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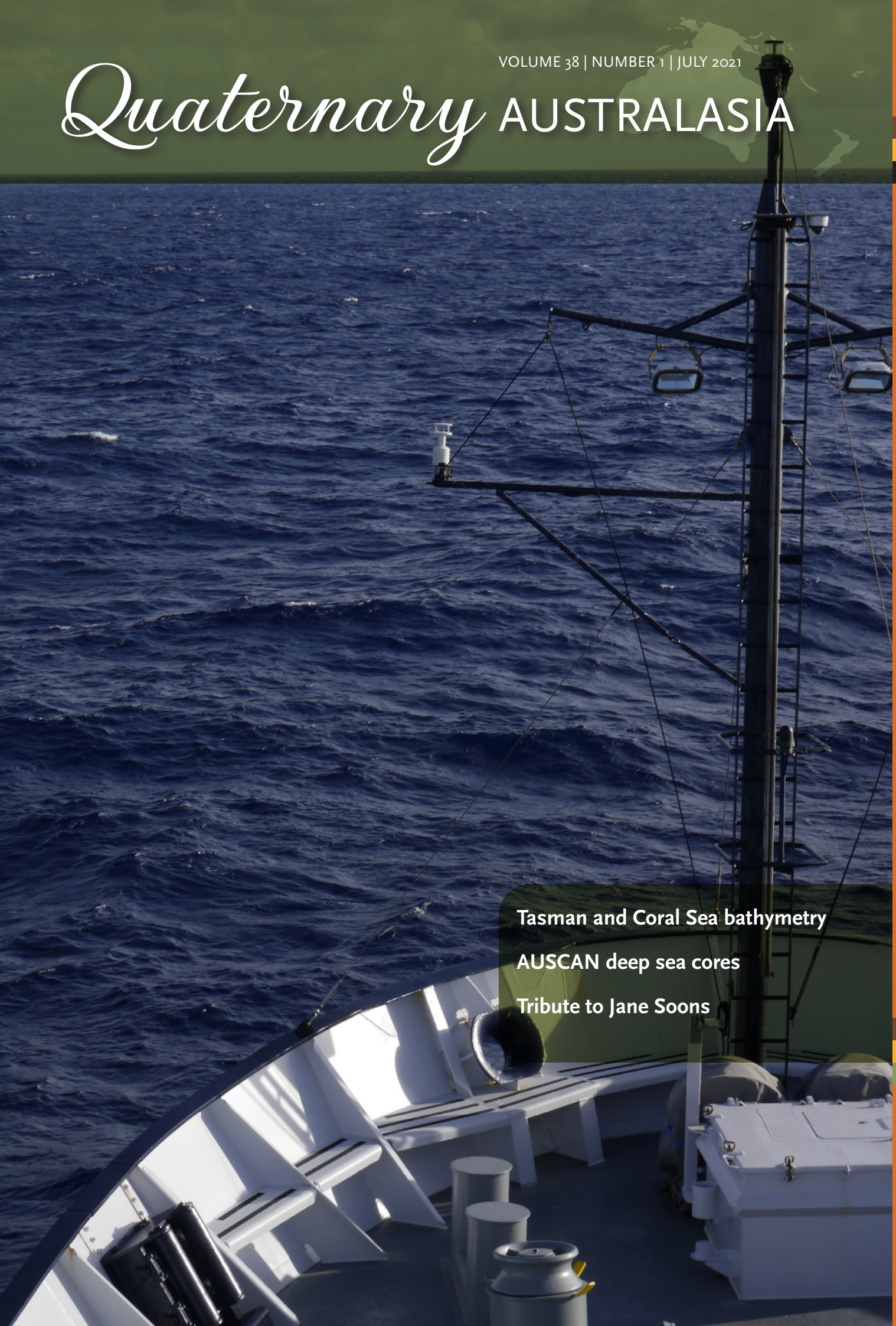
Quaternary AUSTRALASIA



Tasman and Coral Sea bathymetry

AUSCAN deep sea cores

Tribute to Jane Soons

INTRODUCING QUATERNARY AUSTRALASIA'S SHADOW EDITORS

SHADOW EDITOR EMMA REHN

Figure 1: Recording features during a pedestrian survey, historical archaeological fieldwork, Townsville, in 2014. (Photo credit: Allison Fitzpatrick)

Figure 2: In the lab counting and classifying fossil charcoal via stereomicroscope, James Cook University Cairns. (Photo credit: Emma Rehn)

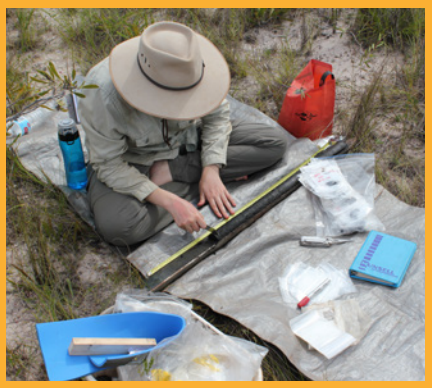


Figure 3: Sampling a D-section sediment core on site at Sanamere Lagoon, Cape York Peninsula, in 2016. (Photo credit: Cassandra Rowe)

SHADOW EDITOR LYDIA MACKENZIE

Figure 1: Monitoring lake health in the past and present in the French Pyrenees. (Photo credit: Anna-Marie Klamt)

Figure 2: Sampling peat cores in the Great Hinggan Mountains. (Photo credit: Rongqin Liu)

Figure 3: Exploring the Kumtag Desert. Not much pollen here! (Photo credit: Bo Chen)

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Quaternary AUSTRALASIA

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Front cover photo & above:

Images of the R/V Falkor (Photo credit: E.J. Woehler).

See News from the Field page 8 where Ben Houseman, Helen Bostock and Alysha Johnson describe the month-long expedition aboard the R/V Falkor, off Queensland's Great Barrier Reef.

EDITORIAL

Dear Quaternarists,

It's been a challenging year, especially for ECRs, as we struggle to stay connected to our research and with each other. On a personal note it has been difficult to watch opportunities to connect shrink as conferences are postponed and international travel is restricted. Which is one reason I was so moved when I recently joined the Australasian section of the Eric Grimm 24 hour memorial seminar moderated by Simon Haberle and others. It felt special to witness academics coming together and sharing their appreciation and memories of such an influential person in the palaeo-field during a period where we may be feeling disconnected. I only had the chance to interact once with Eric at the ANU organised TILIA/Neotoma workshop in 2014. However, watching the online seminar roll around the world, I was reminded of how, as academics, we work best when we share our research and expertise with as many people as possible. Despite the challenges of the 'new' online format many of us are facing (ZOOM, Teams etc), keeping our Quaternary Australasia network connected is even more important now while we are often restricted from meeting in person.

It's a tough time as an ECR to be starting a career post-PhD or looking to make the move to a new position. Reduced funding, limited university positions and restrictions on travel are challenges for those of us hoping to continue in research. Many of us will likely leave academia, and this will no doubt cause flow-on effects in the longer term. Staying connected is crucial, to maintain networks and support each other while we face these challenges.

We encourage you to read the thesis abstracts included in this edition and to support the up-and-coming ECRs in our community. You can also check out the new AQUA ECR blog to see what some of our Quaternary Community are getting up to: https://aqua.org.au/blogs/ecr-blog/.

After more than a year of pandemic conditions, we're beginning to plan further ahead (as much as that is possible). Events, meetings and workshops postponed from last year are being revisited, with some going ahead in new formats (see the Upcoming Meetings section) while others must be delayed further. Emergency adaptations implemented suddenly in 2020 are now being integrated over the longer term, with virtual-only and mixed mode attendance options common.

AQUA will be hosting a pop-up e-conference again this year - abstract deadline was 11 June. We are interested to see how these changes will continue to affect the way we work in the years ahead.

Thankfully some field activities have gone ahead in early 2021, albeit often under changed conditions. In the News section, Helen Bostock, Ben Houseman and Alysha Johnson share their experiences on the Research Vessel Falkor, mapping sea-floor bathymetry and palaeogeography of the southern Great Barrier Reef. Additionally, many excellent papers and thesis abstracts are included in this edition of Quaternary Australasia including contributions by David J. Lowe: 'Evaluating earthquake hazard and risk using liquefied volcanic-ash layers in lakes', and Patrick De Dekker and Colin Murray-Wallace: 'Results from the 2003 AUSCAN cruise offshore Kangaroo Island and the veracity of the records of two deep-sea cores obtained during the cruise, with a discussion on the Holocene history of the River Murray estuary', among others.

Yours Quaternarily,

Emma Rehn and Lydia Mackenzie
Shadow Co-editors

For **Sanja Van Huet and Carol Smith**
Co-Editors

PRESIDENT'S PEN

Kia ora koutou; greetings fellow AQUA members,

I hope 2021 is treating you better, so far, than the global emergency of COVID-19 in 2020. We are still faced with many challenges associated with limited travel, borders being opened and closed, and, of course, the horrific toll on the human health. With the onset of the administration of vaccines in Australia and New Zealand, hopefully we are starting to see the light at the end of the tunnel.

Despite these obstacles, there is a lot going on in our community, which is really positive. Unfortunately, the AQUA conference has been pushed back once again, this time to 2022 when hopefully we will all be able to meet in person. In lieu of this, a great team are organising a 2-day conference via Zoom, to be held on 8 and 9 July 2021. Thanks very much to the organising committee for getting this underway: Michelle McKeown, Priya O'Brien, Annie Lau and Haidee Cadd. Please note that abstract submissions were due 11 June, and registration due 30 June. Both abstract submissions and registrations are online: https://aqua.org.au/conference/aqua-2021-virtual-conference/ For those who are able to, we would appreciate a small donation, which will go towards supporting student awards at future conferences. This can also be submitted online, following the same link. We strongly encourage students and ECRs to submit abstracts. As part of the conference, we will be holding our annual AGM – details to come shortly.

The AQUA executive committee have been pretty busy with some exciting new initiatives. Among these are the development of an Equity Policy, a Climate Change statement, and a Code of Conduct. We are also seeking to be more pro-active in terms of supporting career pathways for students, particularly females. Keep an eye on the AQUA-list for more information.

A new AQUA blog has been developed by Annie Lau, hosted on the AQUA website: https://aqua.org.au/ecr-blog-1-haidee-cadd/ The first blog was posted a couple of weeks ago – an interview with Haidee Cadd. The purpose of the blog is to support students (Honours, Masters, PhD) and ECRs, by showcasing their research, career pathways and experiences. If you have a suitable candidate then please nominate them to be interviewed by emailing Annie. Students/ECRs, feel free to self-nominate! And definitely check out the blog!

A final thing to keep an eye out for is the Geoscience Society of New Zealand (GSNZ) Annual Conference to be held in Palmerston North 30 November – 2 December 2021. Peter Almond and colleagues are organising a "Friends of the Pleistocene" session, which promises to be very interesting.

Congratulations to those who got through to the second round of Marsden proposals here in NZ! Best of luck to those who submitted applications for AINSE support through the Postgraduate Research Award.

Ngā manaakitanga; with best wishes,

Lynda Petherick
AQUA President

A TRIBUTE TO JANE MARGARET SOONS (18 JUNE 1931 – 8 SEPTEMBER 2020)

Carol Smith

Department of Soil and Physical Sciences, Lincoln University, New Zealand.

"[Achieving] in a male dominated world, without modelling herself on men" (University of Canterbury, 2021)

Jane Soons was indeed a UC legend. Jane was appointed University of Canterbury's first female professor in 1971 and blazed a trail for not only the advancement of Quaternary science in New Zealand, but also as a role model for female academics and students of physical geography. She served as President of INQUA 1977-82.

In 1958, Jane became one of the first women PhD graduates from the University of Glasgow. In 1960, Jane arrived in New Zealand from her native England, having been offered a lectureship at UC's Department of Geography. She dived into her new role with enthusiasm, and soon established excellence in this area through her early work on mapping the glacial geomorphology of the Rakaia. She steadily built a notable reputation for work in other domains of geomorphology, including around a project in the Chilton Hills focusing on links between climatic factors and soil erosion in the Canterbury High Country. Even after retirement, she took a geomorphological interest in coastal matters on Banks Peninsula, in particular around a geomorphological solution to the establishment of a channel between Lake Waiwera / Forsyth and the sea, at Birdlings Flat (Shulmeister, 2021). At Lincoln University,

we use this particular investigation as a case study to demonstrate to students the importance of using geomorphology to inform coastal resource management decisions.

But it was not just in the contribution to this and other aspects of Quaternary science and geomorphology in which she created a legacy. It was also her approach to teaching generations of undergraduates and postgraduates. She encouraged her students in a different way of learning. Rather than tell students what the current state of knowledge was about a particular landform evolution (as was the "William Morris Davis" thinking back in the day), she encouraged her students to propose and evaluate possible explanations for what was not known. She encouraged students to carefully observe, infer logically about the cause and insisted on precision in the presentation and interpretation of research findings (Holland, 2001). She was also known to generations of physical geography students through her seminal textbook co-authored with Mike Selby, "Landforms of New Zealand" – still a highly referenced and sought-after book.

Jane's distinguished career and contribution to Quaternary science was recognised by many awards. As well as serving as President of INQUA 1977-82 (and Vice President and Past President) she also convened the National Committee for Quaternary Research for the Royal Society Te Apārangi (1967-87). In 1988 she was awarded the David Livingston Centenary Medal for Southern Hemisphere research by the American Geographical Society. In 2009, Jane received an Honorary Doctorate from her *Alma Mater,* the University of Glasgow. In his oration for Jane's honorary doctorate, Jim Hansom of the University of Glasgow noted that with reference to the Ochil Hills of Central Scotland, to the Rakaia Valley, to the Cass Basin and to other areas in the South Island, it can be said, "That we know as much as we do is a tribute to Jane Soons" (Hansom, 2009).

A celebration of Jane's life at UC was held on 10 June. This was fittingly part of a "UC women united for exceptional research – research women's symposium, June 2021". This will also be the occasion when the University of Canterbury announced their major tribute to Jane Soons and also officially launched a fund in Jane's name to support thesis research by geography and Quaternary studies students. https://www.canterbury.ac.nz/uc-foundation/ways-to-make-a-difference/support-our-research/jane-soons-memorial-fund/

For further details of Jane's extraordinary life and legacy, please go to Jamie Shulmeister's recent tribute in New Zealand Geographer https://onlinelibrary.wiley.com/doi/epdf/10.1111/nzg.12285.

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Previous Page - Top - Figure 1: Presentation of the ANZGG Bronze medal to distinguished geomorphologists who have made a significant contribution to the ANZGG through sustained interest and participation in conferences and other activities of the organisation. Jane was awarded the medal in 2014 but could not attend the meeting. Jamie Shulmeister presented the medal to Jane in Christchurch, 9/12/2014.

Middle - Figure 2: Jane, Christmas 2007.

Bottom - Figure 3: Field trip to the Poulter moraine in the Waimakariri valley, at the confluence of the Waimakariri and Poulter rivers, 2007.

This Page - Top - Figure 4: Jane and Friends, December 25th 2006.

Bottom - Figure 5: Enjoying a beer, March 2018.

All photo credits: Jamie Shulmeister.

SHORT INTRODUCTION TO THE FIELD TRIP REPORTS ON THE RV FALKOR

Helen Bostock

School of Earth and Environmental Science, University of Queensland.

Over the last year the Research Vessel Falkor, run and funded by the philanthropic Schmidt Ocean Institute, has been in the Australian region. The RV Falkor arrived in Australia in January 2020 and initially undertook 2 planned expeditions in Western Australia in the Canyons in SW, followed by Ningaloo Canyons in the NW.

Then COVID-19 hit and the RV Falkor could not continue to operate its original planned voyages. With a bit of negotiation with the Queensland government they got permission to continue to operate in Queensland water, but it was then a scramble to work out how to run a research vessel during COVID-19 restrictions.

Robin Beaman at James Cook University liaised with the Marine Parks, Queensland Government and various organisations and the Schmidt Ocean Institute to pull off a series of 8 back-to-back voyages in Queensland waters, focussing on a range of different priority areas; based on scientific interest and the Coral Sea marine park priorities.

This has been a big opportunity for Australian scientists to get precious ship time on a state-of-the-art research vessel and gather a large amount of new data for the Australian region. When borders and restrictions permitted it also allowed a number of Australian students to get hands-on experience on a research vessel. The two accompanying articles: 'Bathymetric exploration of the Tasman and Coral Seas aboard the R/V *Falkor'* by student Alysha Johnson and 'Ice age geology of the Great Barrier Reef' by student Ben Houseman are from several of these voyages.

If you would like to know more about the RV Falkor voyages over the last year you can see all the blogs and videos on the website Cruises – Schmidt Ocean Institute. And a recent summary of the voyages at A Year of Falkor in the Great Barrier Reef & Coral Sea – Schmidt Ocean Institute. We are grateful to the Schmidt Ocean Institute for their support and determination to continue to undertake marine research throughout the COVID-19 pandemic.

Also a big thanks goes to Dr Robin Beaman who has coordinated all of these voyages and the participating shipboard and onshore scientists. He has also helped support Early Career Researchers to take leadership on some of these voyages.

The multibeam maps and data from these RV Falkor voyages are all being made freely available on national and international databases like AusSeabed AusSeabed Marine Data Portal (ga.gov.au).

Figure 1: The Schmidt Ocean Institute's R/V Falkor on the Tasman Sea. Photo credit: Eric Woehler

FIELD TRIP REPORT
ICE AGE GEOLOGY OF THE GREAT BARRIER REEF

Ben Houseman, Honours

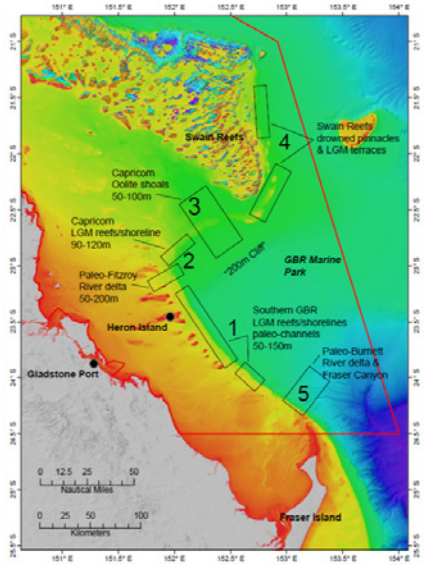
School of Earth and Environmental Sciences, University of Queensland.

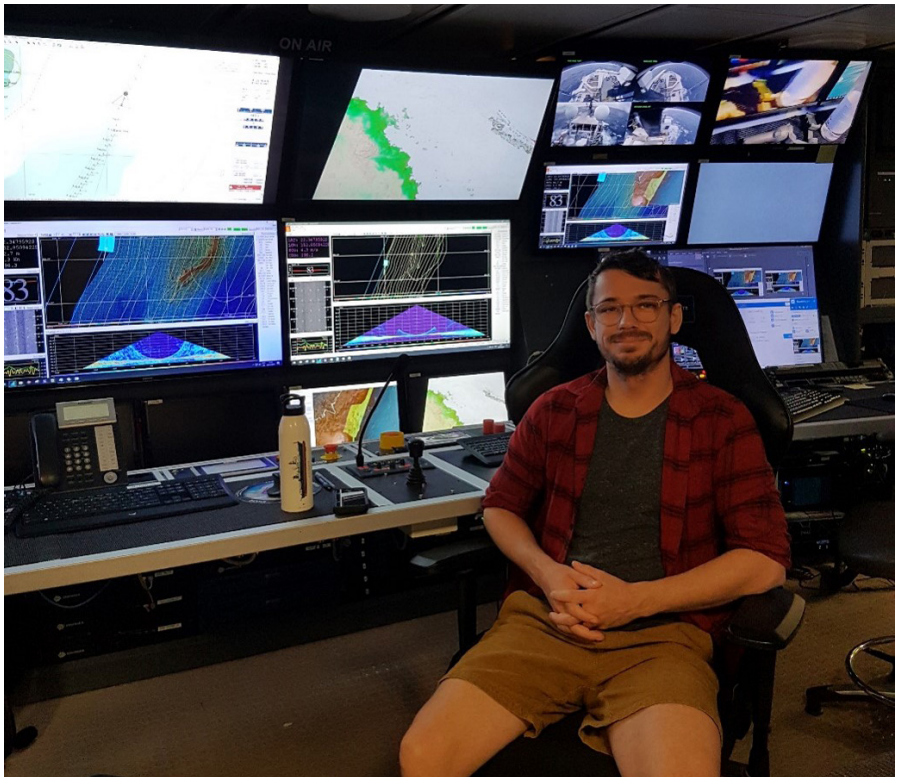
From 22 November to 22 December, 2020 I was a student member of the science party on the research expedition of the R/V Falkor, "Ice age geology of the Great Barrier Reef". (Figure 1.) The project was focussed on the Southern Great Barrier Reef and led by Chief Scientist Mardi McNeil (Queensland University of Technology) and funded and run by the Schmidt Ocean Institute (SOI). (Figure 2.)

The aims of the project were to systematically multibeam map the seafloor of the southern extent of the shelf edge. The voyage had several target areas in the Southern Great Barrier Reef. It was assumed that the southern shelf edge, like its northern counterpart, should feature an array of geomorphological features that date to the Last Glacial Maximum, when global sea levels were around 120m lower than the present day.

The multibeam data sets generated on this cruise will contribute to Australia's efforts to map the seafloor and contribute to the AusSeabed data portal, and the global GEBCO seabed 2030 project, which aims to map the world's oceans by 2030. Additionally, the cruise supported a supplementary project to measure atmospheric aerosols, to inform future cloud brightening experiments for reef shading.

My role as a student member of the science team involved daily monitoring of the two Multibeam systems that were in use (Kongsberg EM710 & EM310), to ensure correct operation and to watch for any potential errors that occurred. (Figure 3.)

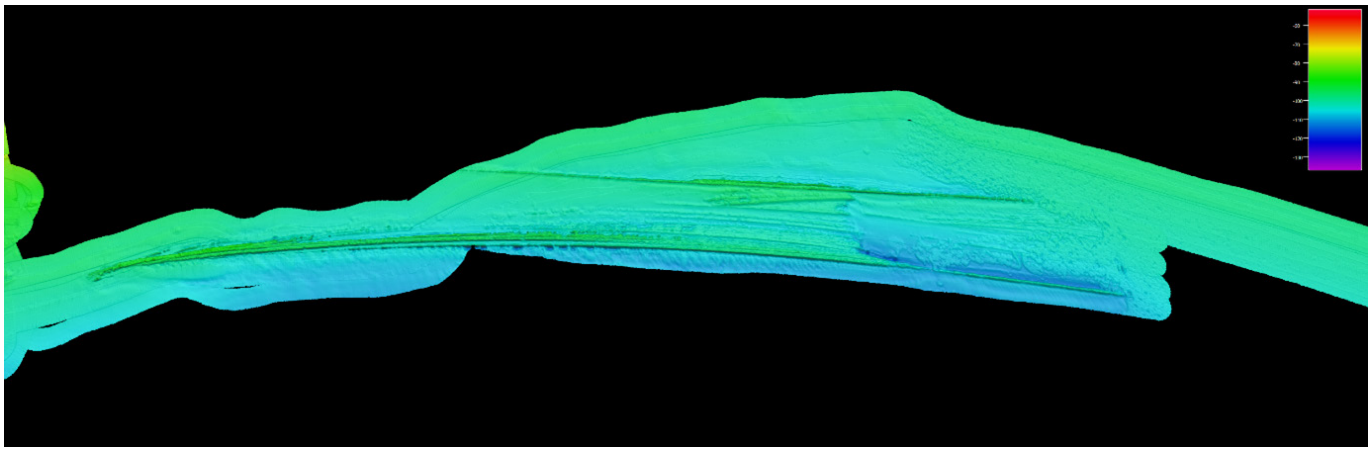


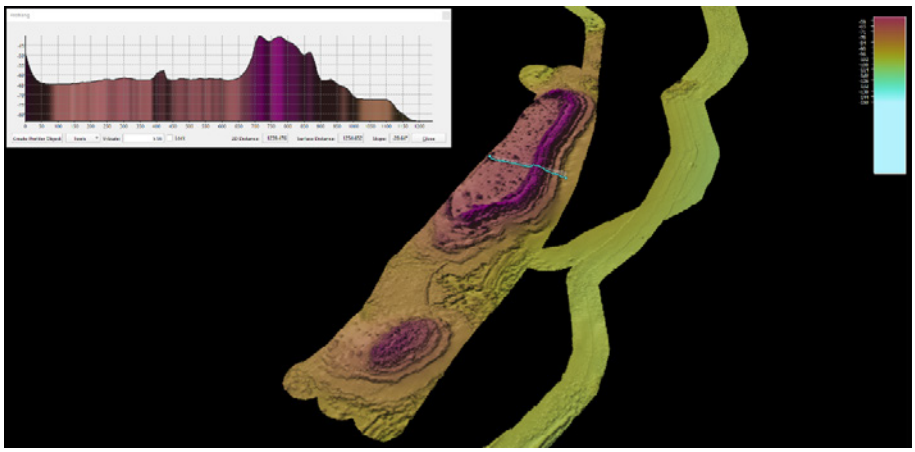


Top - Figure 1: Science party, from left to right Taloi Havini (artist at sea), Haydn Trounce, Ben Houseman, Mardi McNeil and Ella Sinclair. Photo credit: Aimee Catalan/SOI, 2020.

Above - Figure 2: Field site and targeted locations. Figure credit: Mardi McNeil/SOI, 2020.

Left - Figure 3: Ben Houseman in the science control room. Photo credit: Ella Sinclair, 2020.





Above - Figure 4: Drowned beach ridge. Figure credit: Mardi McNeil/SOI, 2020.

Left - Figure 5: Drowned terraced reef, bathymetry profile. Figure credit: Mardi McNeil/SOI, 2020.

The mapping completed by this project revealed several spectacular features dating from the LGM including paleo beach ridges (Figure 4) and drowned terraced reefs (Figure 5).

The results from the voyage provide new insights into the paleogeography of the southern extent of the Great Barrier Reef, the data collected will be used to inform new understandings of the evolution of the Great Barrier Reef, as well as aiding in paleoenvironmental reconstruction and reef adaptation projects.

My time on the R/V Falkor has given me a greater appreciation for the hard work and technical expertise that goes into oceanographic research. If you are interested in finding out more about this R/V Falkor voyage there are a series of blogs and videos on the Schmidt Ocean Institute website Ice Age Geology of the Great Barrier Reef – Schmidt Ocean Institute.

BATHYMETRIC EXPLORATION OF THE TASMAN AND CORAL SEAS ABOARD THE R/V FALKOR

Alysha Johnson, PhD Candidate

School of Environment, Atmosphere and Life Science, University of Wollongong

Over the 2020-2021 summer, fifteen scientists from universities throughout Australia embarked on research voyages on the Schmidt Ocean Institute's R/V *Falkor* in the Tasman and Coral seas, offshore Queensland. I was lucky enough to be one of the scientists and joined the science party for two months of voyaging and mapping.

Across two separate voyages (28 December 2020 – 26 January 2021 and then 6 February 2021 – 6 March 2021), 75,000km^2 of the seafloor bathymetry was mapped using an multibeam echosounder (MBES). This area is equivalent to the size of Ireland. The bathymetric data from these voyages has been provided to Geoscience Australia to add to the AusSeaBed database (Home | AusSeabed) and to the Nippon Foundation – GEBCO, which aims to map the entire ocean floor by 2030 and contribute to the start of the UN Decade of Ocean Science for Sustainability (2021-2030). Though our oceans cover 70% of the Earth's surface, less than 20% of the world's ocean seafloor has been mapped. We know little about vast areas of seafloor, deep marine ecosystems and resources, ocean currents and their interaction with other global systems.

The first voyage, known as "Pinging in the New Year", collected some of the very first bathymetric data for the UN Decade of Ocean Science as we mapped the ocean floor through the New Year. Additional to this primary achievement, both voyages also surveyed seabird populations, investigated seafloor magnetic anomalies, sampled for microplastics, and completed multiple CTD (Conductivity Temperature and Depth) sensor deployments to understand modern oceanography.

As a PhD student, for me these voyages were a chance to test my sea legs and an opportunity to get hands-on experience in the collection of data on seamounts, guyots and reefs (which are the focus of my PhD), as well as to learn about life and science aboard a research vessel. As I handle and work with bathymetric data regularly, learning about how this data is gathered and participating in the decision making behind specific technical parameters has been incredibly valuable for my research.

With the support of the chief scientists and the marine technicians, I helped to troubleshoot issues, operate the multibeam and, clean and process the data. The other students and I also learned how to conduct expendable bathy-thermographs (XBTs) to determine the sound velocity profiles necessary to accurately calculate the seafloor depth from the multibeam "pings". We also learned to equip, operate and interpret the Conductivity Temperature Depth (CTD) sensors and its data and undertook numerous outreach calls with schools and universities globally!

Departing from Brisbane, the R/V *Falkor* set sail north into the Coral Sea Marine park and over the Tasmantid Seamount Chain, a series of extinct undersea volcanoes. We collected high resolution multibeam bathymetric data of regions, as shown in Figure 1, including the Fraser and Recorder Guyots in the Tasmantid Seamount Chain, parasitic cinder cones around Cato Reef, fault lines and slumping surrounding Kenn Reef and parallel contour slumping on Marion Plateau (Figure 2).

One highlight was discovering a platform on Coriolis Ridge, which we unofficially named Veit's Height (Figure 3). This feature took us two days to map and is a 200m shallow platform with significant block collapse and mass wasting around the sides. Furthermore, surrounding Veit's Height on Coriolis Ridge, we found large sediment waves on the seafloor, some of which were up to 10m tall.

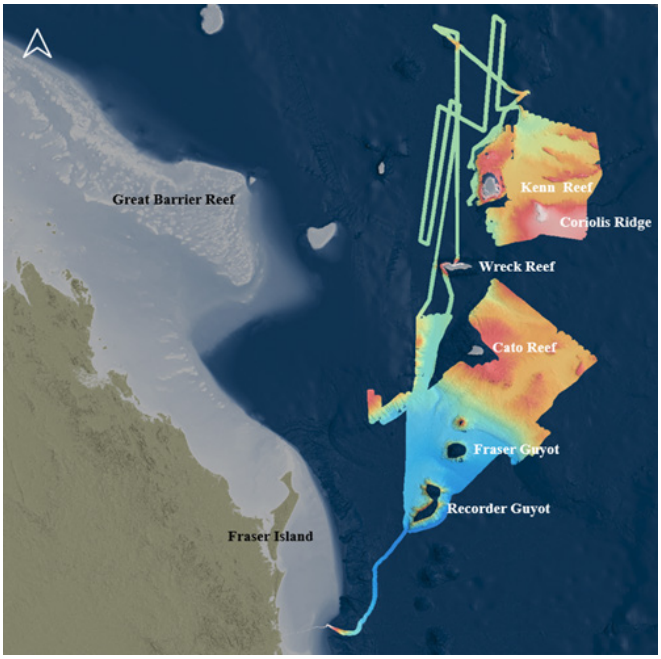


Figure 1: Region mapped off the coast of Queensland by the R/V Falkor December 2020 to March 2021. Image courtesy of Alysha Johnson and Schmidt Ocean Institute

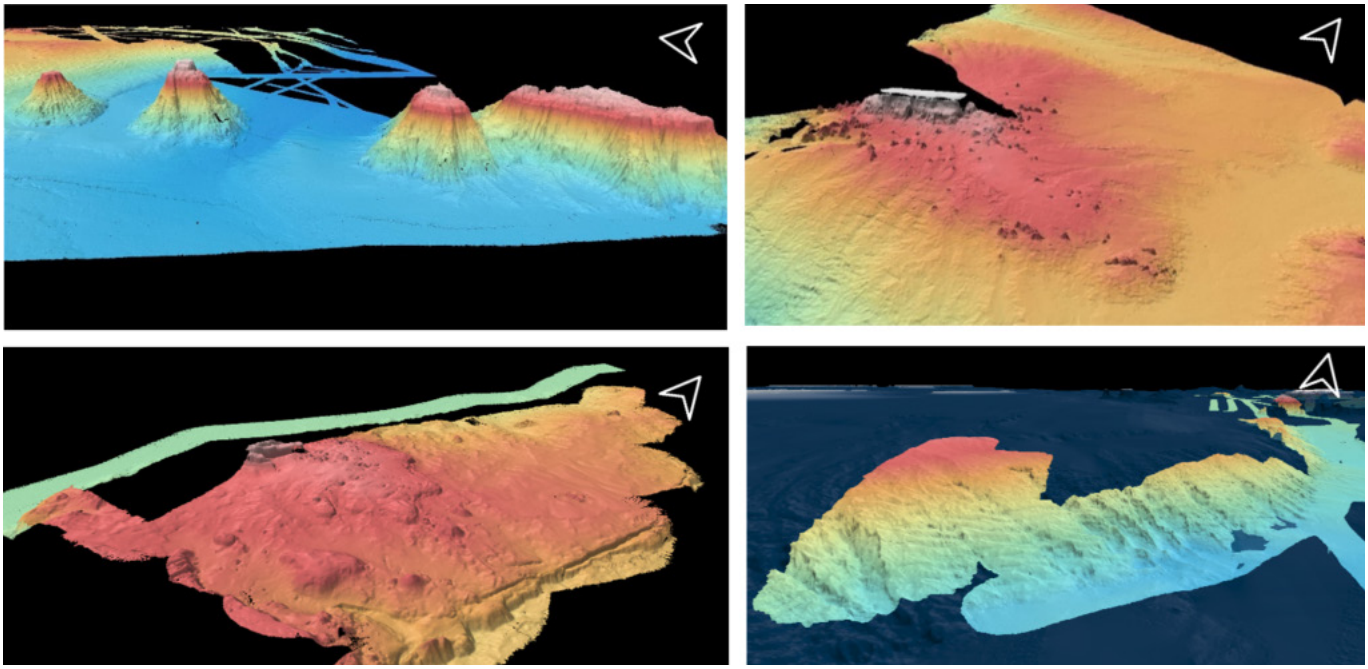


Figure 2: (Combined)
Top Left: Unnamed guyot, Fraser guyot and Recorder Guyot. 4x vertical exaggeration. Image credit: Alysha Johnson and Schmidt Ocean Institute
Top Right: Cato reef and cinder cones on surrounding shelf. 4x vertical exaggeration. Image credit: Alysha Johnson and Schmidt Ocean Institute
Bottom Left: North extent of Kenn Reef with a fault line running N-S in the foreground. 4x vertical exaggeration. Image credit: Alysha Johnson and Schmidt Ocean Institute
Bottom Right: Contour parallel slumping on Marion Plateau. 4x vertical exaggeration. Image credit: Alysha Johnson and Schmidt Ocean Institute

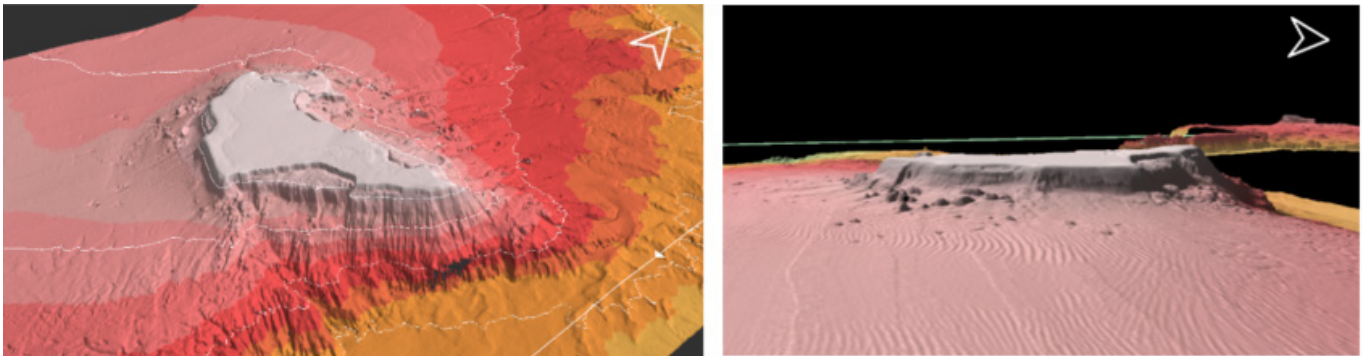


Figure 3: (Combined)
Left: Veit's Height. 4x vertical exaggeration. Image credit: Tara Jonell and Schmidt Ocean Institute
Right: Sediment waves on Coriolis Ridge surrounding Veit's Height 4x vertical exaggeration. Image credit: Alysha Johnson and Schmidt Ocean Institute

Moving forward, I will be using the bathymetric data of some of the reefs and guyots that we surveyed towards my research, where I will be using a range of GIS techniques to explore the geomorphology and evolution of these volcanoes, guyots and coral reefs in the South West Pacific. I will be looking for features such as erosional terraces, drowned coral reefs and mass wasting to reconstruct geomorphic evolution of the volcanoes in the Tasmantid Seamount Chain and compare it with other oceanic volcanoes in the Pacific.

Outside of mapping, plenty of remarkable achievements and good times were had by all aboard. Over 18,000 seabirds were counted, 140 microplastic samples collected, the CTD was deployed seven times, and the magnetometer (which measures the magnetic signals on the seafloor) was in operation for over 2,500km. All science party members had a great experience aboard a ship and joined in with crew fire training, evening quiz nights, morning yoga and card tournaments. Though rough weather and seasickness did strike occasionally, high spirits were maintained during the two months at sea. I would like to thank the Schmidt Ocean Institute for this opportunity.

Above - Figure 4: Science party and crew aboard the R/V Falkor for the January 'Pinging in the New Year' voyage. Photo credit: Eric Woehler
Below - Figure 5: Science party aboard the R/V Falkor for the February 'Seafloor to Seabirds in the Coral Sea' voyage. Photo credit: John Fulner

On a personal level, I was sad to depart the *R.V. Falkor* and her crew, and I am looking towards my next high seas adventure!

For more information regarding Schmidt Ocean Institute and the 2021 voyages, please explore the following websites:

Pinging in the New Year: Mapping the Tasman and Coral Seas – Schmidt Ocean Institute https://schmidtocean.org/cruise/pinging-the-new-year/

Seafloor to Seabirds in the Coral Sea – Schmidt Ocean Institute https://schmidtocean.org/cruise/seafloor-to-seabirds/

Sciblogs | Two months at sea has shown me how little we know of our oceans https://sciblogs.co.nz/field-work/2021/03/12/two-months-at-sea-has-shown-me-how-little-we-know-of-our-oceans/

EVALUATING EARTHQUAKE HAZARD AND RISK USING LIQUEFIED VOLCANIC-ASH LAYERS IN LAKES

David J. Lowe

School of Science, University of Waikato, Hamilton, New Zealand

Liquefied volcanic-ash or tephra layers, for which we have coined a new term, 'tephra seismites', are preserved in lake sediments in numerous 20,000-year-old lakes in the Hamilton Basin in northern North Island. Up to five tephra layers in cores taken from the lakes show signs of liquefaction - the phenomenon seen during the Christchurch earthquakes - that include disrupted tephra layers, voids, and dykes (injectites). These features show that one or more of four newly-discovered 'hidden' faults in Hamilton (see map) were responsible for previously unrecognised prehistoric earthquakes within the past 20,000 years (Kleyberg et al., 2015). Around 30 lakes are scattered amidst the faults, and hence cores are being taken from almost all of these to build up a picture of which fault(s) may have been active in that time. We anticipate that lakes closest to faults that have been active will show more tephra seismites than those farther from the faults.

By studying the nature of the tephra seismites using CT scanning and physical and engineering (geotechnical) methods, the team aims to calculate the intensity of shaking that initiated the liquefaction in the tephra seismites, and to therefore develop a new understanding of seismic hazard and risk in and around Hamilton. The tephra layers provide a means of connecting and comparing the record from one lake to the next, and known ages on the tephras provide a chronology for the cores and liquefaction events (and hence potentially timing of earthquakes).

This novel approach to paleoseismicity could be applied elsewhere in New Zealand, and globally, to help date activity on hidden faults in low to moderate seismicity volcanic regions where faults and tephra seismites occur.

Funding is provided by a Marsden Fund grant (UOW1902) for the project "Earth-shaking insight from liquefied volcanic-ash (tephra) layers in lakes: using geotechnical experiments, CT-scanned lake sediment cores, and tephrochronology to map and date prehistoric earthquakes", and by an MBIE Endeavour Fund (Smart Ideas) grant (UOWX1903) for the project "Evaluating earthquake risk using liquefied volcanic-ash layers in lakes". The projects are led by Professor David Lowe and Dr Vicki Moon (University of Waikato, Hamilton). Others involved in the project, and supporting agencies, are listed on our website (which can also be used to keep track of progress): https://tephra-seismites.com/

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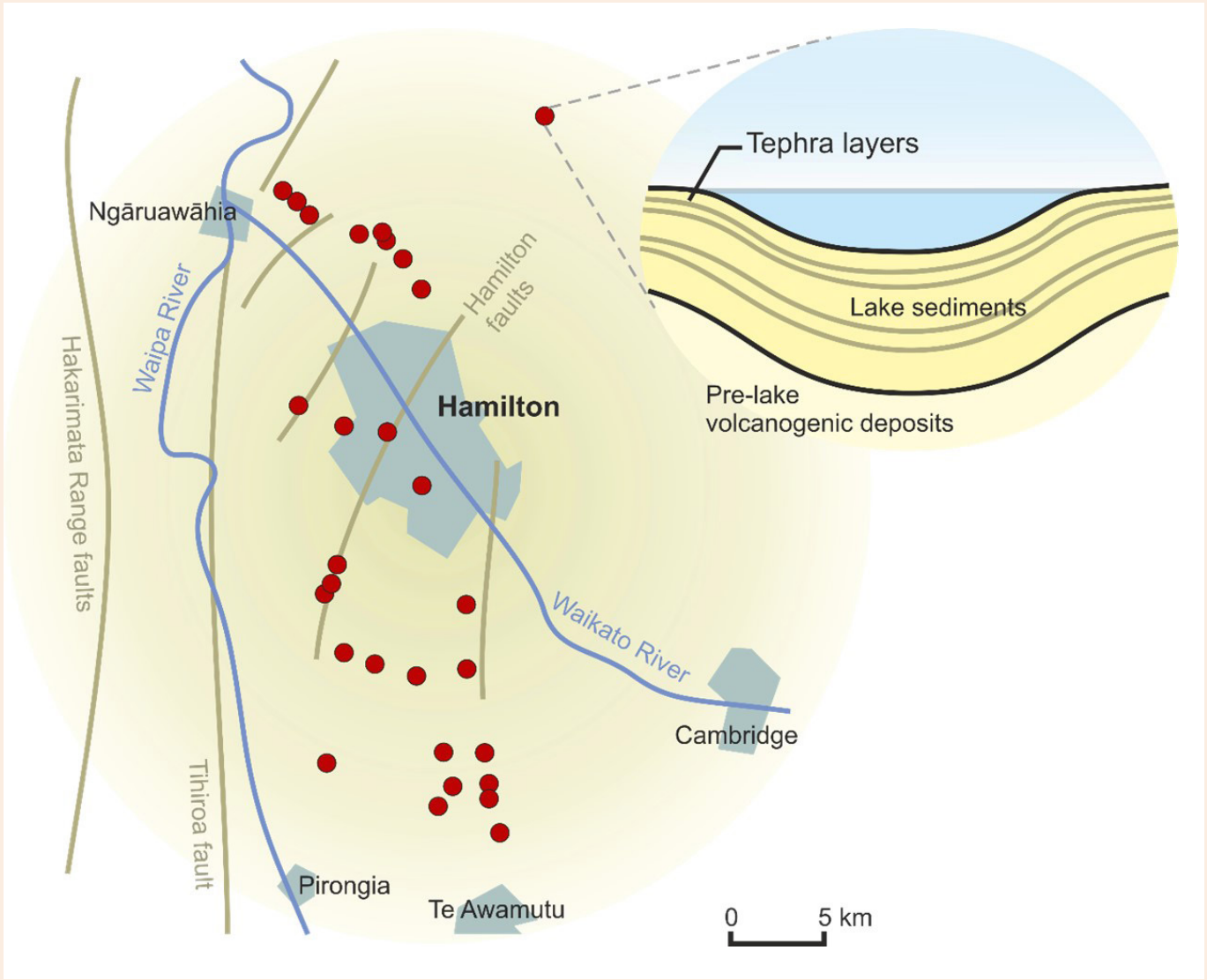
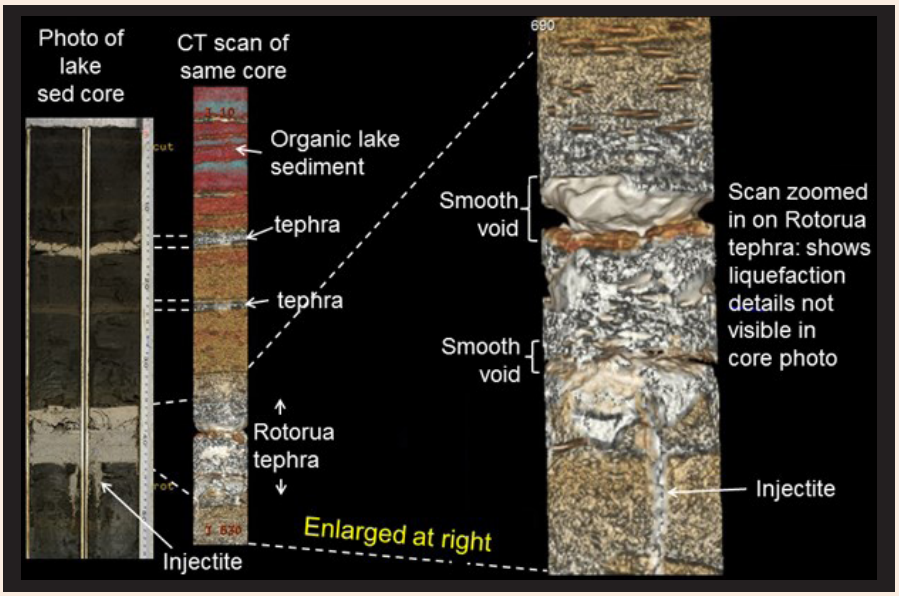


Above - Figure 1: Distribution of four newly-mapped Hamilton faults (after Moon and de Lange 2017; Moon and Spinardi 2019) and tephra-seismite-bearing lakes (red dots) in the Hamilton Basin. Multiple additional strands have been omitted for clarity.
Map credit: Max Kluger.

Left - Figure 2: Kindly collaborators from GNS Science and the Lakes 380 project (https://lakes380.com) coring on behalf of the Tephra Seismites project at Rotokaeo (Forest Lake) in Hamilton in October 2020.
Photo credit: David Lowe.



Top left - Figure 3: From left: Danche Chaneva (PhD student), Dr Tehnuka Ilanko (research officer), and Dr Max Kluger (front, postdoc) checking out pale tephra layers in a freshly opened lake sediment core. Photo credit: David Lowe

Top right - Figure 4: Opened lake sediment core (far left) with two white rhyolitic ash layers visible, the upper being Waiohau tephra (14.0 cal ka) and the lower Rotorua tephra (15.6 cal ka). To the right are images derived by scanning the same core using CT imaging to show increased detail of the tephra seismite character. Image from Hopkins et al. (2021).

Above - Figure 5: Radiographer Nic Ross (back) with PhD student Danche Chaneva (front) putting a lake sediment core in a CT scanner at Hamilton Radiology. Photo credit: David Lowe

RESULTS FROM THE 2003 AUSCAN CRUISE OFFSHORE KANGAROO ISLAND AND THE VERACITY OF THE RECORDS OF TWO DEEP-SEA CORES OBTAINED DURING THE CRUISE, WITH A DISCUSSION ON THE HOLOCENE HISTORY OF THE RIVER MURRAY ESTUARY

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ABSTRACT

A brief account of the achievements of the AUSCAN cruise is presented together with an extensive list of published papers resulting from this cruise. Many of these papers provide considerable detail about the link between marine and continental records, many of which span the entire last glacial cycle (MIS 5e – MIS 1).

The second part of the paper argues that a large estuary to the north of the River Murray mouth during the early Holocene, postulated by Helfensdorfer et al. (2019, 2020) requires scrutiny because their postulated sea-level reconstruction is flawed. In addition, the extensive deposition of sediments dammed near the mouth of the River Murray thought by these authors to have prevented the dispersal of fluvial sediments to the continental shelf and slope is unfounded.

INTRODUCTION

In 2003, De Deckker received a grant from the National Oceans Office in Hobart, together with the goodwill of Mr Yvon Balut, Manager of the iconic French research vessel *RV Marion Dufresne*, which forms part of the fleet of the Institut Français Paul Emile Victor [IPEV] for three and a half days of ship time (a total of 84 hours) to survey deep-sea canyons to the south of the River Murray mouth and around Kangaroo Island. The cruise occurred during a seafloor mapping project conducted by Geoscience Australia along the Australian southern margin between Hobart and Fremantle (Hill and De Deckker, 2004).

Since then, some 25 scientific papers were published as a result of the 3.5-days cruise, in addition to chapters in three PhD theses, and the cruise featured in two ABC Catalyst programs. The list of these documents is presented at the end of this note. Geoscience Australia also produced two DVDs documenting the canyons in the Murray Canyons Group using fly-through animations.

After the cruise, two deep-sea cores [MD03-2607 and 2611] became the focus of many of the publications mentioned above, as they contain long sedimentary sequences: 32.95 m for core 2607 taken at 865 m water depth and 11.97 m for core 2611 taken at 2472 m water depth. These extensive studies involved analyses across numerous disciplines: sedimentology and clay speciation, core colour scanning, isotope stratigraphy on foraminifera, faunal analyses of planktic foraminifera, palynology and charcoal, geochemical markers ($U^{K'}_{37}$, TEX_{86}, Nd and Sr isotopes, $\delta^{13}C$ of lipids as a proxy for C_3/C_4 plants, the biomass burning marker levoglucosan), aeolian dust by XRF scanning, and dating by AMS ^{14}C and OSL. None of these studies showed hiatuses nor evidence of reworking in the cores and consequently are considered to have been taken at sites of continuous sedimentation on the seafloor on 'promontories' in the vicinity of deep-sea canyons. These cores are therefore ideal for examining a combination of marine as well as continental proxies. Disappointingly, there is no record of siliceous microfossils preserved in the cores and it seems that palaeomagnetic minerals have been altered in both cores (Andrew Roberts, pers. comm.). Two additional cores (2610: 7.58 m long and 2612: 35.35 m long) were taken during the cruise but no work was performed on them apart from onboard processing such as photography, broad core sedimentological logging and colour spectrometry.

In summary, the detailed and often high-resolution study of the cores and adjacent canyons has provided some important highlights on Australian Quaternary studies, many of which have been compared with studies in other oceans.

Some of the salient findings are presented in Table 1 (linked to the numbered references from the second list at the end of this paper):

ON THE VERACITY OF THE HOLOCENE RECORD OF CORE MD03-2611

Helfensdorfer et al. (2019) described in the lower River Murray, near its current mouth in South Australia, the formation of an extensive sedimentary succession which they interpret as an estuarine valley fill. The examination

Table 1: Selected key findings of the 2003 AUSCAN cruise offshore Kangaroo Island, southern Australia.

- A high-resolution $\delta^{18}O$ record of two cores based on two planktic foraminifera species and some on benthic foraminifera (23, 24, 15, 21)
- Comparison of marine proxies (SST, frontal shifts) with glaciations in New Zealand, Tasmania and mainland Australia spanning the last 95 ka backed with maps showing the postulated positions of oceanic fronts south of Australia for the 34-14 ka period at 2 ka intervals (23)
- Continental vegetation, charcoal and biomass burning record for the Murray Darling Basin (MDB) spanning the last 125 ka (25,13)
- A record of C_3/C_4 plants shifts during the last La Niña and El Niño phases (20)
- Assessment of different SST proxies in the Australian region (15,16,23)
- A detailed re-examination of MIS4 in the Australasian region backed with OSL chronology and comparison with glaciations in New Zealand, Papua New Guinea and mainland Australia (21)
- A succinct definition of the local LGM in the Australian region (23)
- History of the Leeuwin Current offshore southern Australia over the last 95 ka (9, 11, 20, 23, 24)
- Evidence of the interhemispheric bipolar seesaw going back to Heinrich Stadials back to HS8 (23)
- Evidence of the Antarctic Cold Reversal and absence of the Younger Dryas in the Australian region (6,11,23,24)
- Deterioration of climatic conditions in the second half of the Holocene at sea and on land (20,6)
- A record of airborne dust deposited at sea offshore South Australia and Victoria (11,17,21,23,24)
- A high resolution of the last deglaciation in the Australian region and global implications (24,11)
- Respective flows of the Darling and Murray Rivers and tributaries in the MDB using Nd isotopes and clay species (19, 22, 25)
- A geomorphological examination of the Murray Canyons Group offshore Kangaroo Island (4)
- Ancestral meanders of the River Murray on the Lacepede Shelf (7)
- A better definition of the marine reservoir age in the Australian region (24,25)
- Recent sedimentation rates around the canyons based on radiogenic isotopes (10).

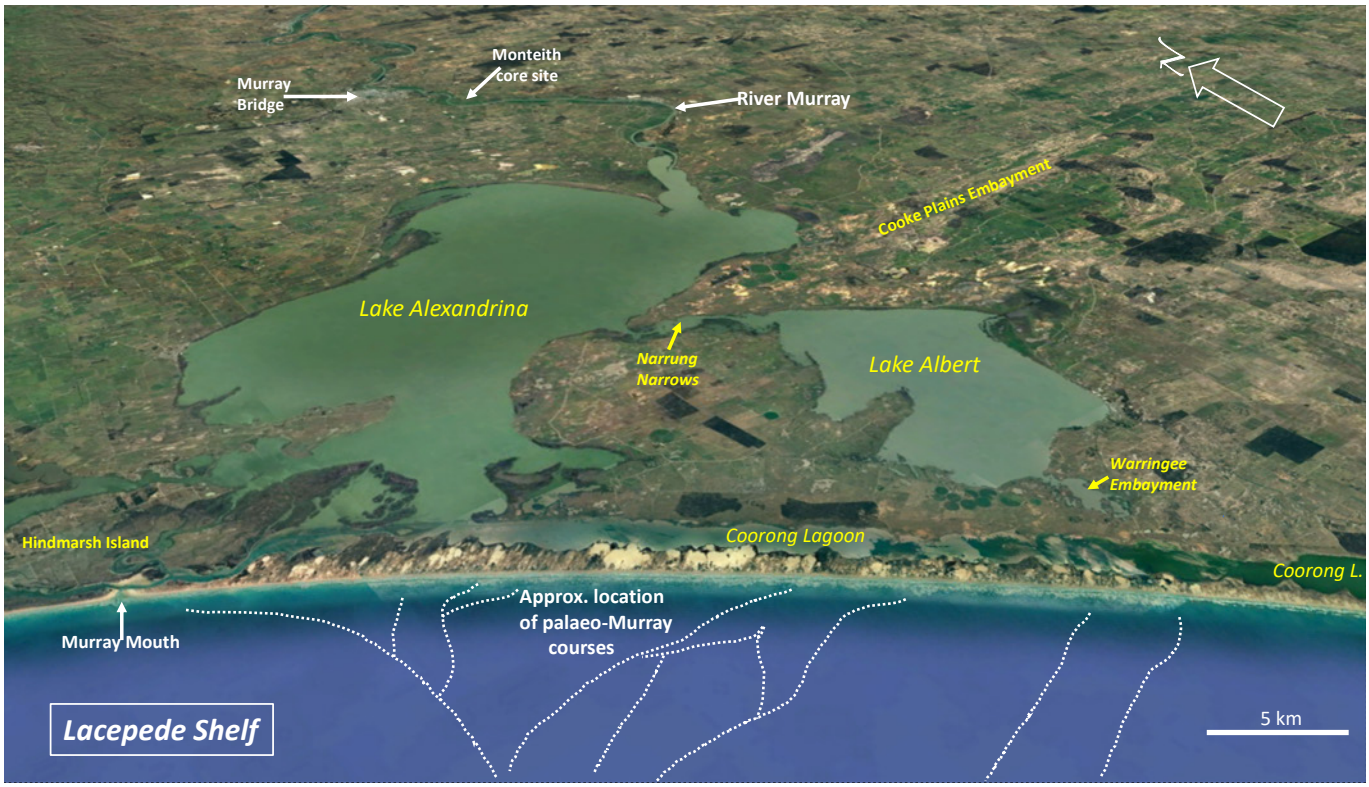


Figure 1: Oblique satellite image showing the present-day course of the River Murray and the adjacent Lower Lakes (Alexandrina and Albert) and Coorong Lagoon, as well as the other locations discussed in the text such as the Murray Mouth. The location of the Monteith core (Helfensdorfer et al., 2020) site is also shown. The location of palaeo-Murray meanders located on the Lacepede Shelf is drawn following the maps provided in Hill et al. (2009). Note that some of the ancient meanders that occur under water today are seaward of Lake Albert and are alternative 'conduits' of fluvial sediments from the River Murray to the ocean during periods of low sea levels. Note the orientation of the map. Satellite imagery obtained from Google Earth© accessed on 11.6.2020.

of cores taken along a transect across the one to three kilometres of the Murray Gorge, with their interpretation principally based on modelling and sediment resistivity, documents the timing of deposition of mostly laminated clays, some 16 m thick spanning the period of 8,518 to 5,067 cal yr BP. They argue that the succession in their Monteith-A core (Figure 1) is associated with post-glacial sea-level rise at that time, some 2 m above present-day sea-level. They suggest that fluvial sediments were thus prevented from being delivered to the ocean and that climatic reconstructions based on deep-sea cores obtained south of the River Murray mouth (Gingele et al., 2004; Gingele et al., 2007) required re-interpretation. Their work thus questions the onset of aridity for the region postulated by Gingele et al. (2004) based on deep-sea core 2611 located south of the current River Murray mouth.

We challenge Helfensdorfer et al.'s (2019, 2020) comments and argue that (1) their salinity interpretation of the Murray Gorge sediments requires correction because they were deposited when sea-level was too low to have entered the Murray Gorge depression; (2) that the sea-level highstand within the region did not exceed 1 m AHD; and (3) that the climatic evolution of southeastern Australia as discussed in (2) remains valid, especially as more recently-published evidence further supports progressive arid conditions prevailing from the mid-Holocene onwards.

The base of the Murray Gorge core at the start of sediment infill was some 16 m below AHD (Helfensdorfer et al., 2020). According to Lambeck et al. (2014), sea-level was close to – 40 m at 10 ka and this implies that unit 2 in core Monteith-A (Fig. 1) with a median age of 10,374 cal yr BP could not have been connected to the ocean. Tabulation of the ages obtained for core Monteith-A against the modelled ages for global sea-level (Lambeck et al., 2014) all indicate that the ocean could not have been connected to the Murray Gorge from 10,000 to 8,000 cal yr BP (Table 1). Importantly, this contention is directly supported by the relative sea-level record from the wider region. Core SV#23 from southern Gulf St Vincent reveals that relative sea-level was close – 40 m based on calibrated radiocarbon ages on *in situ*, articulated specimens of the intertidal to shallow subtidal mollusc *Katelysia* sp., with ages of 10,330±210 yr cal BP and 10,380±220 yr cal BP (Cann et al., 2006).

Table 2: Reproduction of part of Table 1 from Helfensdorfer et al. (2020) that shows the respective depths and median calibrated ages for core Monteith-A on which the global sea level depths (Lambeck et al., 2014) are added in bold numbers. In the last column, sea-level depths for the South Australian region are tabled and note also the early Holocene highstand at 7,070±490 yr BP recorded at Rivoli Bay (Belperio et al., 2002), some 250 km SE of the Murray Mouth.

Lab ID	Depth (m) below AHD	^{14}C date (yr BP ± 1 σ)	Calibrated age (2 σ) (cal. yr BP)	Probability (%)	Median calibrated age (2 σ) (cal. yr BP)	Sea level (m) for median cal. age [Lambeck et al., 2014]	Sea level (m) for Gulf St Vincent [Belperio et al., 2002; Cann et al., 2008; Lewis et al., 2013; Oliver et al., 2019]
UB-38709	2.11	5,761 ± 43	6,409–6,636	100	**6,513**		
			7,241–7,421	93.9			**+1 m AHD at Coffin Bay [Belperio et al., 2002; Lewis et al., 2013]**
UBA-38326	5.06	6,413 ± 45	7,178–7,214	6.1	**7,308**		**7,220±210 cal. yr BP [lab: CS-530]**
UBA-38765	7.36	7,282 ± 49	7,966–8,169	100	**8,062**	~-13.1	
			7,927–8,162	96			
UBA-38710	9.54	7,221 ± 58	7,871–7,895	4	**7,998**	~-12.3	
UBA-38325	12.6	7,748 ± 44	8,411–8,583	100	**8,490**	~-17.45	
			8,691–8,992	93.6			
			8,649–8,678	5.4			
UBA-36739	15.17	8,006 ± 37	8,683–8,689	1	**8,839**	~-21.6	
			9,548–9,824	94.1			
			9,843–9,869	3.4			
			9,872–9,887	2			
UBA-38766	18.33	8,757 ± 44	9,827–9,831	0.5	**9,671**	~34.65	
UBA-38186	19.91	8,884 ± 54	9,701–10,165	100	**9,929**	~-37.96	
UBA-38187	22.76	9,256 ± 44	10,249–10,506	100	**10,374**	~-43.8	**-40 m at ~10 ka [Cann et al. 2008]**

The magnitude of relative sea-level rise during the Holocene is central to the hypothesis of Helfensdorfer et al. (2020). They cite a highstand of 2 m higher than present sea-level, and in a companion paper (Helfensdorfer et al., 2019) appear to derive their 'best approximation' based on the 2 m elevation of a land surface, informally termed a sandflat by Bourman et al. (2000), immediately to the south of the Last Interglacial aeolianite complex on Hindmarsh Island. The sandflat is actually an amalgamated feature in which the southern-most portion is draped by Holocene sandflat facies overlying eroded Last Interglacial Glanville Formation. The 2 m value represents the eroded upper portion of the Last Interglacial Glanville Formation, and the onlapping Holocene facies occur at a lower elevation of up to 1 m above present sea-level on the southern-most portion of the island.

Empirical observations for relative sea-level during the Holocene in southern Australia reveal systematic variations in the timing and magnitude of the early Holocene highstand, associated with the proximity of the site of interest to the edge of the continental shelf (Belperio et al., 2002). A systematic increase in the elevation of the early Holocene highstand is evident within Gulf St Vincent and Spencer Gulf, with progressively higher levels obtained northwards within each gulf. In Spencer Gulf, for example, the highstand increases from 1 m at Port Lincoln, in the southern-most portion of the gulf (and closest to the edge of the Lincoln Shelf), to 2-3 m at Redcliff in the northern-most portion of the gulf (Belperio et al., 2002). The differential elevations of the palaeosea-level observations are a direct function of hydro-isostasy. As the Lower Lakes and lower River Murray are located closer to the shelf edge, the magnitude of the glacio-hydro-isostatic contribution to inferred relative sea-level rise will be lower than suggested by Helfensdorfer et al. (2020). A highstand of approximately 1 m AHD was registered by 7,220±210 yr cal BP at Coffin Bay (Belperio et al., 2002; Lewis et al., 2013) based on the radiocarbon dating of the intertidal cockle *Katelysia* sp. and is consistent with the Holocene successions on southern Hindmarsh Island. Accordingly, a maximum highstand of only 1 m AHD should have been adopted in the study of Helfensdorfer et al. (2020). This point is not semantic as it has significant implications for the landward extension of a water surface in the lower reaches of the extremely low gradient River Murray valley.

von der Borch and Altmann (1979) identified that a major freshwater lake system covering Lakes Alexandrina, Albert, and the Coorong (Fig. 1) and associated ephemeral carbonate lakes at the southern extremity of the Coorong, existed during the mid-Holocene humid period, ending 5,000 years ago. Sapropels from the ephemeral carbonate lakes of the Coorong produced mean calibrated radiocarbon ages of 9060 and 7954 cal y BP, the second of which is equivalent to that of Cooke Plains Embayment (Figure 1). In addition, Gloster's (1996) study of the Holocene record of Lake Albert identified similar features to those found in Cooke Plains. Extensive coring in Lake Albert and of its connecting channel with Lake Alexandrina, the Narrung Narrows (Figure 1), revealed a sapropel unit with a mean calibrated radiocarbon age of 7509 cal y BP obtained for a wood fragment (Gloster, 1996); in addition, sapropel in the central part of the lake returned a mean calibrated age of 7586 cal y BP (Gloster, 1996). A sapropel from the Warringee Embayment at the southeastern end of Lake Albert (Figure 1) was dated at 6198 cal y BP (von der Borch and Altmann, 1979). There is no evidence of marine sediments at those sites (von der Borch and Altmann, 1979; Gloster, 1996). It is noteworthy that Helfensdorfer et al. (2020) do not discuss the presence of any microfossils that would have enlightened on the salinity of the so-called 'estuarine deposit' and therefore confirmed their sedimentary interpretation.

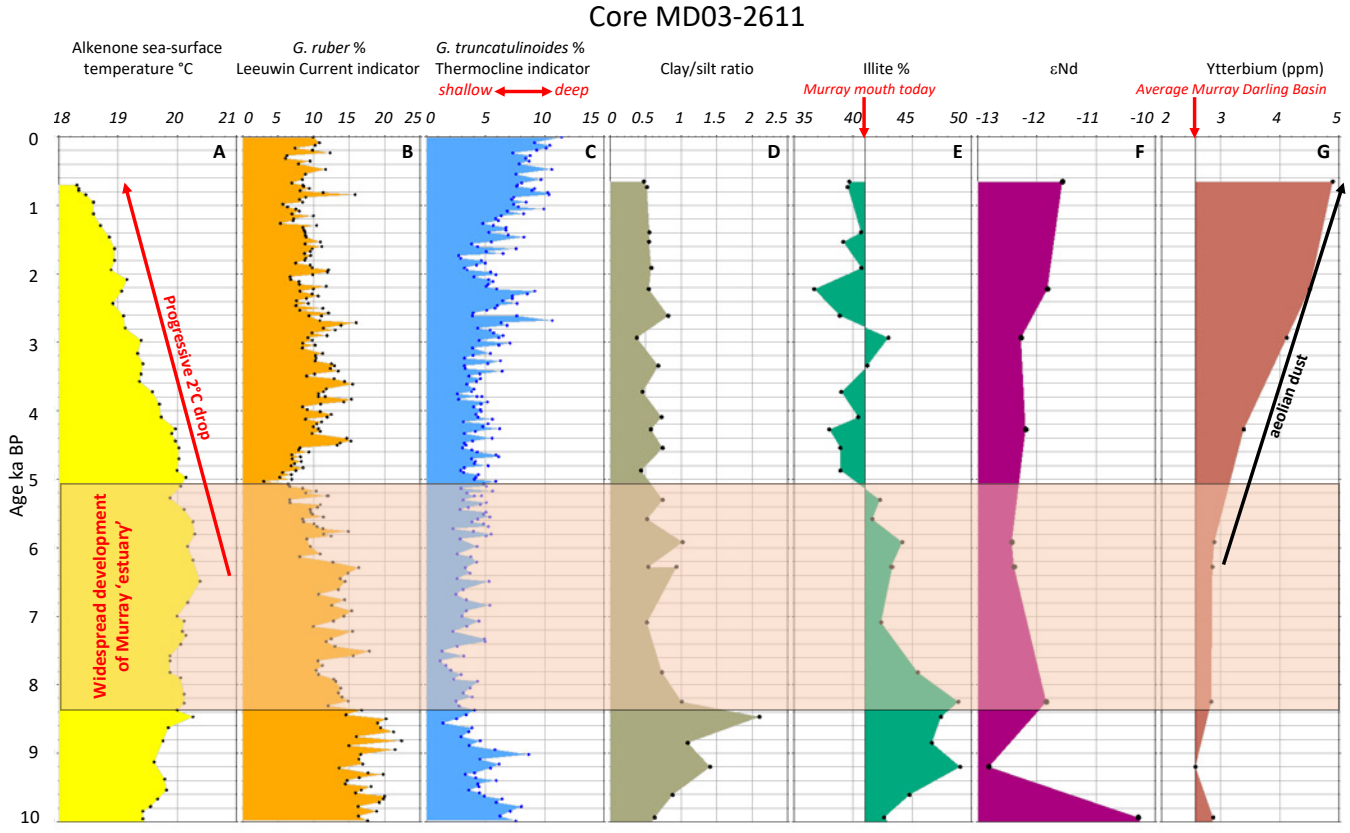
Finally, the claim by Helfensdorfer et al. (2020) that "... *palaeo-climatic reconstructions which rely on conclusions drawn from the Lacepede* [sic] *Shelf cores must be re-evaluated and reconsidered*" requires comment. Marine core MD03-2611 has been extensively studied (see papers in the list of AUSCAN publication nos. 1, 2, 11-15, 20) as well as the adjacent core MD03-2607; these studies provide some of the best information on palaeoclimatic reconstructions based on marine archives combined with terrestrial ones. In addition, the mid – to late-Holocene climatic reconstructions based on core MD03-2611 are corroborated in core SS02-GC15 (Perner et al. 2018) taken offshore Victoria, some 600 km to the southeast.

Figure 2 presents a summary of the findings for the past ten millennia from core MD03-2611 with the data of Gingele et al. (2007) replotted as their interpretation is being disputed by Helfensdorfer et al. (2020). Gingele et al. (2007) found that the higher outflow from the River Murray was caused by additional discharge from wetter conditions in the Murray-Darling Basin and, in particular, in the Murray sub-basin. It has been suggested by Cohen et al. (2007) that for the period 8 to 4 ka there was limited sediment sequestration, although there was a period of enhanced water discharge with well-vegetated catchments and low sediment yields. This matches the trend shown in Figure 2E-F. Furthermore, the isotopic ratios of εNd measured from the clay fraction in the core (Figure 2F) show some fluctuations but retain the typical signal of the River Murray and its tributaries (Bayon et al., 2017). In addition, it is argued by Gingele et al. (2007) for an increase in aridity from c.6 ka and

this is maintained here as the abundance of the rare earth element Ytterbium (Gingele et al., 2007) shown in Figure 2H. The progressive drying and cooling conditions from the middle of the Holocene onward (Gingele et al., 2007) is also confirmed by a marine proxy not affected by the supply of sediment to the ocean; sea-surface temperatures calculated from alkenones measured from MD03-2611 core sediments clearly indicate a progressive and noticeable decrease of some 2°C (Figure 2A) that commenced after 6.5 ka (Calvo et al., 2007, Perner et al., 2018). The same is found in the adjacent core 2611 (Lopes dos Santos et al., 2013), and more importantly at Lake McKenzie on Fraser Island (Woltering et al., 2014) and in deep-sea core Fr10-95/GC17 (De Deckker et al., 2014) offshore Northwest Cape in northwestern Western Australia. All these records indicate that such a cooling phenomenon affected the entire Australian region during the latter part of the Holocene. At the same time, the Leeuwin Current decreased in importance over the core site, despite some fluctuations for the rest of the Holocene. The significance of these changes (Perner et al., 2018) highlight a reduction of tropical heat export from the Indo-Pacific Warm Pool north of Australia via the Leeuwin Current, linked to the El Niño-Southern Oscillation (ENSO).

Climatic deterioration in southeastern Australia has long been confirmed by several key studies in Victoria (Bowler, 1981; De Deckker, 1982; Chivas et al., 1985; Wilkins et al., 2013; Gouramanis et al, 2013), in northern Tasmania (Xia et al., 2001) and New South Wales (Kemp et al., 2012). Collectively, they confirm the findings of Gingele et al. (2007) of a progressive change of climate in the marine and terrestrial realms unrelated to the Murray 'estuary' of Helfensdorfer et al. (2020). Fluvial sediments continuously reached the ocean as the percentage of illite clays changed little during, and since, the deposition

Figure 2: Plot of various proxies obtained from core MD03-2611 that are calibrated with 31 ^{14}C ages. (A) Sea-surface temperatures based on alkenometry (Perner et al., 2018), (B) percentage of the tropical foraminifera faunal assemblage indicating the presence of water from the Indo-Pacific Warn Pool (Perner et al., 2018), (C) percentage of the subtropical planktonic foraminifer *Globigerinoides ruber* indicator of the presence of the Leeuwin Current over the core site (Perner et al., 2018), (D) percentage of the planktonic foraminifer *Globorotalia truncatulinoides* that indicates the depth of the thermocline and consequently sub-surface cooling (Perner et al., 2018), (E) the percentage of the clay illite (with a value of 41% at the Murray Mouth today) that shows the typical waxing and waning of supply of River Murray sediments (Gingele et al., 2007), (F) the clay/silt ratio (Gingele et al., 2007), (G) eNd values extracted from the clay fraction (Gingele et al., 2007), (H) Ytterbium values in ppm measured on the clay fraction are attributed to the supply of aeolian material at the core site and not from a river input (the range of values from the Murray Darling Basin is 1.48 to 3.2 ppm, with a value of 2.01 measured at the Murray Mouth today). The occurrence of the development of the Murray 'estuary' (*sensu* Helfensdorfer et al., 2020) is indicated by the beige rectangle across the entire diagram.



of sediments in the Murray Gorge (Figure 2E). One possibility is that the River Murray may have 'by-passed' its current mouth and reached the ocean through an alternative route, one being via Lake Albert further to the east (Gloster, 1996). Such a finding is not surprising since numerous palaeo-channels of the River Murray on the Lacepede Shelf, several of which are located directly south of Lake Albert, have been documented (Hill et al., 2009) (see identified courses in Figure 1). If fluvial sediments had been transported via this 'conduit' into the ocean, the westerly flowing Flinders Current (Middleton and Bye, 2007) could have easily transported river sediment plumes westward over the two core sites (2607 and 2611).

CONCLUSION

In conclusion, (1) sediment accumulation within the Murray Gorge could not have occurred under marine/estuarine conditions as sea-level was too low for marine waters to penetrate the area at the time stated; (2) the 2 m AHD sea-level highstand invoked in Helfensdorfer et al. (2020) is incorrect, and a value of 1 m AHD is more accurate, as registered at other open ocean localities such as Port Lincoln (Belperio et al., 2002; Lewis et al., 2013) and by the Holocene sandflat facies on southern Hindmarsh Island; (3) the River Murray may have used a different 'conduit' to reach the sea at the time of the Murray Gorge infill via the Narrung Narrows, then Lake Albert and finally the Warringee Embayment (Figure 1); (4) the hypothesis of Helfensdorfer et al. (2020) that the climatic signals recorded in a deep-sea core offshore from the Murray Mouth 'require revision' is also baseless because their claim that the River Murray sediments could not have reached the ocean is incorrect. Fluvial sediments did reach the deep-sea core site, and the climatic interpretation by Gingele et al. (2007), further corroborated by Perner et al. (2018), remains valid. This is further validated by the ample evidence from southeastern Australian lake and river records that all support a deterioration of climatic conditions from the middle of the Holocene in southeastern Australia and a progressive reduction of sea-surface temperatures over the last 6,000 years.

DEDICATION

This paper is dedicated to the memory of the late Dr Franz Gingele who conducted the preliminary investigations on the AUSCAN cores and used his previous work on river clay deposits from the MDB to interpret its climatic history recorded offshore Kangaroo Island. He was an outstanding sedimentologist and marine scientist and is sadly missed.

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STOP PRESS

The following article provides further evidence and support for our article:

Tibby, J., Bourman, B., et al., 2021. A large mid-Holocene estuary was not present in the lower River Murray, Australia. *Scientific Reports* 11(1) DOI:10.1038/s41598-021-90025-9.

NEW BOOK PUBLICATION

Soils of Aotearoa New Zealand

Allan Hewitt, Megan Balks and David Lowe

Springer 1st ed. 2021, XX, 332 p. 192 illus., 147 illus. in color.

https://www.springer.com/in/book/9783030647612

Hardcopy A$338.35 ebook A$197.11

David Lowe

School of Science, University of Waikato, Hamilton, New Zealand

Dr Megan Balks and Prof David Lowe (both from the Earth sciences group, School of Science, University of Waikato, Hamilton) have teamed up with Dr Allan Hewitt (Manaaki Whenua–Landcare Research, Lincoln) to write a book on the soils of New Zealand.

Published by Springer in February 2021, and part of the World Soils Book Series (WSBS), initiated some years ago by series editor Dr Alfred Hartemink (University of Wisconsin–Madison), the book is the first general text on the soils of New Zealand to be published in more than 30 years. It is the only book available that describes New Zealand's soils in the context of the *New Zealand Soil Classification* (*NZSC*) (developed by Hewitt) that has been used in New Zealand since 1992. For international

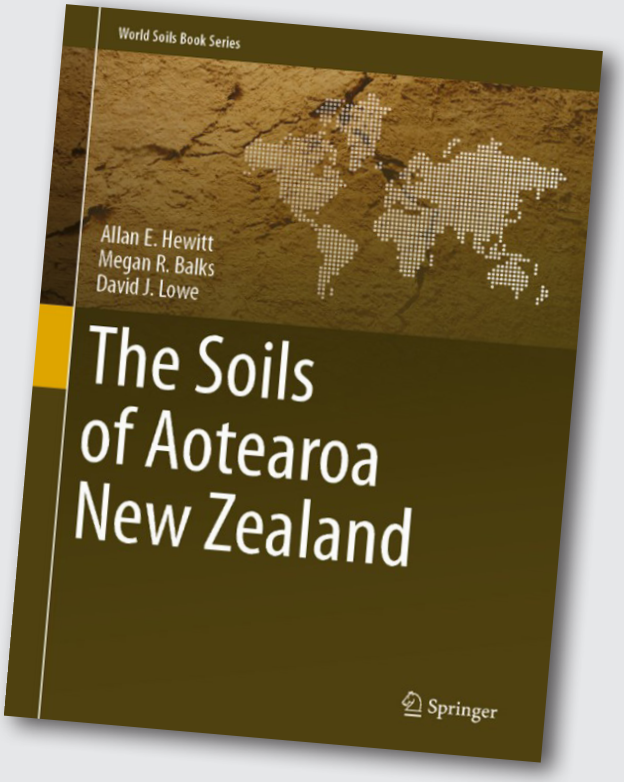
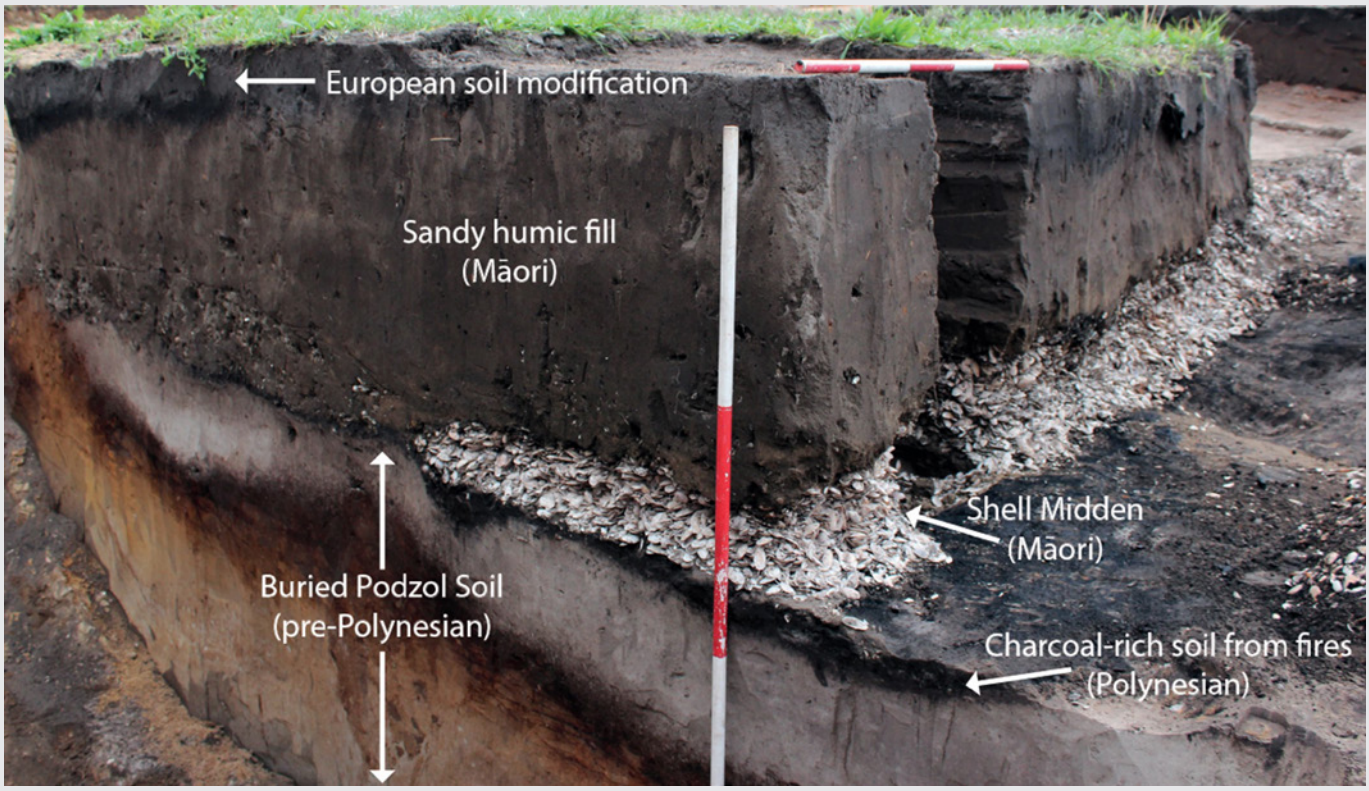


Figure 1: Illustration from the book's chapter on Anthropic Soils (Ch. 3) showing a beautiful and informative layered soil (Artifact Fill Anthropic Soil in NZSC) over a buried Podzol Soil at an early 17th century site at Cooks' Beach on the eastern coast of Coromandel Peninsula (Hoffmann 2017). Photo credit: Andrew Hoffmann.



readers, the book includes equivalent terms for *NZSC* classes using the international soil classification systems, *Soil Taxonomy* and *World Reference Base*.

The book provides an up-to-date overview to the soils of New Zealand structured according to *NZSC* and encompasses 18 chapters. Starting with an introduction on the importance and distribution of New Zealand soils (Chapter 1), it subsequently provides essential information on each of the 15 New Zealand soil orders in separate chapters (Chapters 2 to 16). Each chapter includes a summary of the main features of the soils in the order, and their genesis and relationships with landscapes – which may include an evaluation of Quaternary environments and a stratigraphic approach to underpin the 'competing' geological and pedological processes involved in upbuilding pedogenesis that predominate in a number of orders. The key properties including examples of physical and chemical characteristics of the soils, and their classification, use, and management, are also included in each chapter.

The book then features a chapter (Chapter 17) on soils in the Ross Sea region of Antarctica (with which New Zealand has had a >100-year-long explorative and scientific connection) and concludes (Chapter 18) by considering New Zealand soils in a global context, by examining soil-formation pathways, and by covering methods used in New Zealand to evaluate soils and assist in land-management decisions. A detailed 14-page index completes the volume. Every chapter also includes a 200-word abstract.

The authors' aim has been to provide a clear, modern and reasonably detailed account of New Zealand's soils for undergraduate and graduate students, land managers, farmers, and those with an interest in New Zealand's natural history and landscapes. All chapters are written by the three authors, which helps to maintain a continuity of style and coherence, whereas many other books in the WSBS comprise edited volumes with multiple authors each contributing chapters.

The book comprises 332 pages with 192 illustrations (147 in colour). It is available as a hardcover or e-book, or e-chapters can be purchased individually.

David Lowe (david.lowe@waikato.ac.nz) can provide a pdf of the table of contents in their entirety if such information is needed.

BOOK LAUNCH: "VENERATING OUR SOILS"

The book is to be formally launched at 2.15 pm on Monday 28 June on the University of Waikato campus in Hamilton (venue S block) on the first day of the joint soil science conference of the New Zealand Society of Soil Science and Soil Science Australia being held simultaneously in two hubs, one in Cairns and one at the University of Waikato, Hamilton, along with virtual participation, in the week from 28 June to 2 July 2021. The Right Honourable Simon Upton, Parliamentary Commissioner for the Environment, will speak at the launch. Please contact Dr Tehnuka Ilanko for further information (tehnuka.ilanko@waikato.ac.nz).

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Hoffmann, A. 2017. Investigation of archaeological site T11/2789, Cooks Beach (Pukaki), Mercury Bay: final report. *HNZ authorities 2015/867 & 2015/1022*. 123 pp.

PUBLICATION DETAILS

Hewitt, A.E., Balks, M.R., Lowe, D.J. 2021. *The Soils of Aotearoa New Zealand* (1st ed). Springer, Cham, xx + 332 pp. DOI: 10.1007/978-3-030-64763-6

AVAILABILITY OF BOOK

Springers' website for more information and purchase options: https://www.springer.com/in/book/9783030647612

THESIS ABSTRACTS

FIRE AND ENVIRONMENTAL CHANGE IN NORTHERN AUSTRALIAN TROPICAL SAVANNAS DURING THE HOLOCENE

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Fire has long had a pervasive importance in human lives and actively shapes many landscapes on Earth. Fire has a long history of interaction with Australian ecosystems but poses a growing risk as fire conditions become increasingly severe, due in part to anthropogenic climate change. Tropical savannas cover almost one quarter (1.9 million km^2) of the Australian land mass, and fire occurs in tropical savannas almost annually. A greater understanding of past fire regimes, and their environmental context, is essential for management and planning in an increasingly fire-prone landscape. Despite the central importance of fire in savanna ecosystems, the region remains understudied in Australian palaeofire research.

This thesis combines established visual/microscopic and emerging geochemical methods to create three new multiproxy palaeofire records for three wetland sites in northern Australian savannas. Charcoal from sedimentary records from these sites was separated into three size fractions (>250 µm, 250-125 µm and 125-63 µm) and quantified by stereomicroscope, with aspect ratios and morphotypes recorded to investigate changes in fuel composition over time. Pyrogenic carbon was chemically isolated using hydrogen pyrolysis, with percent carbon measured by elemental analysis with the $\delta^{13}C$ value of the pyrogenic carbon measured by isotope ratio monitoring mass spectrometry to determine changes in fuel composition over time. The novel combination of (optical) charcoal and (chemical) pyrogenic carbon measures enabled the identification of changes in relative fire intensities in the past, crucial to differentiating between anthropogenic and climatic influences within these palaeofire records. The palaeofire records were placed in a broader geochemical context using sediment elemental composition (using µXRF) and placed in a temporal context through the development of ^{210}Pb and ^{14}C chronologies.

The three records are from (i) Marura Sinkhole (eastern Arnhem Land, 13.409°S, 135.774°E), (ii) Big Willum Swamp (Weipa, Cape York Peninsula, 12.657°S, 141.998°E), and (iii) Sanamere Lagoon (Cape York Peninsula, 11.117°S, 142.35°E).

The palaeofire record for Marura sinkhole covers approximately 4600 cal BP to present, with highest fire incidence 4600-2800 cal BP. Vegetation at Marura is of mixed tree-grass composition throughout the record, with variability in the fine (<63 µm) fraction. Variable relative fire intensities and divergence between local and regional fire and vegetation signals suggest increasing human influence on fire at Marura from ~2800 cal BP. Minimal charcoal and pyrogenic carbon transport into the site after ~900 cal BP is likely the result of the imposition of fine-scale patch mosaic burning. European arrival in Arnhem Land shows a delayed effect on fire at Marura, with increased fire incidence after ~1950 CE reaching levels not seen in the preceding 900 years.

The Big Willum Swamp palaeofire record covers ~3900 cal BP to present, with ephemeral conditions leading to minimal deposition early in the record prior to deepening of the site at ~2200 cal BP. Fire incidence at Big Willum Swamp is low until the last century, peaking at ~1970 CE with high relative fire intensities after the establishment of a bauxite mine around the site. Vegetation is a consistent tree-grass mix throughout the record comparable to modern vegetation across the Weipa Plateau.

The palaeofire record for Sanamere Lagoon spans ~8300-5500 cal BP. Fire incidence and sedimentation rate are highest from ~8300-8000 cal BP before an abrupt decline, possibly the result of deepening of the lagoon. Vegetation throughout the record is almost entirely C_3-derived with irregular pulses of grassy burnt material in the fine fraction, indicating that the dwarf heathland currently present at the site has persisted for over 8000 years. High fire intensities that dominate throughout this record are consistent with the modern fire characteristics of heathlands.

The absence of sediments dating from 160 to ~4000 years ago indicates sediment loss from one or more occurrences of scouring, likely triggered by cyclone or active monsoon events.

These records together demonstrate the heterogeneity of fire histories across the savannas of northern Australia. However, while Marura shows decreasing fire incidence through time and Big Willum Swamp contains minimal charcoal and pyrogenic carbon until the recent period, both sites present dramatic increases in fire incidence as a result of European land-use changes. The combination of methods in this thesis demonstrates the interpretive power of a multiproxy approach, with optical techniques such as charcoal morphology and chemical techniques such as the $\delta^{13}C$ values providing greater detail than these methods in isolation. The methods presented in this thesis for assessing changes in relative fire intensities will benefit future palaeofire research.

GOING BEYOND THE LIMITS: A CASE STUDY INVESTIGATING THE POTENTIAL FOR AN 'ANCIENT KAURI' (AGATHIS AUSTRALIS) TREE-RING CHRONOLOGY TO EXTEND BEYOND THE LIMITS OF RADIOCARBON DATING

Priyadarshini (Priya) Parsons O'Brien (Hons)

School of Biological, Earth and Environmental Science, University of New South Wales (UNSW), Australia.

'Ancient kauri' are subfossil samples of the endemic New Zealand tree (*Agathis autralis*) used in dendrochronological and radiocarbon calibration studies. A stockpile of 163 subfossil tree-ring samples has been accumulated but their palaeoclimate potential has never been investigated. The samples are thought to have the potential to form a master chronology that extends at the boundary and beyond the radiocarbon dating limit (i.e. 50, 000 years ago).

This will be explored through the application of modified initial procedures, that involves forgoing the conventional step of visual ring-width pattern matching (i.e. crossdating using a microscope) and instead interrogates the ring-width measurements to find matching growth patterns using the custom designed software package 'COFECHA'. The cluster of matching samples will produce a floating tree-ring chronology that will then be independently verified through traditional techniques.

Furthermore, the floating samples will be radiocarbon dated to identify the associated time period and be analysed for potential climatic signals. The subsequent constructed chronologies prove relevant environmental information persists at the boundary of radiocarbon.

UPCOMING MEETINGS

Editors COVID-19 note: While every effort has been made to confirm that these meetings are still 'going ahead' as planned (or that details have changed) please double check with individual meetings organising committees, or on their webpages for the latest information and possible virtual conference options.

JUNE 2021

Sustainability Research and Innovation Congress 2021

Venue: Virtual & Brisbane, Australia
Date: 12-15 June, 2021.
Virtual event 17-18 June, 2021
https://sri2021.org/

JULY 2021

AQUA Pop-up Conference

Venue: Online
Date: 8-9 July 2021
https://aqua.org.au/conference/

SEPTEMBER 2021

10th International Conference on Geomorphology

Venue: Coimbra, Portugal
Date: 6-10 September 2021
https://www.icg2021.eu/

PEOPLE 3000: Understanding long-term human-environment feedback loops through the integration of archaeology, paleoclimate and ecological models

Venue: Saucache (UTA Campus), Arica, Chile
Date: TBC (September-October) 2021
http://pastglobalchanges.org/calendar/upcoming/127-pages/2099-people-3000-final-2021

NOVEMBER 2021

International Data Week

Venue: Seoul, South Korea
Date: 8-11 November 2021
http://pastglobalchanges.org/calendar/upcoming/127-pages/2047-idw-2021

DECEMBER 2021

AGU Fall Meeting

Venue: New Orleans, USA
Date: 13-17th December 2021
https://www.agu.org/Fall-Meeting

ADVANCE NOTICE 2022

MARCH 2022

IAL-IPA joint meeting "Lagos, Memorias del Territorio"

Venue: BEC Bariloche Events and Congresses, (Argentina)
Date: 20-24 March 2022 (postponed from March, 2021)
https://www.inqua.org/meetings/list/55

IAL-IPA joint meeting: "Lakes as Memories of the Landscape"

Venue: San Carlos de Bariloche, Argentina
Date: TBC March 2022
http://pastglobalchanges.org/calendar/upcoming/127-pages/2009-ial-ipa-2022

MAY 2022

6th PAGES Open Science Meeting

Venue: Agadir, Morocco
Date: TBC May 2022
http://pastglobalchanges.org/calendar/upcoming/127-pages/2065-pages-osm-2022

JUNE 2022

European conference on earthquake engineering and seismology

Venue: International Conference Centre, (Romania)
Date: June, 2022

AUGUST 2022

19th International Swiss Climate Summer School

Venue: Grindelwald, Switzerland
Date: August 2022.
The PAGES-endorsed 19th International Swiss Climate Summer School on "Extreme weather and climate: from atmospheric processes to impacts on ecosystems and society" has been postponed and will now be held at the end of August 2022. Finalized dates are still to be confirmed. A new call will open in September 2021.
http://pastglobalchanges.org/calendar/2020/127-pages/1982-swiss-summer-school-2020

OCTOBER 2022

3rd IPICS Open Science Conference

Venue: Crans-Montana, Switzerland
Date: October 2022

3rd IPICS Open Science Conference "Ice Core Science at the three Poles"

Originally scheduled for October 2020 then 10-15 October 2021 in Crans-Montana, Switzerland, postponed until October 2022.
http://pastglobalchanges.org/calendar/2020/127-pages/1967-ipics-2020

NOVEMBER 2022

PAGES-INQUA joint ECR workshop: Past Socio-Environmental Systems (PASES)

Venue: La Serena y Coquimbo, Chile
Date: 7-11 November 2022.
An initial online session was held in November 2020, and the in-person

meeting was rescheduled for 2022. https://www.pases2020.com/index.php/programme/

2023

XXI INQUA Congress

Venue: Rome, Italy
Date: 13-20 July 2023
https://www.inqua.org/meetings/list/37

ICAZ (moved to 2023)

Venue: Cairns Convention Center, Australia
Date: 7-12 August 2023
https://www.facebook.com/ICAZ2022cairnsaustralia/

SEMINAR SERIES

Pal(a)eoPERCS (Palaeo Early Career Seminars) Series

Weekly seminars given by ECRs across palaeo – disciplines
https://paleopercs.com/

Palynology Short Talks

Monthly seminars hosted by the Palynology Society
https://palynology.org/palynology-short-talks/

International Paleofire Network seminar series

Quasi-monthly seminars on paleofire topics hosted by the International Paleofire Network
https://ipn.paleofire.org/?p=1025

Women in Earth and Environmental Sciences in Australia (WOMEESA) Virtual Seminars

Monthly seminars by women in Earth or Environmental Sciences on their research and career pathway

https://www.womeesa.net/seminarseries

RECENT PUBLICATIONS

Adeleye, M.A., Mariani, M., Connor, S., et al. 2021. Long-term drivers of vegetation turnover in Southern Hemisphere temperate ecosystems. *Global Ecol Biogeogr.* 30: 557– 571. https://doi.org/10.1111/geb.13232

Adeleye, M.A., Haberle, S.G., Harris, S., Hopf, F.V-L., Connor, S., Stevenson, J. 2021. Holocene heathland development in temperate oceanic Southern Hemisphere: Key drivers in a global context. *J Biogeogr.* 00: 1-15. https://doi.org/10.1111/jbi.14057

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MARION DUFRESNE

View of the *RV Marion Dufresne* (offshore Kangaroo Island) which is now part of the French Oceanographic IFREMER (*L'Institut Français de Recherche pour l'Exploitation de la Mer*) fleet. (Photo credit: Yvon Balut from IPEV).

Read about the Marion Dufesne AUSCAN coring program in Research Articles on page 17 in this edition of Quaternary Australasia.

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