called "democratic deficit" (i.e. a perceived lack of democracy in policy decision-making).

2. THE MAD SCIENTIST: PUBLIC PERCEPTION AND MISTRUST

Communication is dependent on relationships, which take time to develop. Trust is an essential component – an element that can be difficult to establish. Mistrust in scientists seems to have developed post-World War II, following the development and (crucially) use of the atomic bomb, nerve gas and rocket-powered missiles (Brooks, 2012). Although the attitude of the public towards scientists has softened, the general mistrust of science and scientists is prevalent in the media (Wynne, 2006).

In earlier times, impressions of a scientist ranged from the mystic (e.g. the alchemist), to the adventurous explorer (e.g. Livingstone), to the naturalist (e.g. Darwin). From the 20th century, public perception seems to have somewhat narrowed. As indicated by the iconic "Draw-A-Scientist" test, children from a young (i.e. preschool) age perceive scientists as balding, middle-aged white men

in lab coats (Chambers, 1983). Stereotypes popularized in the modern media tend to depict scientists as mad lunatics (e.g. Mary Shelley's *Frankenstein*), socially awkward nerds (e.g. *Big Bang Theory*) or evil geniuses (e.g. Dr. Josef Heiter in *The Human Centipede*). These stereotypes are not relatable to the general public, and are generally humourless, further fostering wariness and suspicion both in scientists and science.

Mistrust, partially built on stereotypes, undermines the reliability of scientific findings. This opens the door in the media for so-called "debates", which are actually cases of belief vs. fact e.g. Creationism vs. Darwinism. Celebrities are not afraid to get into the mix, which can result in the dissemination of misinformation, potentially to legions of fans. Such as occurred in 2016, when American rapper B.o.B used Twitter to express his view that the Earth was flat, based on his observation that the horizon did not curve. A fact-based tweet in response from Neil de Grasse Tyson (somehow) culminated in a rap battle. B.o.B released a 3:30 min rap called "Flatline", which included the disturbing lyrics "Globalists see me as a threat. Free thinking, got the world at my neck," "Indoctrinated in a cult called science. And graduated to a club full of liars," and "Aye, Neil Tyson need to loosen up his vest. They'll probably write that man one hell of a check." De Grasse Tyson's response was a rap of his own, ending with the line "Dude, to be clear: Being five centuries regressed in your reasoning doesn't mean we all can't still like your music."

Closer to home, recently elected Hamilton City Councillor Siggi Henry, an anti-fluoride campaigner, espoused her opinions in a www.stuff.co.nz article that "health experts and "smarty pants" scientists have brainwashed the public over fluoride", claiming that "she knows better" and is "more informed on the issue than [the scientists]" (Leaman, 2016). In email communication with the New Zealand City of Hamilton mayor, Councillor Henry stated that "the Ministry [of Health] data supporting the fluoridation of water cannot be trusted." Following a rebuttal statement from University of Waikato scientists, where they declared that the anti-fluoride campaigners had abused the relevant science, Henry replied "because they [scientists] think they are so smarty-pants, they think they can say whatever they like and we should just take it. The more educated you are in a field, the narrower your thinking becomes. I'm not so hot on these academics... sitting in comfy chairs up on their hill. I've studied this subject for over 20 years, I know a little more than they do." (Leaman, 2016). Councillor Henry did not produce any data or studies to support her comments, which contradict the findings of many studies (Sutton et al., 2015) e.g. the effects of fluoridated water on IQ in New Zealand (e.g. Broadbent et al., 2015).

Negative perceptions and mistrust of scientists and their data has the potential to permeate and be reflected in policymaking. Major issues like climate change, immunisation and genetic modification have polarised and panicked the general public (Corbett and Durfee, 2004), when there is actually general agreement in the scientific community. For example, 97% of actively publishing climate scientists agree that recent increases in global temperature are extremely likely to be caused by human activity (Doran and Kendall Zimmerman, 2009; Anderegg et al., 2010). However, only 47% of US citizens are aware of this consensus (http://www.pollingreport.com/enviro.htm). The current President of the United States has made his opinion on climate change clear through his actions e.g. the elimination of funding for climate change research in his 2018 budget, the appointment of a climate change sceptic as Head of the Environmental Protection Agency, and let's not forget his frequent and expressive use of Twitter ("Climate change is a myth created by the Chinese").

Discrediting the validity and authenticity of the data produced by experts reflects a lack of trust of science –a fundamental component for the uptake and acceptance of scientific findings (Wynne, 1992). There also seems to be a lack of understanding of the research process –peer-review practises are rarely mentioned, while argument and debate between scientists is seen as a weakness, rather than a progression towards increased understanding. The mistrust is further fostered by a lack of definitive black and white answers in science – the concept that science will "never be finished", that investigations, discovery and development are ongoing (du Sautoy, 2016).

3. WHY SHOULD WE COMMUNICATE SCIENCE TO THE GENERAL PUBLIC?

Motivations for communicating science to non-experts ranges from institutional, to strategic, to economic, to cultural, to societal (Osborne, 2000). For the individual scientist, motivations might be reflected in skill development, career enhancement and enhanced quality of research (Research-Council-UK, 2010). An effort to communicate scientific findings can raise a scientist's national and international profile, lead to increased networking opportunities, new collaborations, additional funding, increased quantity and/or quality of postgraduate students (Research-Council-UK, 2010). Scientists may also feel a sense of duty to raise awareness of the value of scientific research to society (Research-Council-UK, 2010). Perhaps there is also the drive to try help the public be better informed about science, and provide something

that is both beneficial and useful for people. The ability to effectively communicate to the layperson not only makes science more accessible, but can "make science more diverse and inclusive" (Feliú-Mójer, 2015 n.p.).

Efforts to make science more accessible to the general public are evidenced by the increasing number of popular science shows on TV. However, even these do not necessarily accurately portray the scientific consensus in an accurate light. Following his recent reproduction of Sagan's *Cosmos, Family Guy* creator Seth McFarlane expressed dismay in the current relationship between science and television (Achenbach, 2014). McFarlane stated that even fact-based science channels present "fluff", interpreted as "...a symptom of the bizarre fear of science that's taken hold." (Achenbach, 2014). For example, in 2013 the Discovery Channel presented their Shark Week "documentary" *Megalodon: The Monster Shark that Lives*, suggesting that the 20m long shark who lived during the Cenozoic was still alive today. The programme showed actors pretending to be scientists looking for Megalodon, and was met with strong criticism from the scientific community (Ludwig, 2014). As stated by shark expert Dr. David Shiffman, of University of Miami's Abess Center for Ecosystem Science and Policy, "If this Megalodon special had aired on the Syfy Channel, I probably would have loved it... But Discovery bills itself as the premier science education television station in the world and they're perpetuating this utter nonsense." (Ludwig, 2014 n.p.). There are many similar examples across scientific disciplines, where misinformation is presented, or where a debate is created where none really exists e.g. the dinosaurian origins of birds (Hone, 2012).

There is an emerging recognition that, as scientists, the onus is on us to communicate scientific ideas (Brownell et al., 2013). However, as noted by Brownwell et al. (2013), "While scientists are thoroughly trained in research methodologies, analytical skills, and the ability to communicate with other scientists, they usually receive no explicit training in communication of scientific concepts to a layperson audience" (p.E6). Many universities are beginning to offer courses and programmes in scientific communication. For example, Victoria University of Wellington offers undergraduate courses in the "Science and Society" minor (e.g. SCIE 311 Scientific Communication). The Australian National University offers a coursework Master of Science Communication. Postgraduate programmes are also offered at institutes such as MIT and Imperial College London. While there is growing consensus that responsibility lies with us as scientists, it is also clear that communication is a two-way street.

4. HOW DO WE COMMUNICATE SCIENCE?

The key in communicating scientific findings is to engage the audience (Feliú-Mójer, 2015 n.p.). People typically tend to be interested in exciting "sexy" science (e.g. "Have all other alien species destroyed themselves?" (Hildebrand, 2017)), or something relevant or helpful to their own life (e.g. "Kaikoura earthquake moved the South Island, research shows" (Mitchell, 2017), "13 reasons you need to drink more wine" (Tate, 2017)). The target audience and the type of science presented are key factors in selecting an engaging medium (Table 1 at the end of this article).

4.1 TRADITIONAL METHODS

By convention we publish our findings in journals. As academics, we avoid the direct high costs of subscriptions through University libraries and access to e.g. researchgate.net, academia.edu, Linkedin etc. For those who do not have the same liberties, the high cost of accessing journal articles can be a major deterrent. As of April 2017, the cost of buying access to a single journal article published by Elsevier (e.g. *Quaternary Science Reviews, Quaternary International, Palaeogeography Palaeoclimatology Palaeoecology, Quaternary Research*) is USD35.95 (~AUD48, ~NZD51) + taxes. Wiley (e.g. *Journal of Quaternary Science*) sell article pdfs for USD38 (~AUD50, ~NZD54), but also offer read only (i.e. no saving, no printing) options through the ReadCube app to view on a cloud (USD15; ~AUD20, ~NZD21), or to rent for 48 hours (USD6, ~AUD8, ~NZD9). *Nature* articles are available to buy for USD32 (~AUD42, ~NZD46), or as read-only through ReadCube on a cloud (USD9.99; ~AUD13, ~NZD14) or for rent (USD3.99; ~AUD5, ~NZD6). *Nature Geoscience* follows the same pricing structure, but does have some free articles. *Science* articles can be purchased for USD30 (~AUD40, ~NZD43) for 1 day access to download, save and print. *Proceedings of the National Academy of Sciences* articles can be rented for two days for USD10 (~AUD13, NZD14). These high costs effectively provide a barrier to communication with the general public.

However, for many journals (including those previously listed) authors now have the option of offering their articles for open access (i.e. to be available to both subscribers and the general public for free), for a fee (to the author/institute). Another option is for the author to self-archive their manuscripts to their institute's repository, to be made available to the general public after a stated embargo period (e.g. 24 months from publication – you will need to check with the specific journal). For more information about publishing open access

with Elsevier, see https://www.elsevier.com/about/open-science/open-access. For Wiley, see http://onlinelibrary.wiley.com/journal/10.1002/(ISSN)1099-1417/homepage/FundedAccess.html. There are also an increasing number of fully open access journals (e.g. *Royal Society Open Science, PLOS Biology, GSA Today* etc.). As with author's providing open access to their individual articles, these open access journals are reliant on scientists' willingness to publish in them i.e. "buy-in".

"It's easy(ish) to write journal articles about science communication projects. That's an output. An outcome is a lasting impact for the people concerned." (Wilson, 2016).

In terms of the media, traditional methods of communication include print and newspapers, magazines, TV and radio. Through these methods, the communication is filtered through a middle-man: the media. As such, the communication lines are indirect, and reliant on the media's portrayal of the science and the affiliated limitations/uncertainties (Corbett and Durfee, 2004). Frequently there is no background into the scientific process(es) or context (e.g. social, economic, political) (Corbett and Durfee, 2004). The interface between scientists and journalists can be complex, frequently underscored by different agendas and different lingo (Peters, 2013). In saying that, it is crucial to keep engaging with the "traditional" media; an excellent example is the effective communication of the science behind the November 2016 Kaikoura earthquake by geologists from Victoria University of Wellington.

4.2 LIVE METHODS

Live methods of communication have had varying popularity through time. The Christmas Lectures organized by the Royal Institution of Great Britain have been running since 1824, with live television broadcasts since 1966 (James, 2007). Internationally renowned scientists such as Michael Faraday and Humphry Davy frequently gave Christmas Lectures to popularize science, specifically targeting the 15-20 year old age bracket (James, 2007). Scientific debates, Q&As and TED talks are also effective ways of communicating science to the general public, although once again, these tend to target those predisposed and/or already interested in science. The recent AQUA meeting in Auckland had two excellent public lectures scheduled (presented by Marcus Vandergoes and Chris Turney), although unfortunately attendance from the public was a bit low.

The traditional public lecture has recently evolved to be more interactive with the audience (Bultitude, 2011). The live presentation of "bite-sized" pieces of information has been recently popularized by endeavors such as Café Scientific, Three Minute Thesis Competition, Dance Your Thesis Away.

4.3 ONLINE METHODS OF COMMUNICATION

The exponential growth of the popularity of social media has meant that it is increasingly easy to communicate with non-experts. Blogs, Twitter, Facebook and YouTube have made scientific findings more accessible to the general public (Bik and Goldstein, 2013). On the flipside, they have also provided platforms for individuals to promote opinion masked as fact. A suitable example is the particularly misleading YouTube clip *What they haven't told you about climate change* (https://www.youtube.com/watch?v=RkdbSxyXftc) starring Patrick Moore, one of the co-founders of Greenpeace. Moore spends 4:54 minutes debunking human-induced global warming using just enough science to make it plausible to a non-expert. He does not mention any credentials or qualifications in climate science. On the positive, there are many excellent educational clips on YouTube e.g. *In the field with John Tibby*, on coring lagoons on Fraser Island (https://www.youtube.com/watch?v=qYh1lmRjPpU). Posting videos of field work (which we often do in amazing locations) and even lab work on YouTube are a quick and straightforward means of promotion, and assist in removing some of the mystery surrounding what we actually do.

Blogs are a useful tool for summarising scientific findings or topics of interest, and there are a number of excellent science blogs on the web e.g. ScienceAlert (www.sciencealert.com), an Australian blog internationally ranked number 1 in March 2017 by Feedspot (http://blog.feedspot.com/science_blogs/). Other popular science blogs include New Scientist, Scientific American and WIRED. A key factor does still seem to be accessibility for non-experts, with demographic surveys indicate that scientific blogs are predominantly accessed by those already predisposed to science. In saying that, an interested non-expert can't access something if it is not there to begin with.

Of course, to counter legitimate scientific blogs there are many claiming fraud and conspiracy. For example, "The Deplorable Science Blog" (https://realclimatescience.com/) encourages government employees to become whistle-blowers, speaking out against the multi-billion dollar, "mafia-like" climate change conspiracy. The existence of these belief-based blogs highlight the opinion versus fact debate, and reinforce the need for peer-reviewed science to be accessible to the general public.

If you are interested in establishing a scientific blog, then the following website (along with many others) has some good advice: https://www.theguardian.com/science/2014/apr/17/science-blog-wellcome-trust-writing-prize. Tips include finding your own niche, using (properly referenced) images and videos to enhance your

text, and to think of the blog as part of a conversation to stimulate the reader's thinking (Oakes, 2014). And don't be afraid to advertise your blog on other media platforms! (Oakes, 2014). There are a number of websites that host blogs for free e.g. http://wordpress.com and http://blogger.com. These blog sites are easy to use, with a variety of free templates/layouts. If you are unsure if you want to commit to a serial blog, then it is common practice to ask about posting as a guest on an established blog (Bik and Goldstein, 2013).

5. WHERE TO FROM HERE...?

The need for effective scientific communication is increasingly recognized. The annual 2016 survey from the Australian Academy of Sciences (for Earth scientists) included the question: "Rate how well you think the Earth Sciences community communicates the impact of Earth sciences" in various sub-disciplines. It is in our best interests to promote our scientific findings to non-experts, to reach as many people as possible, beyond the "science-friendly". Honest communication removes the perceived mystique around scientists, and makes science more accessible.

For those interested in getting into science communication, recommended "top tips" include (Bultitude, 2011):

- Know your audience: Who are you trying to communicating with? Bear in mind that the "general public" is diverse. There are unlimited subgroups, each with their own prejudices, interests and concerns.
- Think creatively: Challenge your audience, and yourself. Think long-term in terms of developing your communications skills and engaging your audience.
- Learn from others experiences: See what other people have done, learn from other's mistakes and successes. The following websites are open-access online repositories:
  - *Informal Science*: www.informalscience.org
  - *Collective Memory*: http://collectivememory.britishscienceassociation.org/
  - *Research2practice:* www.research2practice.org
  - *The Exhibit Files:* http://www.exhibitfiles.org/
- Evaluate your own activities: Reflect, monitor attendance, estimate the impact. There are a number of toolkits available for self-evaluation e.g. *Evaluation: Practical Guidelines* (Research Councils UK, 2011), *Ingenious Evaluation toolkit* (RAEng, n.d.), *The User Friendly Guide* (Frechtling Westat, 2010).
- Enjoy yourself! "Enthusiasm is infectious... remember that communication is fundamentally a two-way process – so you should be learning and engaging as much as members of your audience" (p. 15)

For information and inspiration, try visiting *The New Zealand Science Media Centre* (http://www.sciencemediacentre.co.nz/tag/science-communication/) and *Inspiring Australia's Science Communication Toolkit* (http://inspiringaustralia.net.au/toolkit/). And whether you choose to communicate through open-access journal, newspaper, radio, public talks, YouTube, podcasts, blogs or social media (or "other"!), remember the four key things: enthusiasm, clarity, observation, knowledge (Radford, 2011).

"Our task is not just to train more scientists but also to deepen public understanding of science" (Sagan, 1990).

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Table 1: Advantages and disadvantages of various media (Bultitude, 2011).

MEDIUM	ADVANTAGES	DISADVANTAGES
Traditional journalism (both print and broadcast) e.g.: • Newspapers • Magazines • TV • Radio	Large potential audiences (potentially millions of people) High quality due to being overseen by professionals (e.g. journalists) Traditionally recognised as agenda setting Audience selection is possible through appropriate choice of publication/programme	Scientists lack control of how the media covers their work Tends towards one-way communication Frequently provides a limited or superficial focus
Live or face-to-face events e.g.: • Public lectures • Science Centres and Museums • Debates & dialogue • Science busking • Sci-art • Science cafes • Science Festivals	More personal – involves a direct interaction between scientists and publics Scientists are able to better control the content Engenders two-way communication Can involve partnering with other external organisations with complementary expertise	Limited audience reach (tens to thousands of people) Resource intensive, leading to low sustainability of activities Can be criticised for only attracting audiences with a pre-existing interest
Online interactions e.g.: • Internet sites incl. online journalism • Blogs, wikis and podcasting • Facebook, twitter and other social media • Citizen Science	Large potential audiences (potentially millions of people) Can allow direct interaction between scientists and publics Initial content can be controlled by the scientists... Caters for both one-way and two-way communication, depending on audience's preference Always accessible; suits the audience's time preferences	Can encourage superficial or 'jokey' interactions ...but it is very difficult to control how the content is picked up by others Requires regular attention to maintain profile Requires key communication skills that may not be immediately apparent

AQUA CONFERENCE 2016
KEYNOTE AND PUBLIC SCIENCE LECTURE SPEAKERS

Matt Ryan

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Over the course of the AQUA 2016 conference, we were treated to three excellent keynote addresses and two public science lectures.

The opening day of the conference was concluded with a public science lecture on the paleoclimate history of Lake Ohau presented by Dr Marcus Vandergoes (*GNS Science*). Marcus explained how two ~17,000 year-long annually resolved sediment cores retrieved from the lake have the potential to decipher the phasing of high frequency climate modes in Southern New Zealand. The coring system at the site was the first use of a globally transportable hydraulic piston corer. Micropaleontological studies from these cores, and other short cores, from Lake Ohau indicate a significant change in fire regime at 1400 A.D. This was interpreted as an initial burning period following the arrival of Polynesians.

The theme of Polynesian expansion into South Island New Zealand was continued in the keynote address by Professor Atholl Anderson (*ANU*) the following day. Atholl discussed the role of climate change in South Polynesian colonization and cultural development AD 1200-1800. He demonstrated that the focus of agricultural sites and forts, beginning in the fifteenth century, is skewed strongly toward the upper North Island. These cultural constructions become less developed to virtually absent increasingly further south. This north-south gradient of economic opportunity has its origins in a deteriorating climate and may have been more profound than as yet been envisaged.

Professor Chris Turney (*University of New South Wales*) presented the second public science lecture, taking us "Back to the Future". Chris showed how the warmth of the Last Interglacial (LIG; 135-116 ka) can provide a past analogue to assess the future stability of the Antarctic Ice Sheets. Recent studies have modelled the Antarctic ice sheets contribution to future global sea level rise range, as being from negligible to substantial (>7m). Reconstructed sea-levels during the LIG suggest significant ice mass loss from both Greenland and Antarctic ice sheets, contributing to a global sea level rise of 6.6 to 9.4 metres above present day. However, reconstructions of past climate and models of the LIG are variable. Chris revealed how LIG ice at the Antarctic continents surface is being studied to provide a detailed record of warming during the Last Interglacial.

The penultimate keynote address was given by Dr Matt McGlone, on the thermophilous shrub *Ascarina lucida* and the related climatic interpretation of the NZ Quaternary. Matt explained that *Ascarina* can be considered a super fossil, as it is easily identified, well represented, occurs in a wide range of deposition sites and is highly informative due to its intolerance to drought and frost. Terrestrial pollen studies for the early Holocene (~12-8 ka) New Zealand lowlands suggest the climate was wet and tropical. The abundance of *Ascarina lucida* in those records suggests winters were likely drier and frost-free (warm), with wetter, cloudier, cool summers. Matt concluded that the reduced seasonality regime between 12-8 ka may be related to a faster warming of the Southern Ocean than the oceans north of the Subtropical Front, and weaker westerlies producing fewer fronts in winter and weaker highs in summer.

The closing keynote address was presented inside the crater of a 20,000-year-old extinct volcano at the conference dinner held at Villa Maria estate by Associate Professor Phil Shane. Phil's presentation, about the "long life of the Rangitoto volcano", discussed recent drilling carried out through the volcano's edifice. The data suggests that Rangitoto, the youngest and largest volcano in the 'monogenetic' Auckland Volcanic Field (AVF), displays evidence for an early commencement with activity up to 6000 cal years BP. The main voluminous shield-building phase occurred at 650-550 cal years BP. The final phase of activity (~550-500 cal years BP) was explosive and less voluminous, producing scoria cones at the summit and contained more diversity in magma composition, sourced from different depths in the mantle. This activity suggests that major periods of volcanism in 'monogenetic' basalt fields occur at centres that have experienced multiple eruption episodes. Phil concluded by suggesting that hazard scenarios for regions traditionally classified as 'monogenetic' need to encompass the possibility of prolonged episodes of activity and reawakening of volcanoes.

REPORT ON THE SESSIONS

Elyssa De Carli

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The AQUA Biennial Meeting held in Auckland from the 5-9th December 2016 showcased recent research conducted by members of the AQUA community. The sessions were diverse and covered many aspects of environmental and human change over the Quaternary period. Session themes included coastal dynamics, tephras, Australian peats, speleothems, human-environment interactions, and Southern Hemisphere climatic variability. Open Science sessions introduced topics ranging from thresholds in ecological regime shifts in southeast Asia, to tectonics as drivers of river disequilibria in southeastern Australia, and regional synchrocity in environmental and climatic change across the Kimberly in northwestern Australia.

Multiproxy techniques were presented across these research fields, demonstrating the broad 'fox versus hedgehog' approaches used to decipher environmental and human change (Matt McGlone). Some of the many highlights included presentation of the interesting field techniques used to ward off curious locals in the Macquarie Islands (Krystyna Saunders); impressive mapping techniques using drone technology (Rebecca Ballard), resourceful dating methods for Indigenous rock art using Optically Stimulated Luminescence on grains preserved in wasp nests (Kira Westaway), and geochemical analysis crossing scientific thresholds between speleothems and neuroscience (Anthony Dossetto). Public Science Lectures included presentations of large-scale research projects exploring Antarctic ice sheet stability during the Last Interglacial (Chris Turney), and a 17,000 year-long annually resolved palaeoclimate record in Southern New Zealand (Marcus Vandergoes).

The quality and standard of student research presented was recognised with awards to Emily Field (Scientist meets Parliament), Briony Chamberlayne (GNS Quaternary Techniques), with best student talk awarded to Ellen Corrick. Honourable mentions were given to Rebecca Hamilton, Rebecca Ballard, Elyssa De Carli and Michaela Mariani, and best poster was awarded to Martin Ankor.

MID-CONFERENCE FIELD TRIP

Briony Chamberlayne

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The Wednesday morning of the 2017 AQUA Conference (Auckland, New Zealand) saw dozens of Quaternary scientists pile into buses, field trip notes in hand. Led by the ever enthusiastic Phil Shane (The University of Auckland), the field trip would take us to three of Auckland's significant Quaternary sites.

First stop was One Tree Hill, a volcanic cone which provides a 360 degree view of the City of Volcanoes (Figure 1). Phil gave an overview of the Auckland Volcanic Field (AVF), with a focus on the origins and chronology of the area. Following a brief explanation of the dating techniques used and an assurance that Phil's house will remain standing if there were a volcanic eruption, conversation moved to the archaeological significance of the area. One Tree Hill, or Maungakiekie in Maori, was a large pre-European settlement. Drew Lorrey (NIWA) spoke to the group about the cultural importance of the region to the Maori people and how dating of tephra in the area has helped pinpoint the timing of Maori arrival in Auckland to 1314 AD.

The second stop of the day was the scenic Cascades Kauri Park in the Waitakere Ranges. The park contains remnant native and regenerating forest which are the focus of a concerted effort to protect against a spread of the deadly kauri disease caused by the pathogen *Phytophthora agathidicida*. The group walked the Auckland City Loop, a 1 hour trek through scenic rainforest with plenty of opportunity to observe the native birdlife. A highlight of this part of the fieldtrip were the kauri "wiggles" described (with the help of several volunteer poster holders) by dendrochronologist Gretel Boswijk (The University of Auckland) (Figure 2). Gretel explained how her research group were able to piece together an impressive record of annual kauri tree ring widths spanning more than 3000 years from modern, archaeological and sub-fossil trees. Further along in the walk, Drew Lorrey described the coring technique used to sample these giant trees and shared some of his results from some recent work into oxygen isotopes of their rings. At the completion of the loop a gourmet packed lunch was enjoyed by all, and a kick of the football enjoyed on the lawns of the park by those who still had the energy.

Our final destination was Lake Pupuke on the north shore of Auckland. Paul Augustinus (The University of Auckland) shared the research he and his team are

conducting on the sediments from the Crater Lake. Paul highlighted the palaeo-environmental significance of this maar, which occupies a 260,000 year old basaltic explosion crater. Sediments from the maar contain high-resolution records of changes in climate and catchment hydrology. Paul guided participants through the various biological, sedimentological and geochemical analyses which have been undertaken at this site. This multi-proxy approach has resulted in high-resolution records of climatic variability and changes in population and land use through the Holocene.

On behalf of all attendees, I would like to thank all presenters for sharing their knowledge through engaging presentations, and Phil Shane for leading the trip.

ACKNOWLEDGEMENTS

I would like to thank AQUA for the travel award which made attendance at this conference possible and the conference organisers for a great week.

Above: Figure 1: The view of Auckland and Rangitoto Island from One Tree Hill. One of almost 50 volcanoes in the Auckland Volcanic Zone, this classic shield volcano last erupted ~500 years ago. (Photo credit: Jacinta Greer).

Right: Figure 2: Gretel Boswijk presents an annual kauri tree ring width record in the Cascades Kauri Park in the Waitakere Ranges. (Photo credit: Drew Lorrey).

POST-CONFERENCE FIELD TRIP – KAURI AND THE QUATERNARY OF NORTHLAND NEW ZEALAND

Deirdre D. Ryan

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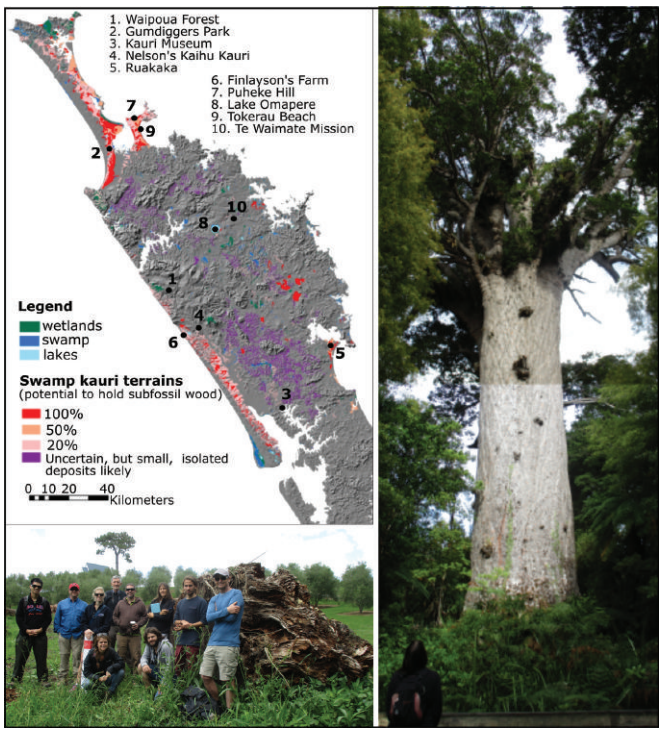
The 2016 Biennial Meeting of AQUA, "Quaternary Perspectives from the City of Volcanoes", was held in December at the University of Auckland, New Zealand. For those of you unlucky enough to miss it, the conference covered a wide-range of topics from Australasian peats and Quaternary coastal dynamics, to human-environmental impacts; all within a convivial atmosphere. Following the close of the conference, a six-day excursion into New Zealand's Northland (Figure 1) charted how kauri-based science, used in conjunction with palynology, tephrochronology, and ground penetrating radar (GPR), is gradually revealing the Late Pleistocene/Holocene natural history of the region. In addition to exploring its more recent role in climate and earth science, a further aspect of this trip was learning of the industrial history surrounding the kauri tree (*Agathis australis*) in northern New Zealand.

Figure 1: The location of Northland field stops mentioned in text (except Omaha) overlaid upon a map of swamp kauri terrain modified from Lorrey and Boswijk (2017). Bottom left: Field trip attendees standing in front of kauri stump. Back row, from left – Tsun-you, Allen, Petra, David, Drew, Sanja, Pana, and Rewi. In front – Diedre Ryan and John-Mark. At right Sanja looking up at *Tāne Mahuta*, the largest known kauri tree. (Photo credit: Deidre Ryan).



This review is to provide a short synopsis of kauri 'history'. Kauri has been at the heart of three major industries in New Zealand following European colonization, and in the past few decades the scientific value of the species has come to fruition. This review will describe the field stops which illustrate how an understanding of the natural history of Late Quaternary New Zealand is being developed.

The field trip was led by Andrew (Drew) Lorrey from NIWA, with contributions from Rewi Newnham, David Lowe, Allen Gontz, and Petra Pearce. Petra and John-Mark Woolley (both NIWA) did a great job assisting Drew with organising a fantastic field trip. Other attendees in addition to myself, were AQUA members Sanja van Huet, Larissa Gontz, Tsun-you Pan, and Pana Panaretos (Figure 1).

KAURI BIOLOGY AND HISTORY

Kauri is a canopy emergent species, reaching heights in excess of 40 m with a girth that can exceed 5 m. The largest known standing kauri tree, *Tāne Mahuta*, located in the Waipoua Forest (Figure 1), reaches a total height of 51.5 m, with the trunk girth measuring 13.8 m. It is estimated to be ~2000 years old.

Large scale deforestation of kauri habitat took place at the end of the 19th century and into the 20th. Forested land was converted for agricultural purposes and kauri timber was used in the construction of buildings and other structures, as well as furniture. Keeping pace alongside the kauri timber industry was the kauri gum industry. Kauri gum produces a valuable, multi-purpose resin that was used principally as a varnish. As kauri forests were cleared the gum was initially found at or just below the soil surface. Later the gum was excavated from peat bog environments, which were cleared and drained to make access to the gum easier (Figure 2). It was from within this industry that gum boots were developed.

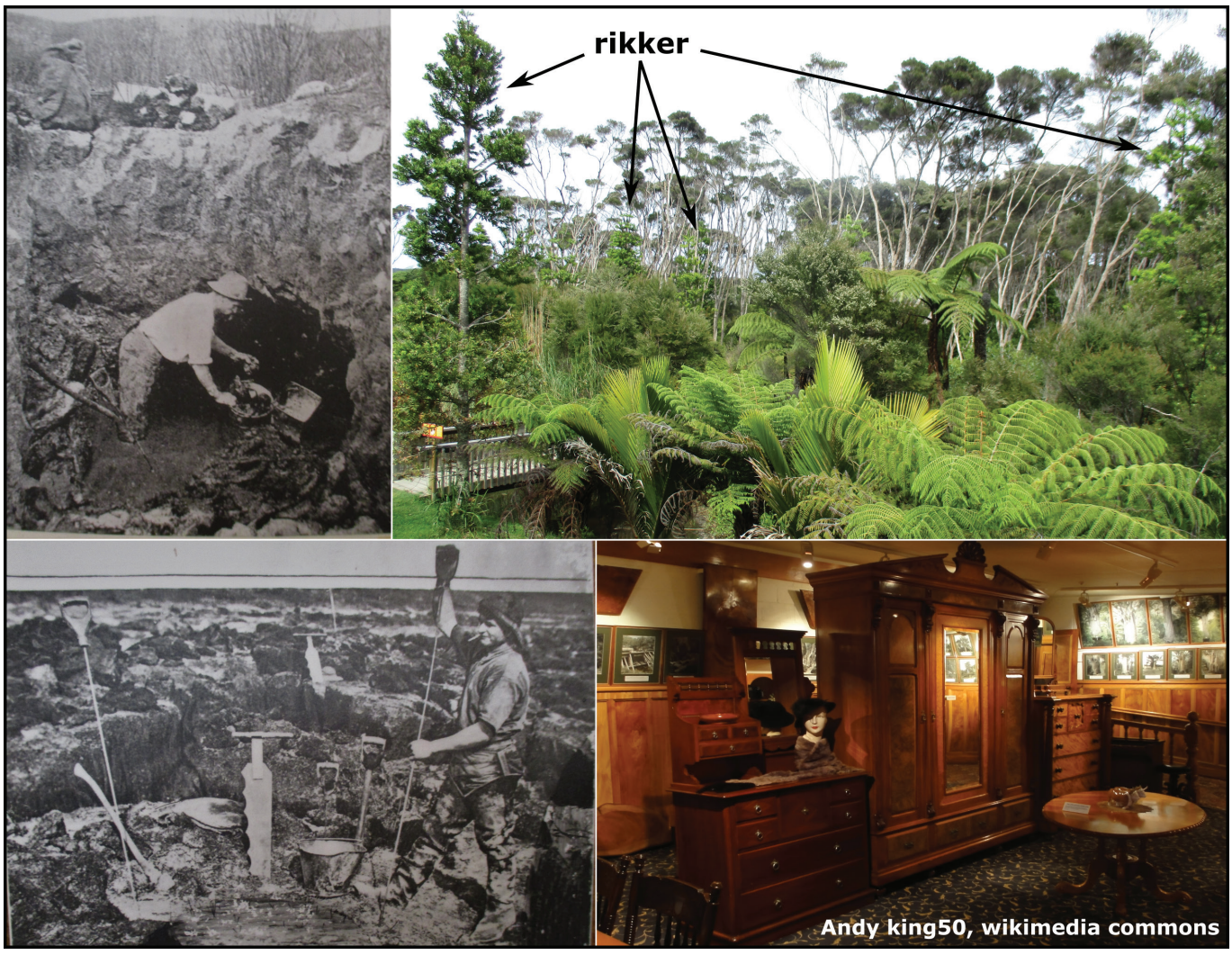
Johnston's Gumdiggers Park preserves gum pits and equipment from active operations that took place on site 100 years ago. The park also contains a recreated village and shelters. The owner, John Johnston educated us on the gum digger culture. He is actively regenerating the kānuka (*Kunzea ericoides*) forest within the heavily modified landscape at the southern end of the Aupouri Peninsula. The kānuka forest is the natural nursery for young kauri, known as "rikker" (Figure 2).

The Kauri Museum at Matakohe displays many large artifacts from the days of kauri logging and the kauri gum trade, including large kauri logs and slabs, kauri furniture and early pioneer household equipment, heritage buildings and even a working sawmill. The Dargaville Museum also has many artifacts from the gumdigger's heyday (Figure 2).

The latest kauri industrial boom, which began in earnest around 1980, focuses on swamp kauri – subfossil kauri stumps and logs of Late Pleistocene to Early Holocene age. The well-preserved and eye-appealing wood is used for furniture production and wood working. Our group learned about the processing of swamp kauri timber and the production and sale of kauri products at Nelson's Kaihu Kauri. Nelson Parker, the owner of the timber mill, believes kauri to be the oldest workable timber in the world. Nelson showed us around his timber yard, where

Below: Figure 2: Black and white photos of gumdiggers from the Dargaville Museum. Note the excavation depth in the above photo and the cleared landscape in the lower photo. Upper right – regenerating kānuka forest with young 'rikker' kauri growing up through the canopy at Gumdiggers Park. Lower right – Late 19th/Early 20th century kauri furniture. (Photo credit: Deidre Ryan).

Above: Figure 3: At top – The group in Nelson's kauri yard in front of large kauri stumps. Bottom left – a recently completed kauri table. Bottom right – Drew looks in on a container of kauri slabs to be sent to scientists performing kauri research. (Photo credit: Deidre Ryan).



kauri stumps and logs (Figure 3), ranging in age from 2000 years to ~55 000 years before present (radiocarbon), were in various stages of production (Figure 3). Nelson generously provides valuable cross-sections of kauri to researcher groups such as NIWA (Figure 3).

The swamp kauri industry has proven somewhat contentious in recent years. A review of the industry is provided in a recent popular science article in the New Zealand Geographic: https://www.nzgeo.com/stories/swamp-kauri/.

The New Zealand Ministry for Primary Industries (MPI) requested a study on the scientific value of subfossil kauri, which was provided by the National Institute of Water & Atmospheric Research (NIWA) (Lorrey and Boswijk, 2017) shortly after Auckland AQUA 2016, and is available at: http://www.mpi.govt.nz/news-and-resources/publications/. Modern and subfossil kauri research has centered on themes of chronology (dendrochronology and radiocarbon), palaeoclimatology, abrupt and/or extreme meteorological and geological events, palaeoecology and non-climatic environmental change, and prospecting for wood recovery and kauri environments. Some of the significant contributions of this research (Lorrey and Boswjik, 2017 and references therein) include:

- an extended calendar-dated kauri tree chronology to cover the last 4 500 years, one of the longest Southern Hemisphere calendar dated tree ring chronologies, providing a valuable ENSO proxy record from the data sparse south west Pacific;
- a floating tree ring chronology spanning the Younger Dryas chronozone (~12 900 to 11 500 calendar years ago);
- floating kauri chronologies spanning thousands of years of time in the interval between the Last Interglacial (LIG) and the Last Glacial Maximum (LGM) making kauri the lone tree ring resource for wood that could be used to define the radiocarbon calibration curve older than the LGM;
- radiocarbon analysis has provided new knowledge of variation in inter-hemispheric radiocarbon offsets during the late Holocene, new insights into ocean-atmosphere interactions, a significant Southern Hemisphere record of atmospheric radiocarbon variability which could be linked to the Northern Hemisphere radiocarbon chronologies, and potential to link subfossil kauri records directly to high latitude ice core records;
- insights into climate and environmental change, which occurred before instrumental observations, e.g. hydroclimatic changes and weather extremes.

Currently, subfossil kauri research is undertaken at NIWA, University of Auckland, University of Waikato, Gondwana Tree Ring Laboratory and the University of New South Wales. It was stressed by Drew that this research would not be possible without the cooperation of timber millers and landowners like Nelson Parker and John Johnston who provide access and samples of subfossil kauri for research. Most subfossil kauri samples provided by millers, and those from archaeological sites, have already been removed from their *in situ* environment and there is no stratigraphic or environmental information to be obtained. This is why cooperation from landowners before and during excavation is also essential.

A recent report by NIWA (Lorrey et al., 2017) found large uncertainty regarding how much swamp kauri has been removed from, and how much remains undiscovered in, the Northland (Figure 1 map). This uncertainty is a result of limited historical records on the extraction of swamp kauri and how much of the wood has been moved through the domestic and international markets. It is estimated that anywhere from 30-80% of the initial pre-extraction quantity of subfossil kauri has been removed from the Northland. Some of the work from both NIWA reports was reviewed in a poster presentation by Drew (Lorrey et al., 2016) at the second poster session of Auckland AQUA.

EXPLORING KAURI OF THE NORTHLAND

Subfossil kauri are typically found within four geomorphological settings: relic fluvial systems, relic coastal barriers that were formerly compartmentalised between rocky headlands, relic aeolian (parabolic and sand wave) dune systems, and composite relic coastal barrier/dune complexes (Lorrey et al., 2017). These environments can produce the organic soils (typically organic humic and mesic but also podzol densipan) that preserve the buried wood. Our stops at Ruakaka, Omaha Beach, Finlayson's, and Johnston's Gumdiggers Park best illustrated this relationship (Figure 1 map).

OMAHA BEACH

Preparation of land near Omaha Beach for the planting of mandarin orchards in 1999-2000 lead to the identification and excavation of subfossil kauri from a former peat bog identified at 60 to 80 cm depth. Initially, due to the presence of an overlying tephra, it was proposed that the trees there were felled by a blast wave from the Taupo Eruption ~1800 years ago (Figure 4). However, as Drew explained, the presence of peat overlying kauri at variable thickness and the array of felled trees (spanning 110 degrees) alongside discrete dendrochronology showed that the kauri were not all killed at the same time. Instead, the assemblage represented the natural death of individual trees through

the life of the forest. This stop in our tour provided the first example of how kauri could support or, in this case, provide evidence against the occurrence of extreme events.

These kauri also provided a maximum age for the overlying tephra; 51 000 years B.P. Rewi explained that the identification of organic microfossils from the peat incorporated into the lower layer of the tephra made it unlikely that the tephra was from the Taupo Eruption. The glass chemistry of the tephra allowed its association with the Rotoehu Eruption. Although previously contentious, the age of the Rotoehu tephra has been recently (Danišík et al., 2012) constrained to ~46 000 years using combined 238U/230Th disequilibrium and (U–Th)/He dating of zircon. A kauri leaf found in the peat at the stratigraphic contact to the Rotoehu tephra was radiocarbon dated to ~45 000 years BP (Lorrey, unpublished) in support of the tephra age.

RUAKAKA, PORT MARSDEN

Beach barrier sediments will form hard pans at the base of younger peats. At the Ruakaka stop we viewed the remnants of a marine isotope stage (MIS) 5 (*sensu lato*) beach dune sequence near Port Marsden, which had been preserved beneath 1 to 5 m of overlying peat bog. The site had been excavated within the past 5 years in preparation for the construction of an industrial centre. The excavation exposed the relationship of the dune sediments and peat bog (Figure 4). The dune sediments at this site have taken on a distinctive color and are colloquially referred to as 'coffee rock'. Kauri tree rootlets from the later forest are still visible within the coffee rock (Figure 4). The peat bogs, in which the kauri grew, developed podzolic soils with a characteristic leached layer and may explain the characteristic 'coffee' color of the dune sediments.

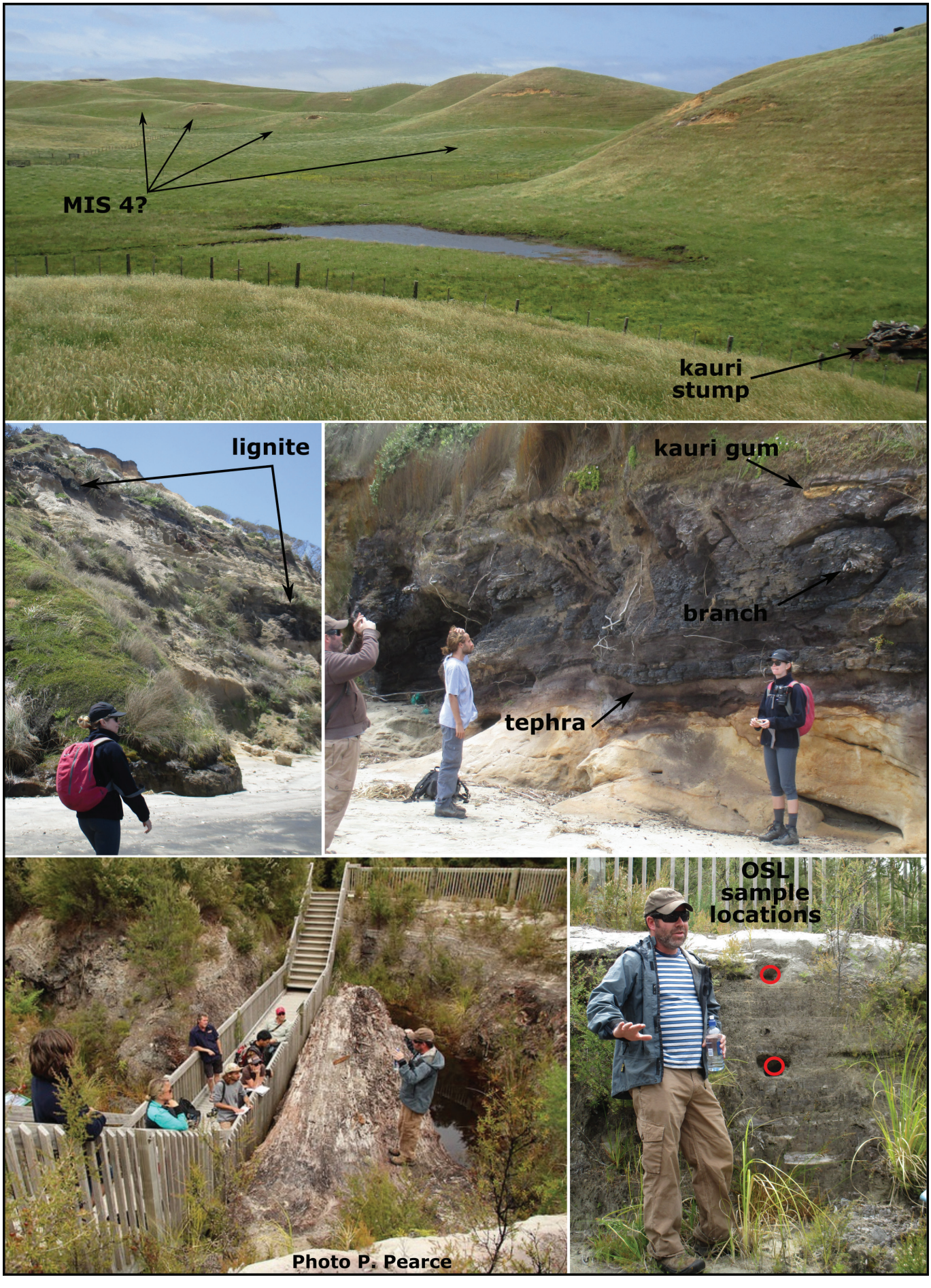
Near the Ruakaka dune and peat sequence, our group visited another bog site within a relic coastal barrier complex setting, where a gridded GPR survey had been undertaken using 160 MHz Mala GX antenna. Since 2012, Allen Gontz (working with Drew and others) has been applying GPR coupled with coring and excavations to several areas of New Zealand's north island. Allen is assessing the capability of this method to identify subsurface architecture: peat structure and features (e.g. thickness), the presence of buried kauri, sub-peat surface morphology, and pre-peat features and depositional environments. GPR proved effective at mapping the stratigraphic sequence of the site: a beach/marine sequence, overlain by aeolian dunes, in turn overlain by peat. An additional benefit to the survey was the revelation that buried kauri were not present at the site, saving the farmer from costly exploratory excavations. Allen's Auckland AQUA 2016 conference poster (Gontz et al., 2016) summarised multiple case studies in New Zealand and Australia.

FINLAYSON'S FARM HIKE – RIPIRO BEACH QUATERNARY SEQUENCE

This section of New Zealand's western, northwest trending coastline is a high-energy environment with dissipative beaches backed by cliffs 60 m in height and greater. The parabolic dune system of the western Northland was once the site of kauri forest and, like many areas where subfossil kauri have been found, was cleared well before excavation. The dune scape is well preserved and many swales where peat would have formed and kauri grown now form small ponds of water (Figure 5). It was here that Drew discovered a kauri stump, with heartwood, that initial radiocarbon analysis dated to 39 000 radiocarbon years, assisting in the establishment of a floating chronology within MIS 3.

The more exhilarating part of this visit was when the group scaled down a near-vertical cliff to view the sedimentary succession exposed within the cliff wall. Then, walking north along a beautiful surf beach towards Maunganui Bluff (formed of Miocene flood basalt, tuff, and lapilli derived from the now-extinct Waipoua Volcano west of the present coast) we saw a succession comprised of numerous aeolian dunes and lignite deposits interspersed with the characteristic pale color of podzolic soil horizons (Figure 5). The lignite deposits contain large

Figure 4: Top left – Drew indicating towards the Rotoehu tephra overlying an *in situ* kauri log, outlined in red. Top right – a slightly closer look. Bottom left – A remnant of peat not excavated from Ruakaka contains what David thought to be the Rotoehu tephra through which a kauri root had grown (pocket knife for scale). Bottom right – kauri rootlets of long-dead kauri protrude from a 'coffee rock' surface.
(Photo credit: Petra Pearce).


MIS 4?
kauri stump
lignite
kauri gum
branch
tephra
OSL sample locations
Photo P. Pearce

kauri branches, roots, and gum (Figure 5). The varying base levels of the lignite deposits within the face of the cliff, although in some instances reflecting the varying depth of contemporaneous swales within a singular dunefield, also reflected multiple phases of dunefield development and subsequent peat deposition. This location implies the record provided by subfossil kauri has the potential to extend beyond the Last Interglacial.

JOHNSTON'S GUMDIGGERS PARK

This stop, already mentioned previously for its role in the preservation of New Zealand Gumdigger culture, was one of the best stops of the trip and is highly recommended. The gumdiggers, in their work, inadvertently had exposed MIS 3 and MIS 5 subfossil kauri forests. The owner of the park, John Johnston, has been working with Drew and others, providing access to, and samples of, this record of Quaternary environmental change. The importance of locations such as Gumdiggers was reviewed in Drew's AQUA 2016 poster (Lorrey et al., 2016).

We were shown a pit that exposed a kauri forest succession. A large kauri trunk, laying near-horizontal, with no remaining crown, was buried at ~2 m depth (Figure 5). The underlying hardpan is at 7 m depth of burial from the kauri trunk indicating an extensive record. The tree fell away from the direction of the coast, raising the possibility that it was felled by wind throw. An overlying kauri trunk and additional tree roots signifies that at least two forest floor surfaces are present within the top two meters. This is in turn overlain by a sand stringer, an additional peat deposit, and the succession is capped by a sand lens (Figure 5). The succession lacks tephra but samples have been taken of the sand deposits for OSL analyses. The sands are aeolian in origin, sourced from the coast when sea level dropped. The capping sand lens is likely MIS 4 in age. This substage was very cold, windy, and wet and, in NZ, most likely the period of maximum glacial conditions.

There is a possibility that the peats and kauri record and Johnston's Gumdiggers Park extends into MIS 7 and Drew is re-evaluating the chronology. Allen is assisting his work with GPR to identify breaks and variations in the stratigraphy.

PUHEKE HILL

Puheke Hill provides a view of the northwestern Karikari Peninsula and Late Quaternary barriers, which form a tombolo sequence orientated perpendicular to the prevailing southwesterly winds (Figure 6). The peninsula is formed of welded last interglacial (*sensu lato*) and possibly older beach-barriers, anchored to rocky headlands of Cretaceous and Miocene volcanics, conglomerates, and sandstones. Puheke Hill (Cretaceous Tokerau Facies), on the north-facing margin of the peninsula, provided a viewpoint from which we could view the Late Quaternary coastal sequence. Drew explained the sequence is in need of further investigation and geochronological constraint. The last interglacial (LIG) dune sequence is overlain by southwest to northeast trending parabolic dunes, possibly MIS 4 in age. Swamp kauri are preserved within the interdune swales. Headward incision through the sequence during the LGM assisted the development of Rangaunu Harbour. To the west of Puheke Hill a mid-Holocene terrace is nested in the LIG sequence landward of Puheke Beach (Figure 6). The age and origin of interdune lakes is also in need of further study.

We visited three additional sites that, although not containing kauri, are assisting in the development of Northland Quaternary development: Lake Omapere, Tokerau Beach, and Te Waimate Mission.

LAKE OMAPERE

A sediment core was retrieved from Lake Omapere by David Lowe, Japanese Professor Shoji Horie and others in 1983. Analysis of the lake sediment revealed that the lake initially formed ~80 000 years, around the MIS 5/4 boundary, inundating peat deposits and kauri forest. The lake dried early in MIS 3, at ~55 cal. ka as indicated by the Rotoehu Tephra, and did not reform until ~600-700 cal. years ago, possibly due to sediment damming following early Polynesian deforestation and accelerated erosion. This work (Newnham et al., 2004), as David pointed out, only took 21 years to publish!

Lake Omapere represents a common challenge in the Northland, a gap (or severe reduction) in the stratigraphy following the LIG, through the LGM and into the early Holocene. Subfossil kauri of MIS 4 through MIS 2 age is sparse in the sedimentary record and the question remains, is the 'gap' due to harsh environmental conditions and a lack of preservation conditions or does it reflect the migration of kauri habitat to locations now offshore?

Opposite: Figure 5: At top – the dunescape inland of Ripiro Beach is thought to contain MIS 4 and older aeolian dunes, however the geochronology has not been firmly established. The landscape would have been cleared of native vegetation for agricultural purposes but still retains faint reminders of its past in small ponds and sub-fossil kauri stumps. Middle row – the cliff face at Ripiro Beach is made up a sedimentary succession including multiple lignite deposits containing kauri gum and other kauri remnants. Bottom left – the large kauri trunk exposed at Johnston's Gumdiggers Park within a peat deposit of ~9 m thickness. The peat overlying the kauri trunk includes lenses of aeolian sand, which have been recently sampled for OSL (bottom right photo). (Photo credit: Petra Pearce).

TOKERAU BEACH

Tokerau Beach, an eastward facing beach on the Karikari Peninsula, brought to mind the 'original' fast food meal. Within the Holocene coastal dunes is an extensive Māori shell midden (containing numerous strike rocks) stretching tens of meters parallel to the coast (Figure 6). *In situ* sections of the midden are variable in thickness but, in places, exceed 10 cm. Midden accumulation began after ~1250 CE, during the Polynesian diaspora, which has been associated with the medieval climate anomaly. The midden could provide a record of fish stock change and, through schlerochronology, a record of water chemistry variation from shell analysis.

TE WAIMATE MISSION

Te Waimate Mission preserves missionary, farming, architectural and European/Māori interaction history and is the site of one of New Zealand's earliest farms, established by Reverend Richard Davis in 1830. However, it was the meteorological records of Reverend Davis that Petra and Drew brought to our attention, as they are the oldest land-based meteorological records in New Zealand.

Perhaps influenced by a visit from Darwin in 1835, Rev. Davis kept meteorological records from 1839-1844 and 1848-1851, inclusive. Recorded daily were the temperature at 9 am and midday as well as midday atmospheric pressure measurement (by barometer) with comments kept on wind flow and strength, cloud cover, climate variability impacts, and bio-indicators. Extreme weather events were also noted. Scattered throughout the diaries are conditions of strong winds and driving windfall, which were referred to as "dirty weather". Winter temperatures during his period of record, which coincides with the end of the Little Ice Age, were on average ~2°C cooler with conditions of frost, ice, hail, and snow. Summers were on average warmer. The data derived from Rev. Davis' records will contribute to the Atmospheric Circulation Reconstructions across the Earth (ACRE) project. Interested parties are referred to Drew and Petra's publication on the diaries (Lorrey and Chappell, 2016) and, for a short synopsis, to NIWA's media release at: https://www.niwa.co.nz/news/scientists-rediscover-new-zealand%E2%80%99s-first-weather-diaries.

CONCLUSION

This Northland field trip was excellent, well planned, fun, and informative. The Northland of New Zealand hosts a complex record of Quaternary natural history that is being revealed with kauri, palynology, tephrochronology, and ground penetrating radar. With the potential for kauri research to extend the record beyond the Last Interglacial and with the unravelling of the MIS 4 – MIS 2 story it must be quite an exciting time to be doing this work. The not-as-yet completed research has already established a robust framework in which the Quaternary geomorphological evolution of the Northland can be placed.

ACKNOWLEDGEMENTS

We had some fantastic hosts on this trip. I believe I am speaking for all of us when I express gratitude to John Johnston (Gumdiggers Park), Nelson Parker (Nelson's Kaihu Kauri), and Ruby and Noel Martin of Wai Hou Oma Lodge who housed and fed us during our time at Kai Iwi Lakes. Drew, Petra, and John-Mark are thanked for a spectacular field trip and Allen, David, and Rewi are also thanked for their individual contributions.

I am also extremely grateful to AQUA for the travel grant that helped to make my attendance at the conference and field trip possible.

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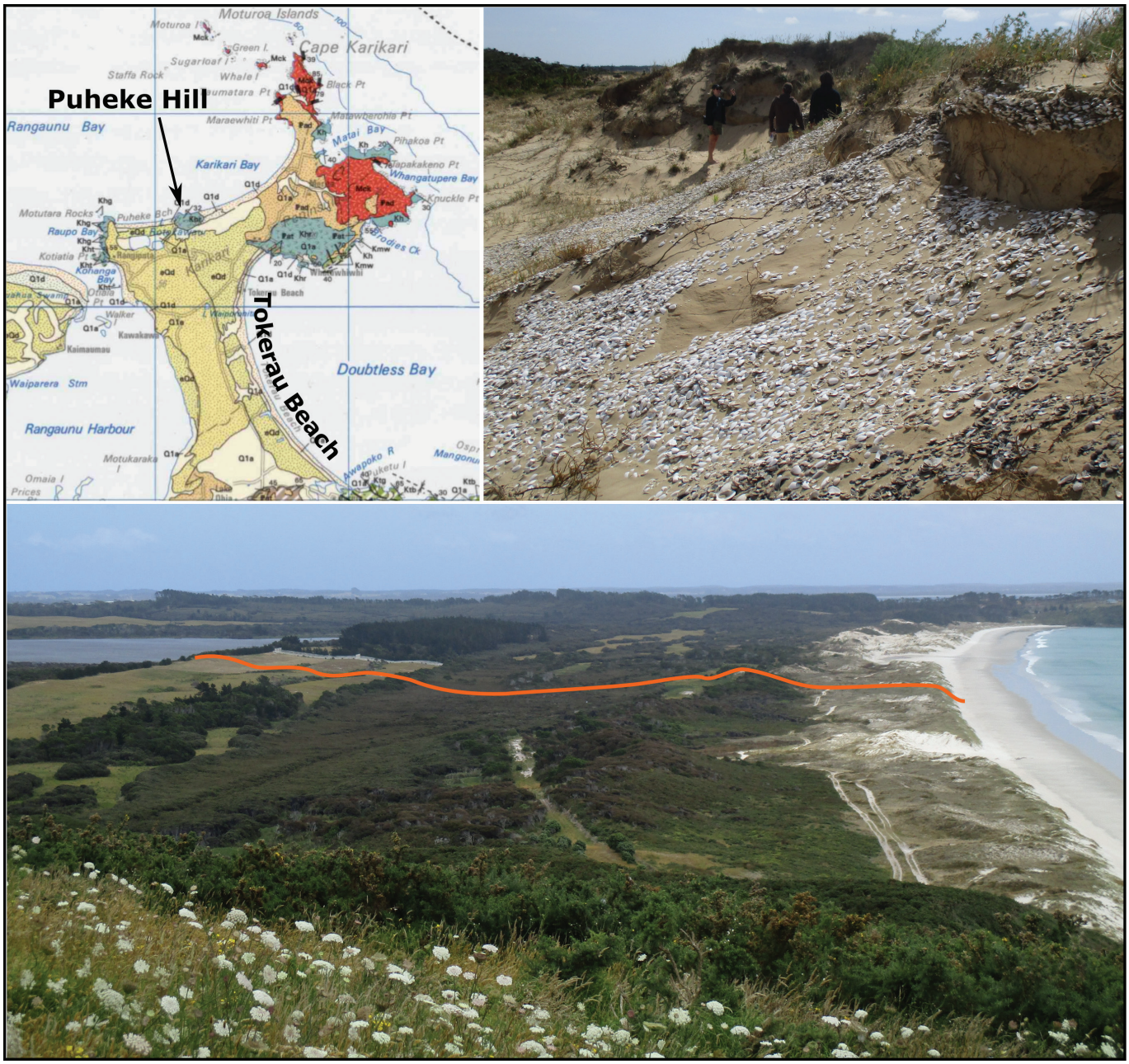

Figure 6: Top left – the Karikari Peninsula as presented in the Kaitaia area geological map, 1:250,000 (Isaac, 1996). Looking west from about halfway up the northern side of Puheke Hill provides a view of Puheke Beach and the landward LIG sequence (bottom photo). An orange line has been traced from the beach to the interdune lake following the surface topography. Top right – the shell midden at the northern end of Tokerau Beach. (Photo credit: Deidre Ryan).

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THERE AND BACK AGAIN – A TRIP TO RANGITOTO ISLAND

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After a week of conferencing it felt good to get out doors and set off to explore Rangitoto Island-Auckland's largest and youngest volcano. David Lowe led our group of enthusiastic AQUA-ites. We arrived early Saturday morning at the Auckland pier and set sail on the ferry to Rangitoto. Arriving on the island we walked past cute beach 'baches' built in the 1940's, and up the Summit Track. Hiking towards the summit we passed the Rangitoto lava fields: beds of sharp, black lava and rubble reaching up to 50m thick at the base of Rangitoto's scoria cone. Not much grows in the harsh environment except for tenacious lichen, mosses and liverworts, which begin the process of breaking down the lava into nutrient rich soils.

The pohutukawa forests along the track were flowering, made up of a hybrid of *Metrosideros excelsa* and *M. robusta*. Peter de Lange, a past student of David Lowe's; now working with the Department of Conservation, was on hand to help identify the different types of *Metrosideros* by their subtle leaf structure. Rangitoto supports the largest area of pohutukawa forest in New Zealand, with the hardy plant able to colonise the exposed lava fields.

Rangitoto island is technically 'oceanic' (despite being a stone's throw from Auckland), with all the plants and animals making their way here via long distance dispersal. Now that Rangitoto is classified as 'pest-free' (having exterminated the possums and hopefully all the rats) the native flora and fauna flourish undisturbed!

By the time we reached the summit of Rangitoto Island the weather had turned, and we were unable to see much more than a few feet in front of us while we had our lunch. However, we did get to peer into the impressive 60m deep, inverted cone-shaped main crater of Rangitoto, which was the site of the last eruption around c. 550-500 cal. yr BP. Practically yesterday from a palaeo-perspective! It must have been quite a surprise for the Maori living on the adjacent Motutapu Island at the time.

To escape the rain, we branched off the main track to investigate one of several lava tubes on the island. The one we ducked into revealed an impressive cave with plenty of room for a quorum of Quaternarists... and several web spinning spiders. Then it was time to head back down Rangitoto, past the main crater, through the pohutukawa forest and over the lava fields to the ferry and back to Auckland. Thank you to David and Peter for an excellent trip!

Figure 1: Hiking to the Rangitoto scoria cone summit (Photo credit: Lydia Mackenzie).

Figure 2: David Lowe describing the geological evolution of Rangitoto Island (Photo credit: Lydia Mackenzie).

Figure 3: One of the many lava tunnels on Rangitoto. No spiders were harmed in the traversing of this tunnel (Photo credit: Lydia Mackenzie).

WINE, VOLCANOES AND AN IMPROMPTU AWARDS EVENING: CONFERENCE DINNER

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On the penultimate evening of the 2016 AQUA biennial conference, Quaternarists piled onto two buses bound for Villa Maria Estate; New Zealand's most awarded winery, just outside Auckland in the Waitomokia Volcanic Crater. Upon arrival we were greeted with a parade of mouth-watering canapes and, perhaps most importantly, a well-stocked bar. An increasingly loud crowd then made their way from the cellar door into a festively-decorated dining room (after all, Christmas was only just around the corner), ready to enjoy a three course meal, and of course, more wine (Figure 1).

During the dinner service, delegates (predominantly wearing paper hats from Christmas bon-bons) were treated to a fascinating keynote address by Associate Professor Phil Shane from the University of Auckland. Phil described the history of the Rangitoto volcano and explained that drilling indicated the volcano had been active from around 6,000 cal. yr BP, with minor volcanism persisting until 650 cal. yr BP. A final phase of activity was around 550 – 500 cal. yr BP. Given that the construction of Rangitoto was previously thought to be in one or two short phases at approximately 500 cal. yr BP, this new data re-writes what we know about the genesis of the volcano and prompts scientists to re-think how Auckland's volcanos may behave in the future.

After Phil's keynote address concluded chaos more or less descended. An impromptu "awards ceremony" for Quaternary "silverbacks" was initiated where several "silverbacks" were called up to the stage to impart 'words of wisdom'. No names will be mentioned, as some of the 'wise words' were not that clear. However, congratulations to all these distinguished Quaternarists for their longevity and their recognised contribution to Quaternary science!

The beautiful venue provided ample space for mingling and I managed to snap several ANSTO staff and discovered a group of fellow ex-Royal Holloway and Quaternary Science MSc students, currently at large in Australasia.

I would like to extend my sincere thanks to AQUA for providing me with a travel award which enabled me to attend this informative and thoroughly enjoyable conference, and to the excellent local organising committee for putting on a great event!

Figure 1: AQUA biennial conference delegates sitting down to enjoy dinner and wine in festive surroundings. (Photo credit: Emily Field).

Figure 2: Associate Professor Phil Shane addressing a captivated crowd. (Photo credit: Emily Field).

Figure 3: ANSTO staff (L-R Dr Craig Woodward, Heather Haines, Patricia Gadd, Dr Krystyna Saunders and Dr Quan Hua). (Photo credit: Emily Field).

Figure 4: Some ex-Royal Holloway and Quaternary Science MSc students (L-R Dr Jonathan Tyler, Dr Kira Westaway, Emily Field, Dr Shaun Eaves and Professor Chris Turney). (Photo credit: Emily Field).

AQUA Representatives Attend Science Meets Parliament 2017

Emily Field

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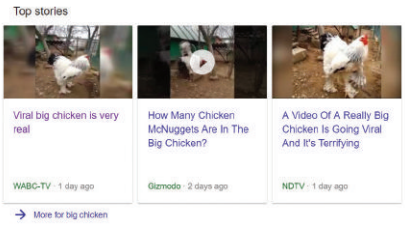
On the 21st and 22nd March 2017, Professor Brad Pillans from the Australian National University and me, Emily Field, from the University of Queensland attended the annual Science meets Parliament (SmP) on behalf of AQUA. I consider myself fortunate to have been awarded this trip as my student prize during the AQUA biennial meeting in Auckland, 2016. Preparations started several days prior to the event when it became clear that the typical "Quaternarist" dress-code wouldn't quite cut it in parliament (the programme recommended "business attire" and "lounge suits and cocktail dresses"). In addition to a wardrobe crisis, SmP delegates had been provided with details of the parliamentarians they would be meeting, and therefore 'politician' research was required (the reading of maiden and recent speeches was recommended!). Armed with suitable attire and knowledge, we joined approximately 200 delegates, and descended on Canberra.

Day one of SmP was hosted in Old Parliament House, a beautiful building with a real sense of history. Attendees were tweeting eagerly from the first, the result being that #SmP2017 began trending on twitter. One particular quote from Dr Alan Finkel, Australia's Chief Scientist, was given in the opening address and proved to be one of the most memorable from the event, where he told the gathered scientists that instead of pursuing "escape routes" in the face of global threats (e.g. searching for new habitable planets or buying properties in remote New Zealand far from any hypothetical catastrophes), they needed to make parliament aware that "beakers not bunkers" are required. However, Dr Finkel was quick to point out that beakers need "backers and bankers", and it is therefore essential that science is effectively communicated to (and most importantly, reaches) policy makers who have the resources to bring about change. This is particularly important in a world where the internet can quickly spread not only fact and logic, but also hype and spin.

Alice Workman, political reporter for BuzzFeed, and Dr Susannah Eliott, the CEO of the Australian Science Media Centre then discussed how science can be turned into news and become an influencer of opinion. Dr Eliott pointed out that, ultimately, the media is a form of entertainment and needs to be profitable. Therefore what gets reported is generally what is thought to "sell best" to the public. Unfortunately, scientific news is often considered less interesting to the general population than, for instance, daily sports, finance, TV and show business. Science therefore needs to be presented in the form of a pitch that people can understand. Alice Workman cited simple concepts which are generally the hallmarks of those articles that go viral ("clickbait"). She gave the example of the "big chicken" that had gone viral just the day before,

Figure 1: Professor Brad Pillans and Emily Field in Parliament House. (Photo credit: Emily Field).



Top Right: Figure 2: A really big chicken goes viral (http://www.ndtv.com/offbeat/a-video-of-a-really-big-chicken-is-going-viral-and-its-terrifying-1671854; accessed 23/5/17).

Right: Figure 3: Is there a science to making things go viral? (Photo credit: https://www.youtube.com/watch?v=obUcXSMiQ5I; accessed 23/5/17).

explaining that the simple and effective communication of this video enabled it to reach, and be watched by millions of people in a very short space of time – "at the end of the day, it was just a really, really big chicken". In a similar vein, she quoted a silly yet simple video; where two BuzzFeed employees placed an increasing number of elastic bands around a watermelon until it exploded – so many people streamed this video live that US workplace productivity was drastically affected on what was otherwise a very ordinary Friday afternoon.

Understandably, many scientists are uncomfortable with "dumbing down" their research, and some research is too complicated to come across well in a simple format. Also, while social media is growing ever more influential, it takes time and effort to cultivate a social media presence where people will simply come to you for information. Many people in the audience were unaware that there is a Science Media Exchange where researchers can upload articles which can be picked up by journalists (https://www.scimex.org/). Ultimately, the locations where people go to get their trusted information are changing. Scientists need to keep abreast of these changes to information sources to avoid a scenario where people no longer trust the experts.

The "rise of the anti-expert" seemed to be a common theme over the two days, with many expressing their concerns. In his speech on day two of the Conference, Senator the Hon. Kim Carr (Shadow Minister) stressed that scientists needed to defend their discipline and stand up against anti-intellectualism, particularly in a climate where the current political system is clearly not working for everyone. This was giving growth to "fascism in the west". This has been highlighted by Scientific American, which has published articles on the "War on Science" which is already underway in the US. Concerns were raised in the parliamentary forum that this could also extend to Australia, although the Hon. Craig Landy MP (Assistant Minister for Industry, Innovation and Science) had faith in Australians and that this may be avoided. The Hon. Richard Marles MP, (Shadow Minister for Defence), argued that it is essential we avoid a scenario where science is turned into a religion which people can choose to follow (or not). The Hon. Adam Bandt MP, (Australian Greens Spokesperson for Science), believed that, eventually, Australia needs to get to a point where no politician should fear for their job if they do not cut the science budget.

Science outreach, community engagement and inspiration are key. Dr Bobby Cerini from the Inspiring Australia Programme told delegates that inspiration comes from people taking the time to communicate what they are passionate about. Another theme across both days of SmP was diversity and equality, in particular the increasing number of women in science and the problems retaining them throughout their careers. During a televised lunchtime address at the National Press Club on day two, the Hon. Arthur Sinodinos (Minister for Industry, Innovation and Science) focused on this issue, with a powerful video being shown: "What If Millie Dresselhaus, Female Scientist, Was Treated Like A Celebrity" (watch the video here – it's excellent: https://www.youtube.com/watch?v=sQ6_fOX7ITQ). In the parliamentary forum, the Hon. Karen Andrews MP also spoke on this issue. Andrews pointed out that women should not be employed simply to "tick a box", but that the school of thought needs to be changed, whereby equality is needed to fill a skills gap. She emphasised that it is therefore essential that an environment more supportive of scientists is created.

During his rousing speech to the delegates at the Gala Dinner on the evening of day one, the Hon. Bill Shorten MP questioned why there is often discourse surrounding risks that small business owners take, yet the risk that scientists take pursuing their careers is ignored (i.e. scientists spend 7+ years studying to be faced with minimal job security at the end). Job security was also a focus of the Early Career Researchers (ECR's) "speed-dating" networking function during lunch on day one; where each "date" consisted of a quick introduction and "pitch" of each participant's research before moving onto a discussion. Key topics included: how can we address diversity? Do you have a contingency plan if academia does not work? How can we increase job security?

For the ECRs in particular it was very interesting to learn of scientific career pathways in industry. Dr Alex Zelinsky, Chief Defence Scientist, spoke of his "non-linear" transition from engineering and research to defence, whilst Dr Subho Banerjee, the Deputy

Figure 4: Lunchtime address at the National Press Club. (Photo credit: Mark Graham).

Figure 5: Gala dinner in New Parliament House. (Photo credit: Mark Graham).

Secretary for the Department of Education and Training also spoke of his move from a science degree into a government agency. Dr Zelinksy and Dr Banerjee both highlighted the need for continued scientific curiosity, thinking and imagination in career pathways outside of academia. Many felt that the transition from university to industry was difficult, and that, in future, greater collaboration between industry and academia was required.

Included in these fascinating discussions was advice to delegates on how to communicate their science to politicians. This was highlighted particularly during a panel discussion on "how to convince parliamentarians", which included an interactive rehearsal session. During the interactive rehearsal session techniques for effective communication with non-experts were practiced in pairs, and then delegates were split into groups of four. In each group each person took turn to 'pitch their research' in a two minute timeframe. The others in the group then gave feedback. The process was then repeated, but with half the time available, until eventually the pitches were reduced to 15 seconds (leading to a very distilled version!).

Unfortunately, my meeting with Senator Kimberley Kitching was cancelled due to what appeared to be a rather hectic day in Parliament House, however valuable skills were gained during these workshops. The delegates also had the opportunity to attend Question Time, which was an incredibly interesting insight into how parliament functions (or doesn't!).

Brad Pillans had more luck with his politician – Brad spent an enjoyable 30 minutes with Pat Conroy MP, Labor member for the electorate of Shortland, near Newcastle. Brad says it was a pleasure to meet a politician with very well-informed views on climate change and energy issues.

Just weeks after being made Australian of the Year, Professor Alan Mackay-Sim also addressed the delegates and shared his vision for science. He argued that for a long time Australia has been accustomed to living a developed country's lifestyle, yet has relied on primary production industries (e.g. the mining industry). To maintain and continue the living standards we currently enjoy Australia needs to make a move towards knowledge-based industry and science. The conference ended with a parting piece of sage advice to delegates from the Hon. Kim Carr: "be optimistic".

I thoroughly enjoyed my two days in parliament and learnt valuable lessons about communicating science effectively to decision makers and importantly, the challenges that the scientific community face. A very sincere thank you to AQUA for making this trip possible.

Figure 6: Emily Field and fellow School of Earth and Environmental Sciences researcher Dr Elin Charles-Edwards (first and second from the right) with two astronomers following the "science in 60 seconds workshop". (Photo credit: Mark Graham).

Below: Figure 7: From left to right: Brett Rosolen (AARNet), Regina Sander (CSIRO), Brad Pillans and Pat Conroy MP, after a productive meeting during SmP. (Photo credit: The office of Pat Conroy).

Bottom: Figure 8: In conversation with Australian of the year Professor Alan Mackay-Sim. (Photo credit: Mark Graham).

A brief report on the inaugural SHeMax workshop. Auckland, New Zealand, 3-4 December 2016.

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The first weekend of December 2016 saw around 40 participants attend the inaugural Last Glacial Maximum in the Southern Hemisphere (SHeMax) workshop. SHeMax is a new INQUA-funded project that builds on past work done by the SHAPE and INTIMATE projects, with a specific focus on the nature and timing of the LGM in the Southern Hemisphere. A key focus of the SHeMax project will be to describe climatic variability in the Southern Hemisphere during the LGM. The records currently available for this time are of low spatial – and often chronological – resolution (Shakun and Carlson, 2010). The signal appears to vary by both proxy and region, although several proxy datasets (e.g. Denton et al., 1999; Kershaw et al., 2007; Vandergoes et al., 2005) suggest an earlier onset of glacial conditions than the global LGM (approximately 26-18 ka; e.g. Clark et al., 2009; Hughes and Gibbard, 2014). It has also been suggested that the LGM was not uniformly cold and dry as per the established paradigm (Reeves et al., 2013), but instead featured millennial-scale variability. The aim of the workshop was to summarise the current state of knowledge in a series of regional syntheses, and then discuss the scope of initial work to be done under the auspices of the project. The meeting was run by three of the four executive committee members of SHeMax – Lynda Petherick, Jasper Knight, and Jamie Shulmeister – with support from Drew Lorrey and New Zealand's National Institute of Water and Atmospheric Research (NIWA).

The workshop was held at the NIWA office in Auckland, a stone's throw from the sparkling waters of the Viaduct Harbour. The meeting attracted attendees from such far-flung locations as South Africa, the United Kingdom, and even Australia, as well as two INQUA-funded attendees – Ignacio Jara (Chile), and Peter Eze (Botswana). Twenty(!) of the attendees were postgraduate students, which promises good things to come for the future of Southern Hemisphere palaeoclimate research.

The morning of each day was devoted to a series of regional summaries, each presented by an expert in the area. A few key points from each summary include:

- Southern Africa (Peter Eze)
  - The onset of the LGM appears to be gradual rather than abrupt
  - A lack of data, due largely to poor preservation of LGM-aged sediment, as well as the lack of researchers
  - There is an urgent need for extensive, multi-proxy datasets
- South America (Ignacio Jara)
  - Evidence for the timing of the LGM is variable, with maximal glacier advances generally occurring before minimal SSTs
  - It is difficult to disentangle temperature from precipitation change from existing records
- Tropical Australia (Lynda Petherick)
  - Some evidence for climatic variability through the LGM
  - Very few continuous records through the LGM
  - It is difficult to disentangle temperature, precipitation, and anthropogenically-driven change
- Temperate Australia (Jamie Shulmeister)
  - The onset of the LGM is not clear from existing records, but the switch to glacial conditions generally seems to be closer to 40 ka than 30 ka, with maximum temperature depression 22-18 ka
- Arid interior of Australia (Paul Hesse)
  - No consistency in the timing of events, due in part to the quality of records and chronologies
  - Proxies generally suggests a cold climate, with high summer precipitation/evaporation, and persistent woodland
  - Driest period appears to have been much later (Holocene)
- The oceans (Helen Bostock, with contributions from Patrick de Deckker, Tim Barrows, Julia Gottschalk, Zanna Chase, Luke Skinner and Elisabeth Michel)
  - Southern Ocean records suggest a gradual transition into an early LGM from 30-27 ka, with peak LGM at 23 ka, and an abrupt transition out of glacial conditions ~18 ka
  - Subtropical ocean records show less obvious glacial structure, but this may be due to local circulation

- Australian glaciers (Tim Barrows)
  - New production and scaling rates published in 2016 will affect conclusions about the timing of the LGM from glacier records
  - Temperature or precipitation as the key driver of glacial extent?
- Sub-Antarctic islands (Krystyna Saunders)
  - It is unclear whether the sub-Antarctic islands preserve a synchronous glacial signal, and whether this follows a Southern Hemisphere or Northern Hemisphere pattern
  - Glacial histories vary between islands, most likely due to latitudinal changes in climate and topographic control on glacial equilibrium line altitude
- Antarctic margin and interior(Duanne White and Joel Pedro)
  - LGM onset difficult to determine at margin, but deglacial conditions preserved ~18-20 ka, or as late as 14 ka in some parts of the East Antarctic ice sheet
  - LGM cooling in ice core records began ~27.8 ka
  - All Antarctic ice cores show strong warming by 18 ka, although warming may have commenced in West Antarctic as early as 20 ka
  - Lake and shelf sediments are generally missing LGM-aged sediment
- New Zealand (Marcus Vandergoes, with contributions from Rewi Newnham, David Barrell, Shaun Eaves, and Matt Ryan)
  - Notable climate variability recorded during the LGM, with three stadial-like episodes recorded in pollen records from the south Westland around 28.7-25.5, 24.4-22.6, and 21.9-18.5 ka. This pattern of variability appears to be broadly applicable to the rest of New Zealand
  - Moraine records suggest maximum glacier extent around 28 ka, with glacier retreat generally underway by ~17 ka

On the afternoon of the first day, we were also treated to two new palaeoclimate records –a hydrological record from the riverine plains of south-eastern Australia (Justine Kemp), and a speleothem record of hydroclimate from the Flinders Ranges of South Australia (John Hellstrom).These data provided new insights into the delivery of moisture to Australia during the LGM. It was particularly exciting to see this new data for the arid margins, an area characterised by limited sediment preservation. So it seems that new proxy data collection is off to a good start!

The remainder of the workshop was spent in discussion, including the identification of major knowledge gaps that will be targeted as part of the SHeMax project. Some initial discussion time was devoted to key definitions that are necessary to define the scope of the project. An obvious – but significant – issue is that the timing of the LGM in the Southern Hemisphere is different to the global LGM as defined by $\delta^{18}O$ stratigraphy (Martinson et al., 1987), sea level records(Clark and Mix, 2002),or maximum global ice sheet extent(Clark et al., 2009). There is therefore uncertainty in the time span that the SHeMax project will cover. For example, glacial conditions in Australia may have commenced as early as 40 ka (e.g. Williams et al., 2006). The deglaciation appears to have commenced fairly uniformly around ~19-18 ka, such that an end date around 15 ka will encompass the termination of glacial conditions. A reasonable period of investigation for the project may therefore be 40-15 ka, although it may be that this time period will be flexible by region. A related issue is that of etymology –a variably-timed LGM in the Southern Hemisphere has been referred to as the 'early LGM (eLGM)' (Fogwill et al., 2015), and the 'local LGM (lLGM)' (Putnam et al., 2013)– a consensus is needed on the terminology to be used in future publications. A few more ideas were thrown around, including the 'Southern Hemisphere extended cold period', and my personal favourite, 'Goethe's Epoch of Great Cold'. We also provisionally defined spatial limits of investigation of 80°S and 15°S for the project, although these may also be proxy – and region – dependent.

On the morning of the second day of the workshop, we split into smaller groups to discuss specific themes including proxy data, chronologies, quantitative data, land-ocean relationships, glacier records, oceans, and model-data comparisons. After an hour or so of discussion, each small group presented their thoughts, during which the challenges of characterising the LGM in the Southern Hemisphere were openly acknowledged. It is clear that there are at least two major spatial gaps in our knowledge – both Western Australia and southern Africa are underrepresented in proxy datasets, due both to the nature of the environments, and a lack of researchers working in the regions.

In general, it seems that a more thorough understanding of our proxy data is required. Some considerations discussed include investigating what season/s are reflected by each proxy, whether changes are due to climate, environmental, or anthropogenic impacts, whether proxies record a local or regional signature, the lag time of proxies to environmental changes, and, in the case of pollen, whether changes are due to temperature variation or vegetation succession. Addressing these

issues may account for some variability observed between LGM climate records, and hence take us some of the way to reconciling proxy-specific differences in LGM climate reconstructions.

Chronological control on our proxy data was also highlighted as an area of concern, although terrestrial reservoirs in the Southern Hemisphere are often relatively difficult to date, due to slow accumulation rates and/or discontinuous preservation. Chronological control is also a major problem in ocean records, owing to large and uncertain reservoir effects, particularly around the Antarctic margins. Regarding the development of age-depth models from individual dates, an interesting question is whether we should consider 'anomalous' ages i.e. those identified as outliers and excluded from the age-depth model. This will be a point for future consideration, along with the possibility of standardising the software used to create age-depth models for SHeMax records. In terms of the presentation of chronological data, we were reminded to always present ages with appropriate error bars! A key outcome of this discussion was that we will aim for records contributing to the SHeMax project to be presented on chronologies constrained by a minimum of one date per 1000 years. When a chronology is not sufficiently well-resolved, then we should be careful not to over-interpret the associated proxy data (e.g. interpret events at a millennial scale).

Several other priorities were identified during the small-group discussions, including a need for more quantitative data, a need for a better understanding of modern climate drivers in the Southern Hemisphere, and a tendency to look for signals that we think should be in the record, rather than interpreting data objectively. We also discussed the use of proxy data to validate model simulations – for example, proxy data tend not to resemble the Southern Hemisphere insolation curve, but models frequently produce outputs that do. The outcome of this discussion was for each of the presenters of a regional summary to produce an assessment of that region for two time slices: 21 and 32 ka ± 1000 years. These will be included in the first SHeMax publication, and will form the basis for a comparison with PMIP model outputs.

The workshop concluded with a discussion of the next step in the SHeMax project, namely the publication of a framing paper outlining what we mean when we discuss the 'LGM', as well as the issues identified during the workshop. The paper will also include the time-slice summaries for each region, with full regional summaries to be published in individual articles in a special edition later in the year. We anticipate the paper being available in early 2017.

For a mid-term PhD student about to attend her first AQUA conference, this workshop was a fantastic introduction both to the colourful AQUA community, and to the many issues faced by those of us working in the Southern Hemisphere LGM. On the flip side of that coin, it is clear that there are exciting opportunities for new research, and hopefully the SHeMax project will provide the foundation for a better understanding of the drivers of LGM climatic variability in the Southern Hemisphere. The workshop was both well attended and very well organised, with some delicious snacks supplied by NIWA providing us with the necessary fuel for our lively discussions. The workshop was certainly a success, with several tangible outcomes, and we went into the week of the AQUA conference with the way well paved for the direction of future SH research. For further details about the SHeMax project, please contact Lynda Petherick (lynda.petherick@vuw.ac.nz).

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Numerical Analysis of Palaeoenvironmental Data course

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It was with a mixture of anticipation and trepidation that the participants of the Numerical Analysis of Palaeoenvironmental Data course (13/2/2017), held at the University of Adelaide, entered the room. Participants had travelled from all across Australia, with attendees from James Cook University, Universities of Sydney, NSW, Melbourne, Western Australia, Southern Cross University, Australian Nuclear Science and Technology Organisation, as well as from Auckland and Victoria Universities, New Zealand. Ten days of learning statistics and 'R code' from one of the world's foremost experts? Sure, they said. It'll be fun, they said...

The course instructor was Gavin Simpson, a world class 'R' expert and quantitative (palaeo) ecologist who uses statistical methods to address his research objectives. Prior to his current appointment at University of Regina, Saskatchewan, Canada, Gavin worked as a research associate at the Environmental Change Research Centre, University College London with John Birks; a pioneer of quantitative techniques in palaeoecology.

The course was composed of morning lectures; where the theory of the statistical approaches we were applying was introduced, and afternoon practicals that put our new knowledge into practice. All statistical application techniques undertaken in R were structured for individuals of all skill levels. The topics covered included introduction to R, linear regressions and modelling, time series analysis using wavelet and spectral analysis and the application of Generalised Additive Models (GAMs). A large focus of the course centred on stratigraphic techniques and ordinations, including application of cluster analysis and rate of change analysis as well as other statistical techniques to summarize data.

Mid-week, Gavin presented a seminar highlighting some of his latest research: using GAMs to test recovery of aquatic ecosystems from eutrophication, based on diatom composition data. He also discussed the use of GAMs as a method for testing regime shifts in time series data to determine the presence of alternate stable states. The variance within the dataset was modelled with GAMs to examine fluxes in variance and return of stability of an ecosystem. This seminar highlighted the potential use of statistics, particularly GAMs, in palaeolimnology.

To conclude the course, participants were asked to identify additional statistical topics and questions they wished to discuss. Gavin then diligently developed a series of impromptu lectures based on the group's suggestions for the final day of the first week. Those who were able to stay for the second week of the course met with Gavin for one-on-one advice on individual data sets.

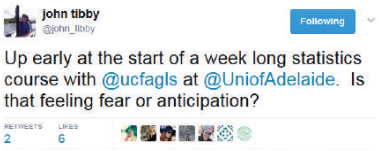
Thankfully the intensity of a 10 day statistics course was offset by an array of social events. Each evening the day's statistics were counterbalanced with a G&T at one of the local's favourite venues, The Howling Owl. On Wednesday a group dinner was held at the Lady Burra Brew House, where locally brewed craft beer and burgers were a hit (Figure 1). Of course, no trip to Adelaide is

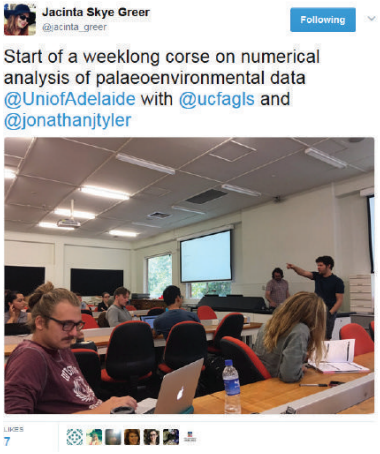
complete without visiting some of South Australia's stunning wineries. A wine tour was organised through beautiful McLaren Vale for several of the out-of-town visitors on the Saturday. A short stop at Aldinga Beach ended the wine tour nicely with some sunshine and sand, looking over the Southern Ocean (Figure 2).

A very big thank you to Jonathan Tyler for all of his efforts in organising this workshop. It was an extraordinary opportunity to learn about practical statistical techniques and their applications in palaeoecology, from a world class expert. The knowledge gained during the course will continue to benefit both the individual participants and the broader AQUA community for a long time. We cannot thank Gavin enough for making the trip to the Southern Hemisphere to help us all become a little more stats-savvy.

Figure 1: Mid-week group dinner at the Lady Burra Brew house. (Photo credit: Kristen Beck)

Figure 2: A very merry group at Aldinga Beach at the end of a lovely day of wine and cheese tasting in McLaren Vale. (Photo credit: Kristen Beck)





THESIS ABSTRACTS

Ocean Deoxygenation: a paleo-proxy perspective

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Global warming is driving oxygen loss from the oceans, the consequences of which are far reaching for organisms that depend on dissolved oxygen to live. The Southern Ocean (SO) accounts for one quarter of the total oxygen loss since 1970. However, future trends remain unclear.

To help forecast future SO deoxygenation accurately, a precise knowledge of historical oxygen trends and their drivers is essential. In this thesis, 12 sediment cores retrieved from the New Zealand region were used to investigate dissolved oxygen changes in the southwest Pacific sector of the SO since the Last Glacial Maximum (LGM) as well as the potential factors driving these changes.

Sediment composition must be quantified to identify potential changes in oxygenation. This requires the complete digestion of the sediments. However, due to the carbonate rich composition of the New Zealand sediments, their digestion remains a challenge. A new method described in this thesis addresses this problem and shows that exposing sediments to concentrated HCl at 150°C before microwave digestion resolves the issue. Using this method to investigate authigenic-Uranium and Rhenium (aU and aRe) variations in the sediments, this thesis demonstrates that intermediate depths of the southwest Pacific sector of the SO were deoxygenated during the LGM compared to the Holocene.

To explain this change, export production (EP) and circulation changes were investigated. EP was found to be mostly constant throughout the time studied and did not drive observed oxygen changes. However, dramatic circulation changes were inferred from benthic foraminiferal $\delta^{13}C$ variations together with aU and aRe variations. These circulation changes induced a deepening of oxygen rich Antarctic Intermediate Water (AAIW) between the LGM and the Holocene as well as an increase in AAIW oxygen content. These results are at odds with earlier work and highlight an asymmetry in AAIW response to climatic forcing during the LGM in the Pacific.

Palaeoecology of the South Wellesley Archipelago. A history of human occupation and environmental change

Lydia Mackenzie (PhD)

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A wealth of palaeoecological studies from the Australasian region identify periods of significant environmental change during the Holocene. However, relatively few studies have focused on the coastal lowlands of tropical northern Australia. This thesis addresses the gap in spatially distributed paleoenvironmental research in northern Australia by producing the first reconstructions from the South Wellesley Islands in the Southern Gulf of Carpentaria. Radioisotope analysis of lead (^{210}Pb), plutonium ($^{239/240}Pu$) and radiocarbon (^{14}C) provide robust geochronologies. Chronologies are combined with loss on ignition, particle size and micro X-ray fluorescence analysis of sediment cores to identify site formation and development through time. Pollen, macroscopic and microscopic charcoal records reconstruct vegetation change and fire regimes across the island throughout the late Holocene.

This research examines seven sediment profiles using micro X-ray fluorescence geochemical data and particle size analysis. An open coastal environment was present 1,250 cal. yr BP on the southeast coast of Bentinck Island, with fluvial deposition of detrital elements from the eroding lateritic bedrock. A prograding shoreline, dune development and tributary diversion created a series of swales parallel to the coast by 800 cal. yr BP, forming the extensive Marralda Wetlands. Saline mudflats developed at sites on the north and west coast 500 and 450 cal. yr BP, respectively. Geochemical and grain size analyses find wetlands formed as accreting supratidal environments or coastal swales intercepting groundwater. The timing of coastal environments transitioning to saline mudflats and eventual wetland development indicates localised late Holocene sea-level regression, stabilisation and coastal plain development in the southern Gulf of Carpentaria. Elemental data identifies phases of wetland development across Bentinck Island, highlighting the value of geochemical analysis as a proxy of past environments in tropical northern Australia.

Fossil pollen and charcoal analysis of four key wetlands across Bentinck Island reconstruct vegetation succession and fire regimes in the late Holocene. The Marralda

Swamp wetlands on the protected southeast coast found a diverse mangrove community was present between 1,250 and 850 cal. yr BP, with particle size analysis indicating a high-energy environment associated with a tributary. Palynological results find mangrove species declined and woodland, savanna and freshwater aquatic taxa increased by 800 cal. yr BP indicating a brackish/freshwater wetland developed. Further freshwater expansion occurred on the southeast coast by 400 cal. yr BP, reaching its maximum extent in the last 200 years. Palynological investigations from the north and west coast of Bentinck Island encompass the last 550 cal. yr BP. On the west coast an open savanna landscape is replaced by a mixed woodland and aquatic taxa significantly increase suggesting wetland expansion in the last 200 years. On the north coast the salt tolerant Chenopodiaceae dominates the site, suggesting a hypersaline mudflat developed 450 cal. yr BP. The increasing presence of Pandanus and the appearance of aquatic taxa suggest this site remained an ephemeral source of freshwater during the monsoon season.

This thesis reconstructs vegetation and fire regimes during periods of human occupation and abandonment of Bentinck Island, separating anthropogenic and natural drivers of change during the Holocene. Macro charcoal results analysed using CharAnalysis find interpolated charcoal accumulation increased between 350-200 cal. yr BP on the southeast and west coast of Bentinck Island. Charcoal results correlate with archaeological evidence of population increase on Bentinck Island in the late Holocene. The traditional owners were removed from Bentinck Island in 1948, leaving the South Wellesley Islands unoccupied for the first time in 2,000 years. Peak charcoal and magnitude significantly increase across all sites after AD 1950. Results find the removal of Kaiadilt people interrupted traditional burning practices causing the frequency and intensity of fire regimes to significantly increase.

Lake Wellington's History: A Palaeoecological Approach

Adrian Bonica (Honours)

School of Applied and Biomedical Science, Federation University, Victoria, Australia.

Lake Wellington is one of four permanently linked lakes which make up the Gippsland Lakes system. Amongst these lakes, Lake Wellington is unique for its large size, diverse wetlands, and comparatively low salinity. However, over the two decades, salinity in Lake Wellington has attracted increasing concern over its rising trend, and its implications on wetland vegetation and biodiversity. Currently, little historical data exists regarding the lake's baseline salinity conditions, and is therefore pertinent to investigate Lake Wellington's palaeo-environmetal proxies to establish how salinity changed since early European arrival.

This research aims to analyse a 2.5 m sediment core from Lake Wellington, to investigate historical salinity fluctuations, and identify signatures of catchment modification and its consequences. To provide more reliable insight into past conditions, a multi proxy approach has been employed. Diatom species are identified, their known salinity tolerances investigated, and ITRAX profiles produced for titanium, silicone, potassium and chloride. Elemental profiles of Cl suggests NaCl in Lake Wellington has steadily increased, while Si, K and Ti indicates periodic flood events and deposition river bank sediment respectively. Flood event inferences are further supported by particle size distribution measurements made using laser diffraction methods. Loss on ignition techniques are also adopted to determine Lake Wellington's organic and carbonate content, and ostracods are sampled to evaluate historical macrofossil ecology, and therefore aquatic conditions. Results indicate that prior to the construction of an artificial tidal inlet connecting the eastern lakes to Bass Strait, Lake Wellington may have been periodically subjected to minor salinity increases, though not to the degree presently observed. Complementing ITRAX data supports the notion of a gradual yet prolonged salinity rise in Lake Wellington since European arrival. However, diatom results illustrate a step change in salinity following the tidal inlet's construction. Here dominant species in diatom communities shift, reducing in brackish water species *Cyclotella striata* and *Cyclotella choctawhatceeana*, and increasing in thalassic species *Thalassiosira* spp. Diatom results indicate brief periods of heightened salinity prior to the opening of the artificial entrance, likely associated with drought and low river flow. However following the entrance's opening, an increase in Lake Wellington's average salinity took place.

Solving the monkey puzzle: Long-term environmental history of *Araucaria araucana* (the monkey puzzle tree)

Bianca Dickson (Honours)

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Disturbance is a key process driving ecosystem dynamics, with one of the fundamental processes underpinning ecological concepts, succession, explaining the development of an ecosystem following disturbance. Despite the importance of disturbance in ecosystem dynamics, disturbance ecology is a relatively unexplored field. Within disturbance ecology, focus is typically on common and widespread disturbance events (e.g. fire), which are often involved in deep ecological relationships with organisms. In contrast, relatively little is known about the long-term influence of less widespread disturbances, such as volcanism on ecosystems. This thesis explores the role of disturbance from volcanic ashfall on ecosystem dynamics within a forest type that is situated within one of the highest densities of active volcanoes on Earth, the *Araucaria araucana* forests of south-central Chile.

The impact of volcanic eruptions on the immediate vicinity surrounding an eruption centre is, while often catastrophic and well documented, usually of limited spatial extent. By far the largest spatial impact of volcanic eruptions is via the spread and deposition of ash (herein: tephra). Tephra deposits can blanket landscapes in layers that are many metres thick, disturbing ecosystem dynamics, particularly vegetation systems. The limited evidence of the role of volcanic ashfall on vegetation dynamics reveals two important influences: (1) that tephra deposition can cause a significant disruption of vegetation dynamics and (2) that the thickness of a tephra deposit is proportionate to its impact on vegetation.

The current distribution of *A. araucana* forests, at high altitude and primarily within one of the highest densities of active volcanoes on Earth, prompts questions over the role of volcanic disturbance in this ecosystem. This project aims to better understand long-term vegetation dynamics and response to tephra deposition in *A. araucana* forests of the Araucanía region of Central Chile.

This region has been blanketed in tephra fallouts over the last few millennia, with one known event, the Alpehue Tephra deposited ca. 2900 years ago, being up to 3-m thick. A sediment core was extracted from Lago Cilantro (a site located within an *A. araucana* forest surrounded by active volcanoes and within the Alpehue Tephra limits) and analysed for the effects of volcanic disturbance on vegetation dynamics using a set of palaeoecological proxies. The results indicate that over the last ca. 9000 years, while some shifts in the local vegetation were correlated with volcanic events, *A. araucana* ecosystems are remarkably resilient to even large-scale (>2.5 m thick) deposition of volcanic ash. Instead, long-term vegetation dynamics in this region were governed by climatic change. This project will increase knowledge of how potentially vulnerable species, such as *A. araucana*, respond to both climatic change and disturbance to predict their response to future environmental changes.

North By Northwest: A palaeoecological study of the archaeology in northwest Tasmania.

Anthony Romano (Honours)

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To achieve the global imperative of sustainability, we must understand the various factors that have shaped our environment. This is particularly important for recently European colonised landscapes, such as Australia, in which imported landscape management paradigms have resulted in widespread environmental degradation. In this context, integrative studies of archaeology and palaeoecology that provide important insights into how inhabited landscapes have evolved in concert with humans are a critical and necessary endeavour. The research presented here seeks to understand the various influences in landscape development over recent millennia in northwest Tasmania, a part of Australia that was subject to periodic intense occupation and exploitation during this time. I employ an interdisciplinary approach that has the potential to provide important insights into the historical legacy of humans in Australia and critical information relevant for the sustainable management of Australian landscapes.

Tasmania has a long history of human occupation (ca. 40,000 years). The arrival of Aboriginal Australians and their millennia of land management practices have imparted a deep influence on the landscape, while the invasion of Europeans, in contrast, has resulted in rapid and often catastrophic environmental degradation. This study aims to provide an environmental context for the rich archaeological record of northwest Tasmania's Western Tasmanian Aboriginal Cultural Landscape (WTACL) National Heritage area and determine the impact, if any, of Aboriginal land management on the environment surrounding occupation sites. Multiple lake sediment archives from across northwest Tasmania situated in close proximity to archaeological sites were analysed for past environmental (palaeoenvironmental) changes using a set of palaeoecological approaches.

Inferred palaeoenvironmental changes were assessed against changes in the archaeological record, estimates of human population growth and climatic change. The data reveals the combined effects of fire, climate, hydrology and people on long-term environmental change in the study region, along with indications of a period of increased climatic variability during which an occupied site becomes less variable and an unoccupied site becomes more variable. This study is the first comprehensive research into the archaeology and palaeoecology of the northwest coast of Tasmania and will provide critical insights into long-term human-environment interactions in Australia.

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UPCOMING MEETINGS

JULY 2017

12th International Mammalogical Congress

Venue: Perth, Western Australia

Date: 9-14 July 2017

www.promaco.com.au/IMC12/index.php.

Institute of Australian Geographers Conference

Venue: University of Queensland

Date: 11 – 14 July 2017

Session on Australian Wetland Palaeoecology Through Time

https://absoluteevents.eventsair.com/QuickEventWebsitePortal/iag2017/web

17th International Congress of Speleology (17th ICS)

Venue: Penrith, Western Sydney, Australia

Date: 23 – 29 July 2017

www.speleo2017.com

AUGUST 2017

AUGEN (Australasian University Geoscience Educators Network) Conference

Venue: The University of Sydney

Date: 5-6 August

Who: First-time and experienced educators, students, postdoctoral fellows, professional society representatives, high school science teachers, plus academic, industry and government geoscientists. Registration is free and includes tea/coffee and lunch.

www.eventbrite.com.au/e/2017-augen-conference-tickets-29916807978

Asia Oceania Geoscience Society (AOGS) meeting

Venue: Singapore

Date: 6-11 August, 2017

Session SE7: Advances in Geochronology Shedding New Light on Landscape Denudation: the Source-to-Sink Sediment Conveyor

www.asiaoceania.org/aogs2017/public.asp?page=home.htm

"Best practices in tephra collection, analysis, and reporting – leading toward better tephra databases" workshop (INTAV, SACCOM)

Venue: Portland, USA

Date: 14-18 August, 2017

www.iavcei2017.org/postA_2.html

10th International Carbon Dioxide Conference (ICDC10)

Venue: Interlaken, Switzerland

Date: 20-25 August 2017

www.oeschger.unibe.ch/events/conferences/icdc10/

INQUA Peribaltic Working Group Field Conference "From past to present – Late Pleistocene, last deglaciation and modern glaciers in the center of northern Fennoscandia" (Peribaltic Working Group, TERPRO)

Venue: Finland-Sweden-Norway

Date: 20-25 August 2017

www.inqua-peribaltic.ut.ee/inqua-peribaltic-working-group

Past Climate Changes Symposium

Venue: Cape Town, South Africa

Date: 27 August – 1 September 2017

www.pages-igbp.org/calendar/upcoming/127-pages/1645-past-clim-chg-symp-sth-afr-17

"The backwoods: at the periphery of the adaptive zone" (Ground squirrels on the march, HABCOM) meeting

Venue: Ukraine

Date: 28 August-3 September 2017

www.inqua.org/habcom/projects/1606.html

SEPTEMBER 2017

Field meeting "Late Cenozoic evolution of Yellow River and its environs" (HEX, TERPRO)

Venue: Lanzhou, China

Date: 10-18 September, 2017

www.qra.org.uk/events/?id=35

DATESTRA Session at SEQS 2017 (SEQS, SACCOM)

Venue: Tautavel, France

Date: 11-15 September, 2017

www.datestra-seqs.strikingly.com/#2017-activities

Annual meeting "G@GPS: Groundwater and Global Palaeoclimate Signals" at 44th IAH conference (G@GPS, TERPRO)

Venue: Dubrovnik, Croatia

Date: 25-29 September, 2017

www.iah2017.org

OCTOBER 2017

CAVEPS New Zealand

Venue: Skyline, Queenstown

Date: 2-6 October, 2017

www.facebook.com/groups/418078698316877

LoessFest (Loess and Pedostratigraphy, SACCOM)

Venue: Gorgan, Iran

Date: 8-12 October, 2017

www.loessfest2017.com

NOVEMBER 2017

9th International Conference on Geomorphology

Venue: New Delhi, India

Date: 6-11 November, 2017

Session: "Palaeohydrology and Fluvial Archives – hydrological extreme and critical events (HEX, TERPRO)"

www.icg2017.com

8th PATA Days meeting International Workshop on Paleoseismology, Active Tectonics and Archeoseismology (EGSHaz, TERPRO)

Venue: Blemheim, New Zealand

Date: 13-19 November, 2017

www.gns.cri.nz/Home/News-and-Events/Events/PATA/Welcome

DECEMBER 2017

Australian Archaeology Association Conference

Venue: Latrobe University, Bundoora

Date: 6-8 December, 2017

2018

JUNE 2018

INQUA INTAV

Venue: Brasov, Rumania

Date: 25-29 June, 2018

AUGUST 2018

20th International Sedimentological Congress

Venue: Quebec City, Canada

Date: 13-17 August, 2018

www.isc2018.org

ADVANCED NOTICE

JULY 2019

XX INQUA Congress

Venue: Dublin, Ireland

Date: 25-31 July 2019

www.inqua2019.org

SEPTEMBER 2019

The International Conference on Paleoceanography (ICP13)

DATES TO BE CONFIRMED

2019

SVP Brisbane

2020

Palaeo Down Under 3 Brisbane

Figure 1: View of Brasov. Photo credit: Constantin Barbu. https://commons.wikimedia.org/w/index.php?curid=11002974

TEPHRA HUNT IN TRANSYLVANIA, AN INTER-CONGRESS FIELD CONFERENCE ON TEPHROCHRONOLOGY AND ITS APPLICATIONS

Brasov, Romania, 25-29 June 2018

We are pleased to announce that the next inter-congress meeting of the International Focus Group on Tephrochronology and Volcanism (INTAV) is to be held in Brasov, Romania, 25-29 June, 2018.

A medieval city in the Transylvanian region of Romania, Brasov is located in the southern Carpathian Mountains and easily accessible from Bucharest. It is near to several late Quaternary volcanic centres and the loess fields of the Danube-Black Sea area, where tephra has played an important role in providing chronology for these sequences. The INTAV executive thank Daniel Veres and the local organizing committee for offering to host INTAV, and to welcome us to such a geologically diverse and culturally-rich region that is a bit off the beaten path.

The conference, together with several workshops, promises to be a truly interesting, informative, and memorable event. There will be something for everyone. A special feature will be a 50th anniversary commemoration of the publication of the first paper on the use of the electron probe to analyse glass shards as a correlational tool for tephrochronology (D.G.W. Smith and J.A. Westgate, 1968, Earth & Plan. Sci. Letters 5, 313-319).

This will be the first fully-fledged field conference on tephrochronology and applications to be held since the seminal meetings in Kirishima, Japan, in 2010, and in Dawson City, Yukon Territory, 2005, and so will be an opportunity not to be missed. Catch up with friends old and new and find out the latest advances in our discipline whilst enjoying the hospitality of friends and colleagues in Romania and adjacent countries and their fantastic landscapes and cultures. As well as local intra-conference trips, post – or pre-conference field trips may be offered.

INTAV and the LOC are applying for funding support from INQUA, PAGES, and other sources to help support students, early career researchers, and scientists from countries with low GDPs, to attend the conference. So, ECRs, students and others: please talk to your supervisors now and plan to come to Brasov in 2018!

More details about the conference will be provided soon.

Local organizing committee:

- Dr Daniel Veres, Convenor/Chair, Romanian Academy and Babes-Bolyai University, Cluj, Romania (tephrochronology, paleoclimate)
- Prof David Karatson, ELTE Budapest, Hungary (geomorphologist, volcanologist)
- Dr Ioan Seghedi, Romanian Geological Survey (volcanologist, geochemist)

Figure 2: View of Ciomadul lava dome complex, East Carpathians, Romania, that has seen explosive eruptions between c. 51,000 and 29,000 years ago (from Karátson et al., 2017). Photo credit: INQUA.

- Dr Alexandru Szakacs, Sapientia University, Cluj, Romania (volcanologist, geochemist)
- Dr Ulrich Hambach, Chair of Geomorphology, University of Bayreuth, Germany (loess magnetism and paleoclimate)
- Dr Alida Timar-Gabor, Babes-Bolyai University, Cluj, Romanian Academy (OSL dating)
- Prof Cristian Panaiotu, University of Bucharest, Romania (paleomagnetism)
- Dr Britta Jensen (Unvi. of Alberta, Canada), INTAV liason/support

REFERENCE

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Quaternary AUSTRALASIA

Quaternary Australasia publishes news, commentary, notices of upcoming events, travel, conference and research reports, post-graduate thesis abstracts and peer-reviewed research papers of interest to the Australasian Quaternary research community. Cartoons, sardonic memoirs and images of mystery fossils are also welcome.

The Australasian Quaternary Association (AQUA) is an informal group of people interested in the manifold phenomena of the Quaternary Period. It seeks to encourage research by younger workers in particular; to promote scientific communication between Australia, New Zealand and Oceania; and to inform members of current research and publications. It holds biennial meetings and publishes the journal Quaternary Australasia twice a year.

Full annual membership of AQUA with an electronic subscription to QA is AUD50, or AUD35 for students, unemployed or retired people. The AQUA website (www.aqua.org.au) has information about becoming a member; alternatively please contact the Treasurer (address below). Members joining after September gain membership for the following year. Existing members will be sent a reminder in December.

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