Geoscientist

AOTEAROA / NEW ZEALAND

ISSN 1179 -7983

ISSUE 38

November 2022

Geoscience Society
of
New Zealand

GEOSCIENCE SOCIETY OF NEW ZEALAND

A member body of the Royal Society of New Zealand
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Print version ISSN : 1179-7983 **Online version ISSN : 1179-7991**

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GEOSCIENTIST AOTEAROA

'Fingers of Ice'– Icebergs floating on Hooker Lake at Aoraki /Mt. Cook National Park July 2022. Photo: Janis J Russell

Kat Holt
President

Tēnā koe,

The end of 2022 is approaching fast! It's very hard to believe that the first year of my term as President is almost over. I've been so thankful that its been possible for me to undertake my President's Tour. By the time you read this, I would have visited nearly all the branches, giving an update on the Society and its activities, as well as delivering a lecture on the contributions of palynology to the geosciences here in Aotearoa. I wish to express my gratitude to all my hosts at the various branches for their hospitality, and to thank all the members who attended my talks and gave me such an enthusiastic response. For those of you who missed out, a recording of my talk will be available on the GSNZ YouTube channel at some point in the near future, if not already. Last chance to catch me in person will be at the Manawatū Branch in early 2023 (date TBC), and hopefully the Tauranga Branch at some point as well.

I'm very excited about welcoming the Geoscience community to Papaioea Palmerston North later this month, when we will finally be able to gather for our annual conference, following postponement in 2021. I'm also very excited about presenting our annual awards for 2022 at the conference dinner on the evening of the 30 th of November.

Anke, Julie and the team at Conference and Events have been working really hard to get things back online and ready to go for 2022. Its really encouraging to see that all the sponsors who committed to the 2021 conference have stayed with us for 2022. This is testament to the strong relationships between the Society, the Geoscience Community and our key stakeholders. For those of you attending the conference, do make sure to visit our sponsors and exhibitors at their stands and show your appreciation for their support for the Society and our conference.

Reflecting back on the past year, I feel really proud of the work the National Committee members and the wider Society, especially under the challenging conditions imposed by coronavirus. Momentum has been building in some of the Special Interest Groups (SIGs), most notably GeoID (Geoeducation, Outreach and International Development) and the Palaeontology SIG, where respective convenors Jenny Stein and Daniel Thomas have been coordinating regular online seminars.

While it's fair to say that some of us are well and truly over spending time on Zoom, it's clear that it really is a useful tool for helping us make our events and groups more accessible. I also need to give a big shout out to Jenny Stein for the effort she has put in with many other endeavours, including organising a GSNZ stand at the Tauranga STEM festival in October, organising an event to mark International Geoethics day, and making some awesome resources for geoscience concepts in Te Reo Māori, to mark Māori Language week, and all while carrying out the role of GSNZ Secretary!

Our Newsletter Editor Janis Russell also deserves special mention for the work she has put into revamping the newsletter format and coordinating the rebranding, as well as efforts in supporting our new merchandising, including helping to make the beautiful microscopy images of photographer Kamen Engel available to GSNZ members to purchase.

Do you have an idea for something the Society could do to enhance Geosciences in Aotearoa, or ideas for new member benefits? Are you interested in starting a Special Interest Group? Or would you like to produce a publication with support from the GSNZ? We are really keen to hear from you about what new initiatives you would like to see. Or better yet, we would welcome your input as a National Committee member! If you are interested in coming on board the Committee for 2024, or at some time later in the future and would like to know more about what's involved, please don't hesitate to contact me (president@gsnz.org.nz).

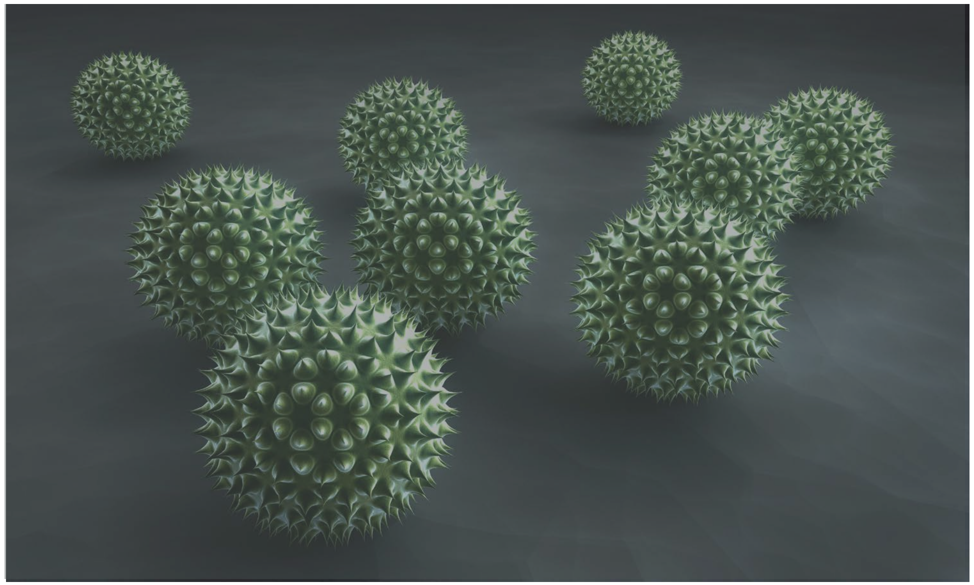
We're calling for nominations for the National committee ahead of our AGM, held on 30th November, at the GSNZ conference in Palmerston North. So if you're keen, now's the time to tell us! In particular, we'll be looking for someone to advocate for ECR issues and take over as convenor of the ECR SIG, as Jenni Hopkins steps down from the role to go on maternity leave.

Which brings me to my final words. A huge thanks to Jenni, who has made an amazing contribution, advocating for early career geocientists whilst on the National Committee. During her time on the committee, Jenni has advocated for the interests of ECRs at every opportunity, and these efforts have manifested an ECR special interest group, travel support for ECRs to attend the GSNZ conference, and reduced GSNZ membership fees for ECRs.

Jenni, we wish you and Shaun all the best for your new family.

Noho ora mai,

Kat



Janis Russell
Editor

Kia ora koutou,

While Covid has not yet left our shores, the lifting of restrictions means we are now able to turn our focus back to other, seemingly less urgent, matters.

It is great to see some of our taonga getting more attention again. The first (p14) of the articles in this issue outlines important major updates in the NZ Geopreservation Inventory – our primary resource for advocating for the protection of our geoheritage.

Further examples of geoheritage protection advocacy are evident in two other related articles regarding the threats posed to the Kaikōura concretions (p23), and the work done by the Waitaki Whitestone Geopark in North Otago (p27).

The NZGI is a legacy, that began over 30 years ago, and its one that will become increasingly important over the next few years and decades.

A post-Covid surge in visitors and the pent up demand for special holidays in some of our most important and/or scenic areas is likely to put pressure on some of these places.

It's also timely, in the face of the Resource Management Act overhaul. Talk of increasing claw back to strengthen business interests, in the wake of Covid-induced financial hardships, as well as the need for further development will test the teeth of the new RMA legislation so we can't afford to rest on our laurels.

There are always difficult choices to be made between preserving people's livelihoods, increasing prosperity, and protecting our unique geoheritage.

In the case of geoparks, the twin pillars of visitors and geoheritage create a nexus that allows people to interpret both physical and cultural elements in the landscape and make up their own minds about its value, *to them*, in conjunction with any official assessment.

How we speak about value aspects of geoscience in everyday contexts matters too. Very often those values prioritise economic/use ones above others – whether it's about energy sources, climate change, land development, natural distaster mitigation, or resource extraction.

While people's physical wellbeing has always taken priority in evaluating positive health outcomes, the inability to cope with an uncomfortable present and an uncertain future, plays havoc with mental and emotional components of our existence.

Yet, interacting with landscape, and learning about its timeline and the processes involved, plays an important role for mental health and wellbeing by connecting and contextualising ourselves in time and space. It reminds us that change is constant, even when imperceptible on a human scale, and it focuses our gaze outwards.

Furthermore, it creates space for wonder, awe, and aesthetic appreciation. One could argue that—after a period major disruptions, restrictions on personal freedoms, social upheaval and significant losses of life or reductions in health—marvelling at the most ancient aspects of our terrestrial heritage may give us greater room to pause, reflect, and reset.

If we are, again, going to have visitors in droves, let's at least take the opportunity to have them engage with our wonderful geoheritage, in an appropriate and beneficial way, for both humans and our geo-taonga.

This will ensure that the legacy of our geoscientists, who had the foresight to create an inventory of our precious geoheritage, will be of value to us all. ■

Ngā mihi,

Janis

GEOSCIENTIST AOTEAROA:

SUBMISSION DEADLINES:

- 1ST FEBRUARY (FOR MARCH ISSUE)
- 1ST JUNE (FOR JULY ISSUE)
- 1ST OCTOBER (FOR NOVEMBER ISSUE)

EDITOR'S NOTICE:

A REMINDER FOR CONTRIBUTORS

Please remember that contributions for the Geoscientist Aotearoa should adhere to the guidelines set out in the Geoscientist Aotearoa section inside the back cover of each issue.

In particular, all images (figures, tables, photos etc) must be supplied separately and not just embedded in a Word document. Pre-formatted (grouped or annotated) images are unnecessary and undesirable as this may hinder page formatting. Similarly please check legibility of text when used as a label on a figure that may need to be be reduced in size to fit an A5 format.

It is the responsibility of the submitter to ensure that these requirements are followed. This is especially so when forwarding articles on behalf of others.

PLEASE NOTE THAT THE GUIDELINES HAVE BEEN REVISED AND EXTENDED. AN UPDATED VERSION IS NOW AVAILABLE IN THIS ISSUE (P65).

NZ GEOPRESERVATION INVENTORY

WEBSITE UPGRADE

Bruce W. Hayward

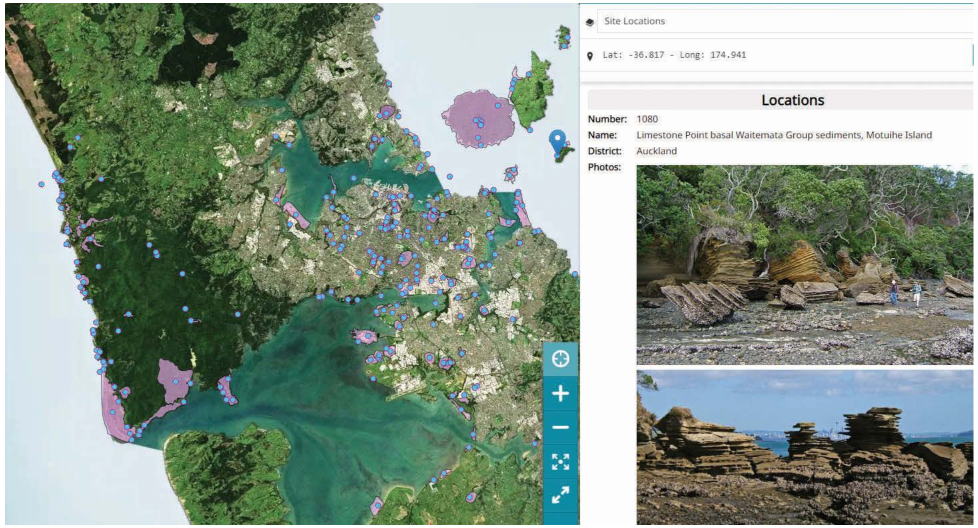
The New Zealand Geopreservation Inventory was compiled by members of our society in the 1980s-1990s with funding assistance, from Lottery Science and DoC, to pay graduate students to do the hard graft in their summer vacations. The inventory remains the Society's major resource for promoting the protection of New Zealand's geoheritage.

Initially the inventory was made available in hard copy in the Society's Miscellaneous Publication series in subject category. Once all the categories were complete, they were combined and the complete inventory made available as a set of 12 hard copy Miscellaneous Publications by regions. Over the next few years, the focus shifted to mapping all the larger sites and then the set of inventories was republished and updated with hard copy maps included.

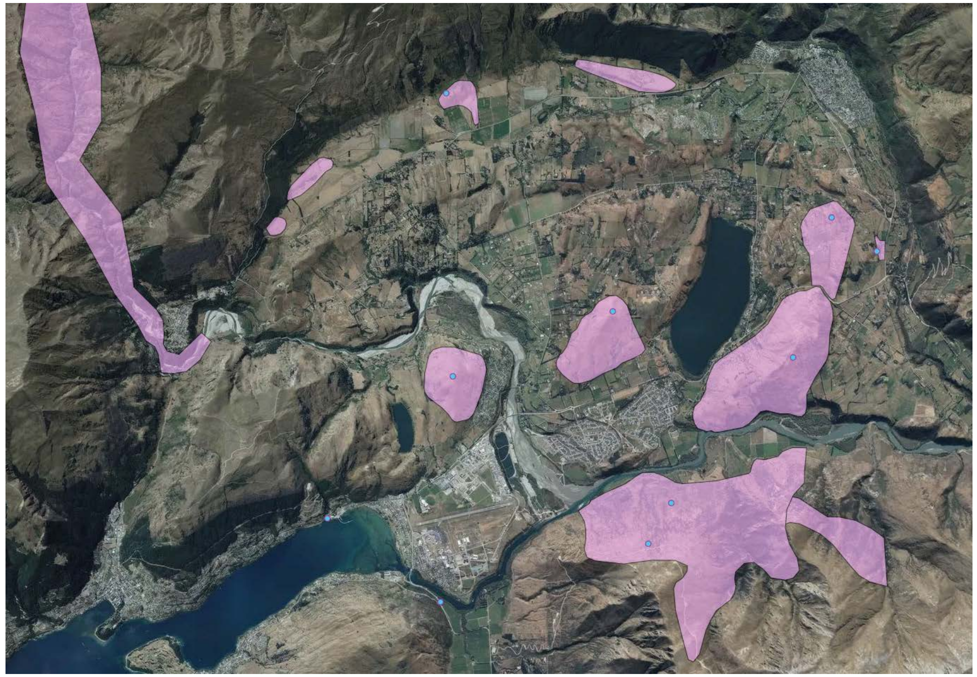
In 2006, the inventory listing of sites was made available on-line and searchable by name and map sheet. The next advance was in 2014 when we partnered with MAIN Trust NZ who hosted the NZ Geopreservation Inventory as a QGIS interactive database with all information accessible for each site using New Zealand satellite and topographic base maps. There have been some limitations with this site and so Elise Smith from MAIN Trust and her technical team have transferred the inventory to a new host site Naturemaps.nz. If you have bookmarked the NZ Geopreservation Inventory in your browser, you should now change it to https://naturemaps.nz/maps/#/viewer/openlayers/484 as the former site has now been closed.

The inventory continues to be updated, with periodic refinements of maps and addition or deletion of sites as new information becomes available, and currently holds 3200 sites. The new web site kicks in with a map of New Zealand with two layers over a satellite or road base map. To access information on any site, highlight the geological areas layer and click on the pink map polygon for that site. Over 1000 sites now have uploaded photographs – to access these, highlight the site locations layer and click on the sites blue dot site marker. Enjoy. ■

Screen capture of mapped Inventory site polygons with no base map.



Screen capture of mapped polygons and blue location markers in the Auckland area, with photos of Limestone Pt, Motuihe Island (flagged).



Screen capture of mapped polygons of geoheritage features in the Arrow Basin, Queenstown.

ARTICLES

TNZ CASE STUDY: TONY CHRISTIE

BIDDING FOR SGA 2021

Tony Christie, minerals geologist and Emeritus Scientist at GNS Science, was a keen conference attendee. Then, with support from Tourism New Zealand, he used his experience to host them.

"I find conferences so motivational. You hear from people speaking about new things – it's been a large influence on my working career," Christie says. *"I was so keen at going along I got involved with organising some."*

Christie has been on organising committees for around 15 conferences since the 1980s and has now convened four.

He convened the Australasian Institute of Mining and Metallurgy NZ Branch conferences in Rotorua (2012) and Wellington (2016) and was shoulder-tapped to host the International Applied Geochemistry Symposium in Rotorua in 2013. He most recently bid for and convened the 16th Biennial Meeting of the Society for Geology Applied to Mineral Deposits (SGA), which took place virtually in March this year.

Why? Hosting a conference in New Zealand has multiple benefits, Christie believes.

"*New Zealand holds a lot of interest to the geoscience community, which helps. Rotorua is top of my list for bringing people here because of the geothermal activity. It's been well publicised in journal papers and people are interested in coming to see mineral deposits in the making. It's that 'natural laboratory' element which entices many."*

But ultimately New Zealand mineral exploration is largely funded from overseas. Hosting a conference in New Zealand can help bring overseas mineral explorers to New Zealand to see opportunities for exploration here. At the same time, they attract overseas researchers to New Zealand, providing the potential to develop collaborative research projects. New Zealand researchers can learn from the new ideas and expertise, while showcasing their current research. Plus, they're excellent professional development and networking opportunities for young scientists."

"You're rubbing shoulders with some of the world's top people in geology. That opens doors."

Christie also points to the personal professional benefits, which in his case includes a long-term collaborative research relationship forged at his 2013 meeting. This led to a research programme on biogeochemical sampling and surveys in mineral exploration.

"It does help with international profile, too. I ended up being a Council Member for the SGA because of my interactions there."

Christie says for those starting out on the conference bidding journey, Tourism New Zealand's Business Events team can offer valuable advice and support. Indeed, it was Tourism New Zealand, in conjunction with Events & Venues Rotorua, who suggested Christie bid for SGA – as far back as 2014.

Tourism New Zealand's Conference Assistance Programme then funded and supported the delivery of a professional bid document and bid presentation, plus trips for Christie to the SGA Biennial Meetings in Nancy, France in 2015 and Quebec, Canada in 2017 to present the bids to the SGA Council.

Support also included travel to the Glasgow event in 2019 to promote SGA in Rotorua, and assistance in developing marketing materials for the event. Christie acknowledges that assistance, *"I wouldn't have been able to do it without the funding"*.

Unfortunately, SGA's long-awaited arrival in New Zealand coincided with the COVID-19 epidemic. Christie laments that *"It was disappointing to have to go fully virtual."*

"I'm very grateful to TNZ for all the help they provided that led to a very successful conference for an online event with some 500 registrations, including 470 from overseas." ■

CONFERENCE FUNDING AND SUPPORT AVAILABLE

Tourism New Zealand's business events team offers support for international conferences of more than 200 international delegates through its conference assistance programme.

This includes supporting costs for a financial feasibility study of the conference, production of a professional conference bid document, funding bid travel requirements, and marketing and promotional support if the bid is successful.

For more information on bidding for an international conference visit: businessevents.newzealand.com

A UNIQUE DRIFTWOOD ACCUMULATION

DEVELOPED ON THE SOUTHERN PART OF THE REGIONAL BEACH SYSTEM AT PAEKĀKĀRIKI, WELLINGTON, NEW ZEALAND

Tom Haskell: Haskell Exploration Services, Waikanae

The Turbidite Sequence in Makirikiri Stream

On 12/02/2017, I noted an extensive driftwood deposit in the beach adjacent to, and south of, Paekākāriki, on the west coast of Te Ika A Maui, (New Zealand's North Island) 40 km ENE of Wellington (Fig. 1). Paekākāriki is on the southern end of the Manawatu lowlands, where a sand beach, including the Kapukapuariki Rocks, wedges out southwards against a rocky coast. This section of sand is the southern end of a beach that extends in a westwardly concave arc set into the lowlands to beyond the Whanganui River mouth, 120 km to the north. I evaluated the deposit 250 m from its termination (Fig. 1). 150 m and 1 km to the NNE, two local streams cross the beach, with the combined Horokiwi and Wainui stream complex, which drains an area of around 5 sq km of hill country, at 3.6 km.

I (Haskell, 1964) described the geology of the Makirikiri Stream/Whakarora Trig area 7 km NNE of Tainui in Wairarapa (Fig. 1), New Zealand, using data collected earlier that year by the Victoria University of Wellington Geological Society. The area is characterised by an Aptian to Maastrichtian marine sequence in an east-plunging syncline. I noted that a 80 mm thick interval of highly carbonaceous mudstone was present in a Motuan (middle-upper Albian, 100 – 103 Ma) turbidite interval exposed in the Makirikiri Stream succession to show that the interval containing it was a continental shelf succession deposited inshore and adjacent to a river system.

To further review the sedimentation systems, involving carbonaceous material on active shore lines, the Paekākāriki example of deposition of carbonaceous material on a shoreline was evaluated early. This review covers 1.4 km of the southern end of the north-northeast trending shore line, extending to the mouth of the combined Horokiwi and Wainui streams, here termed the Ames Street beach (Fig. 1). It comprises a typical sandy beach and includes the Kapukapuariki Rocks (Figs 1, 2). The evaluation of the deposit was made 190 m northeast of the southwestern end of the beach, where a coastal protection boulder bank has been installed. Small scale driftwood accumulations (Fig. 2) are usually present on the beach as shown at location B (Fig. 1), 400 m from the end of the beach, observed approximately one year later.

A Drift Wood Accumulation on Paekākāriki Beach

Walls (1997) points out that driftwood is a ubiquitous feature of almost every place where water meets land, occurring in extraordinarily long, thin, partly aquatic but largely terrestrial, zones. He notes that "The quantity of driftwood at any site and its rate of arrival, departure and decay depend on many things". Storm events are probably the main provider, and driftwood on the shore probably arrives en masse, like Cyclone Bola (eastern North Island, March 1988) while smaller storms contribute less, but more often. Current patterns, winds, and coastal configuration determine where this wood ends up. Storms can take it away again, if there is a combination of high tides, strong wave action and off-shore winds.

Murphy et al. (2021) note that driftwood originating from natural and anthropogenic sources is abundant in coastal regions and that the present state of understanding is limited, and predominantly founded on studies of rivers and tsunamis.

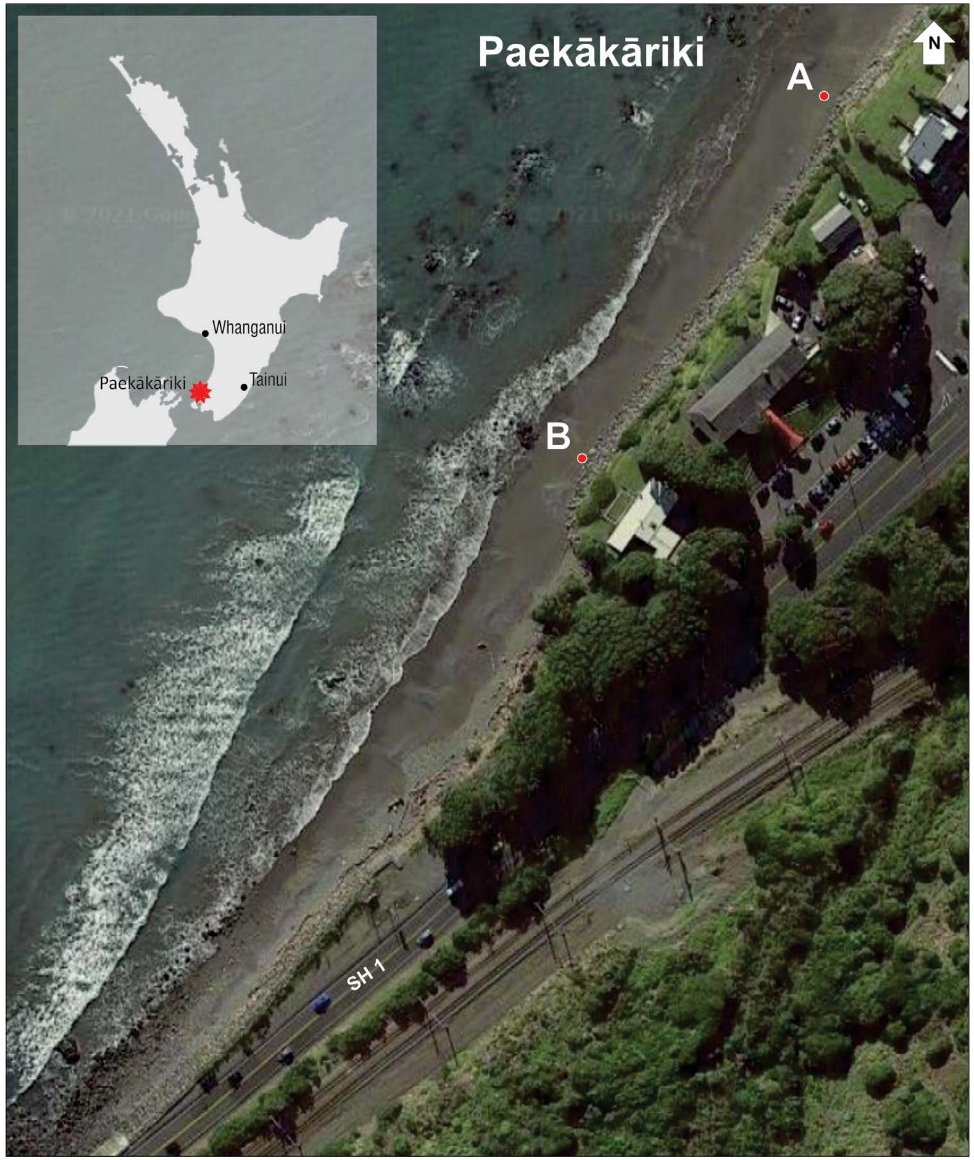


Figure 1. Location map. Ames Road beach, Paekākāriki, New Zealand

In these cases, timing and driving processes are significantly different from when typical climatic or storm conditions prevail in coastal waters. Dong-Jiing, D., et al. (2011) studied the results of Typhoon Morakot in Taiwan in 2009, which washed an unprecedented amount of driftwood into the sea. They found that the amount of coastal driftwood deposited is not only related to the amount of precipitation, but is also to the distance from the source, which they equate to landslides, to the river mouth. On the coast, they note that the amount of deposited driftwood declines in

Figure 2. Driftwood accumulation at location A on Fig. 1 on 12/02/2017, with position of Figure 4 cross section.

Figure.3. Driftwood accumulation at location B on Fig. 1 approximately one year later.

a log-profile function with distance from the river mouth. They also note that much of the driftwood washed into the sea remained offshore.

Drift wood deposit on the Paekākāriki Beach early in 2017

Drift wood on Paekākāriki beach is usually relatively sparse (Fig. 3), and, in common with that on other North Island west coast beaches, originates on the west coast of the South Island and is swept north around Farewell Spit and eastwards by the D'Urville current (Personal communication, Dr Keith Lewis, NIWA (retired, 2022).

However, during, and subsequent to, storm rain and wind conditions on 12/02/2017, drift wood in pieces generally up to 1 m long (Fig. 2), were washed out to sea from the Horokiwi and Wainui streams (Fig. 1). Using Dong-Jiing, D., et al's (2011) model, the floating debris was then progressively by the northwest to north storm wind components (Table 1), and was stranded on the beach. Here, as seen in figures 2 and 4, it banked up into a progressively thickening northwestwardly sloping wedge across the sandy shore line. The wedge would have reached its maximum extent during subsequent successive high tides, and then been progressively eroded by the same process, reaching the state as seen in these near low tide pictures taken on 12/02/2017.

At this tide level (Figs 3, 4), the inner wedge fragments on the beach are dry where they were initially deposited above high tide level by the combination of high tide and onshore storm wind. The wedge extended some 15 m seaward from the high tide mark, where it was around 1 m thick (Fig. 4). The inner part of the wedge had dried out, but the remainder stayed wet. At this state of the tide, a significant part of the woody debris from the original wedge is waterlogged, and in suspension in the sea water, in the surf and wave zones. Water-logged debris settled to the sea bottom off the beach, then was moved as bottom sediment into progressively deeper water by successive tidal movements. This extended the foot of the wedge offshore into deeper water.

The coastal sand and driftwood distribution, from observations on the eroded inner sand dune and beach Ames Street beach on 12/02/2017 (Figs 2, 4), has two distinctive sections. Present coastal activity is in equilibrium with the dune sands that characterise the Kāpiti coast, generally resulting in generation of a sandy slope extending seawards which is usually stabilised by vegetation. This slope, or a modification of it, is presently stabilised by a bank of boulder reinforcing (Figs 2, 3). At the observation point, the exposed low tide beach section below the reinforcing consisted of an inner sand zone around 1 m wide. The sandy beach profile then continues seaward at least 30 m on a 1 in 30 gradient. Seaward from the sand zone was the 1 – 3 m wide, and around 0.5 m thick, driftwood wedge with local superficial dry and sandy layers (Figs 2, 3, 4). The wedge continued a further 3 m and up to around 1 m thick, comprising entirely wet driftwood fragments. The outer margin of this wedge was subject to then active erosion on the inner edge of the surf zone, which resulted in a further generally 3 - 5 m wide, and 1 m thick, zone of floating fragments inside clear sea. There appeared to be saturated fragments settling into the sea, which would indicate that there was a sea-bottom layer of it.

The accumulation was gone a week later. It was probably largely dispersed southwards down the coast by outgoing tidal currents, enhanced by prevailing winds, into the rocky, fault controlled, Paekākāriki to Pukerua Bay coast. There are very

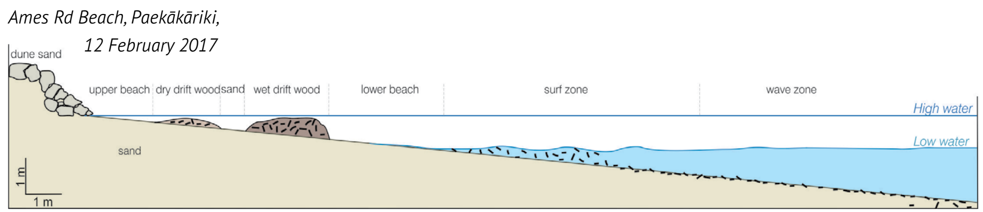


Figure 4. Cross section showing distribution of sand and driftwood across Ames Street beach at location A on Fig. 1 on 12/02/2017.

limited beach locations for stranding there, and the debris would have been dispersed towards Pukerua Bay. It would have been progressively deposited on the sea bottom as saturation and density increased, and corrosion and fragmentation reduced wood particle size.

There is presently little beach or debris at the location of figures 2 and 3 adjacent to the reinforcing. The high tide line along the 150 m of beach south of the reinforcing essentially corresponds to the line of the reinforcing. The beach extends some 7 m further inland, and includes an inner 5 m zone of stranded driftwood, including common 5 m scale logs.

Conclusions

The fortuitous observation and photography of the accumulation of drift wood on Paekākāriki Beach enabled a review of an unusual and recently active stranding. It enabled the detailed over-all cross section of the stranding to be mapped, along with its development and dispersion witch were controlled by the weather systems that prevailed at the time, and the generation of dispersal mechanism.

It showed that the debris was generated by material uplifted from the drainage area of the Horokiwi and Wainui streams in a rain and wind storm on 02/02/2017, and transported south by surface drift dispersed generated by the then storm based prevailing wind.

When the storm energy ebbed, it had formed into a temporary, but stable, 15 m wide wedge. When standard weather patterns were subsequently established, the driftwood was progressively dispersed back into the surf zone by tidal movement enhanced by wave action. In this process, progressively more waterlogged driftwood settled to the sea floor, and then moved seawards by preferential out and downwards agitation within wave base level. Storm seas would determine the depth to which this material was carried, and, combined with tidal movement, established the driftwood sea floor distribution pattern.

The decreasing offshore water movement energy is also expressed in sediment grain size, resulting in deposition of silt at the appropriate depth. The Makirikiri Stream occurrence is an example Motuan inshore deposition, generated after the area subsided below the depth where shells were deposited, but not broken up by wave action, and sand deposition had given way to silt deposition. ■

Table.1 Rainfall and wind speed in Kāpiti area from a storm on 02/02/2017 as a model for weather activity on 12/02/2017.

Rainfall at Whareroa Stream, MacKays Crossing

Date	Rainfall (mm)
30 Jan 2017	0.5
31 Jan 2017	3
01 Feb 2017	1
02 Feb 2017	56
03 Feb 2017	0
04 Feb 2017	0
05 Feb 2017	0
06 Feb 2017	0
07 Feb 2017	4.5
08 Feb 2017	0
09 Feb 2017	0
10 Feb 2017	0
11 Feb 2017	0
12 Feb 2017	1

Wind speed at Paraparaumu Aerodrome, Paraparaumu

Date & time	Wind direction	Wind speed km/h	Gust km/h	Drift rate km/h
02 Feb 2017 12:00	50	11.1	16.7	0.44
02 Feb 2017 13:00	130	1.9	11.1	0.08
02 Feb 2017 14:00	20	9.3	18.5	0.04
02 Feb 2017 15:00	360	22.2	37	0.88
02 Feb 2017 16:00	360	27.8	61.1	1.11
02 Feb 2017 17:00	350	35.2	61.1	1.48
02 Feb 2017 18:00	330	44.4	72.2	1.78
02 Feb 2017 19:00	340	40.7	94.5	1.62
02 Feb 2017 20:00	340	37	68.5	1.62
02 Feb 2017 21:00	10	22.2	44.4	0.40
02 Feb 2017 22:00	320	48.2	77.8	1.28
02 Feb 2017 23:00	340	35.2	81.5	1.62
03 Feb 2017 00:00	330	37	63	1.48
03 Feb 2017 01:00	320	27.8	61.1	1.11
03 Feb 2017 02:00	360	13	44.4	0.52
03 Feb 2017 03:00	10	7.4	20.4	0.30

KAIKŌURA'S LARGE SPHERICAL & OVOID DOLOMITE CONCRETIONS UNDER THREAT

Bruce W Hayward, Kate Pedley, Greg Browne and Mark Lawrence

The 2016 Kaikōura Earthquake uplifted large areas of seafloor and intertidal reef along the east coast of Marlborough and northern Canterbury exposing features that had previously been submerged beneath the sea or were only occasionally seen when the tide was low. The reef on the west side of the boat harbour at South Bay is one such example (e.g., Kitt, 2017). Here the uplift has exposed a reef composed of bedded late Cretaceous mudstone and fine sandstone (Herring Formation) liberally covered with intact and broken spherical to ovoid dolomite concretions. These concretions range in size between 1 m and 5 m in diameter, with the biggest being among the largest beautifully-rounded concretions in the South Island (along with Waipara Gorge and Shag Pt – Hayward, 2014). The majority are larger than the famous Moeraki Boulder spherical concretions (up to 2 m diameter) on the Otago coast that attract thousands of tourists every year.

▲ The location of South Bay reef (arrowed) with concretions at South Bay, Kaikoura Peninsula.

Many of the South Bay concretions are loose on the reef, having eroded out from the softer host rock around them. Geologically the concretions show many different forms which, in addition to their size, makes the locality significant. Many of the loose concretions have broken apart and expose their inside structure, which in some consists of concentric rings produced by a radial growth pattern. A few concretions have a soft centre from which well-preserved microfossils have been obtained that date the rocks as Late Cretaceous (~70 million years old). In all but one or two concretions there is no obvious central locus around which the concretion crystals grew (Browne, 1985).

A number of the concretions are still in-situ in the Herring Formation sedimentary rocks with the long axis of the more ovoid bodies aligned parallel to the bedding. In several concretions the original sedimentary layering can be seen passing from the host rock into and through them, which illustrates how the concretions grew within the sediments. Some of the concretions show deformation of the surrounding bedding (above and below) as individual concretions grew within the sediment. After the concretions had been formed the sediments were more deeply buried by further sediment and the soft sediment layers compacted between the hardened, non-compactable concretions.

Detailed chemical and isotope studies of similar, but smaller, concretions that were visible intertidally at Gooch's Beach on the north side of Kaikōura Peninsula before the earthquake uplift (Browne, 1985; Lawrence, 1991) show they are made of dolomite (calcium magnesium carbonate). These studies show the concretions were wholly formed in marine conditions without the influence of meteoric waters. It appears they grew within the sediments soon after they were laid down at burial depths of ~2-20+ m (Lawrence, 1991).

The dolomite concretions at South Bay are one of at least eight localities within the Herring Formation where similar concretions occur (Lawrence, 1991). South Bay is one of the two coastal localities where the concretions are clearly visible (when the tide is

▲ Oblique aerial photograph of the uplifted South Bay reef with large concretions at low tide and South Bay harbour beyond, 2022.

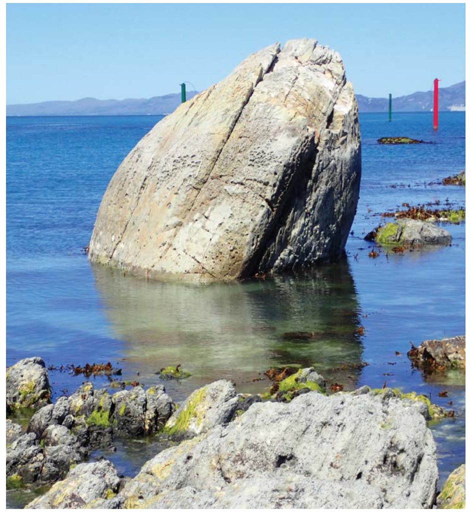
out) and easily accessible (Browne, 1985; Browne et al., 2005). All the other localities are inland stream exposures a long way from most public roads (Lawrence, 1991). The concretions at Gooch's Beach on the north side of the peninsula are similar, but generally smaller and therefore not so prominent and attractive as those now visible at South Bay reef.

A concretion is a hard, compact rock formed by the precipitation of mineral cement within the spaces between particles, and is usually found in sedimentary rock. They may be made from one of a number of different minerals. The Moeraki Boulders were formed by calcite cementation (the most common type of concretion in New Zealand), the Herring Formation concretions are made of dolomite, and in other parts of New Zealand we sometimes also have large spherical concretions made of siderite (iron carbonate) or barite (barium sulphate). Dolomite concretions of Late Cretaceous age are not at all common outside of Marlborough although smaller dolomite concretions are reasonably common in younger rocks around New Zealand.

The New Zealand Geopreservation Inventory (Geoscience Society of New Zealand, 2022) has rated the South Bay concretions as being of national significance for their scientific, educational and aesthetic values. Two other localities of large spherical or ovoid concretions in New Zealand have also been rated as of national importance as concretions – Moeraki Boulders (Otago) and

▲ Large subspherical dolomite concretions partly exhumed but still in-situ with flattened direction parallel to the bedding of the host rock, South Bay, Kaikoura, 2018.

Koutu Boulders (Northland) (Hayward, 2014). Nine other spherical concretion sites in New Zealand have been rated as of international or national significance based on the well-preserved fossils (e.g., crabs, ammonites, marine reptiles) that are often found inside them (Hayward, 2014). Using the Geoscience Society of New Zealand's Best Practice Guide for assessing and identifying Outstanding Natural Features in New Zealand for protection under the RMA (Hayward, 2019), these large South Bay concretions would easily qualify as an Outstanding



▲ One of the largest (4 m diameter) concretions is now partly exposed at the entrance to South Bay boat harbour, Kaikoura, 2018.

Natural Feature (ONF) on the basis of their scientific, educational, accessibility and aesthetic values.

The earthquake uplift greatly reduced the accessibility of the Kaikōura boat harbour, a vital piece of the infrastructure for the whale-watching tours that are the major tourist attraction for the town. As a result, in 2017, 22,000 cubic metres of material was dredged so that the sea channel and harbour floor could be restored to their pre-earthquake depth. Piers, jetties, launching ramps, a breakwater, retaining walls and rock groyne walls were constructed. A new tender jetty was also added so that cruise ships can berth off the coast with tourists ferried into shore.

In 2020, the provincial growth fund allocated $1m for a study into how South Bay Harbour and surrounding areas could be improved. In mid-2022, this resulted in

▲ The South Bay reef is littered with many concretions that have broken apart displaying their internal structure.

▲ Artist's impression of planned South Bay marina development with the reclaimed reef arrowed.

the release of a business case for South Bay Harbour Redevelopment. Plans within this document show the proposal to build a sheltered marina encircling the seaward side of the concretion reef. It indicates that the reef itself will be "reclaimed" to create a flat area for "possible commercial/retail building and parking" surrounded by "public space paving/landscaping". In other words, Kaikōura Council is proposing to sacrifice its own version of the Moeraki Boulders in favour of a parking area. The Geoscience Society of NZ is in the process of alerting the planners that the South Bay reef is an outstanding natural geoheritage feature, and that the RMA's NZ Coastal Policy Statement, Policy 15 states that councils are required "To protect the natural features and natural landscapes (including seascapes) of the coastal environment from inappropriate subdivision, use and development: by (a) avoiding adverse effects of activities on outstanding natural features and outstanding natural landscapes in the coastal environment. and (b) avoiding significant adverse effects and avoid, remedy and mitigate other adverse effects of activities on other natural features and natural landscapes in the coastal environment." ■

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ARTICLES

WAITAKI WHITESTONE GEOPARK

PROPOSED TO BE NEW ZEALAND'S FIRST UNESCO GLOBAL GEOPARK

Lisa Heinz

The Waitaki Whitestone aspiring Geopark is one step closer to becoming New Zealand's first UNESCO Global Geopark following the recommendation from the UNESCO Global Geopark Council to accept the application. The next step is for the Executive Board of UNESCO to endorse the recommendation which is expected in April 2023. The application process began in 2019, when the Waitaki Whitestone Geopark Trust submitted its final dossier to the New Zealand Commission of UNESCO to be forwarded to UNESCO in Paris. Following this, UNESCO sends two evaluators to carry out a field evaluation of the area. These missions usually start in May the following year. Due to Covid-19 pandemic restrictions the evaluation mission was delayed until July 2022.

The cumulation of years of work by the Waitaki Whitestone Geopark saw UNESCO assessors Nickolas Zouros (Lesvos Island UGGp, Greece) and Anchel Belmonte Ribas (Sobrarbe-Pirineos UGGp, Spain) visit Waitaki in July 2022. The three-day evaluation mission began with a Pōwhiri at the Moeraki Marae before visiting various sites including Te Kaihīnaki / Moeraki Boulders, Puketapu, Devil's Bridge Wetland, Takiroa Māori Rock Art, a helicopter flight into the western area of the Geopark including the Ahuriri Valley and Ōhau Moraines, Ōamaru Lookout Point, Elephant Rocks, Vanished World Centre, and an education programme with Duntroon School.

Check out a video of the highlights of the evaluation mission on our website www.whitestonegeopark.nz/post/our-unesco-evaluation-mission

The establishment and management of the Waitaki Whitestone Geopark has been a collaborative endeavour from the start. The Waitaki Whitestone Geopark Trust would like to extend a special thank you to Te Rūnanga o Moeraki, Waitaki District Council, New Zealand Commission for UNESCO, Vanished World, the Geology Department of the University of Otago, GNS Science, Tourism Waitaki, OceanaGold, Adair Craik Chartered Accountants and communities of the Waitaki district and Geopark ambassadors for their support and involvement.■

Waitaki Whitestone Geopark

Incredible forces formed our Geopark under an ancient sea. Volcanoes, mountains, rivers, glaciers, and people then further shaped this region. Written in the stone and in our land is the story of the Waitaki – a geological wonderland, steeped in Kāi Tahu Whānui histories and culture waiting to be explored.

What is a Geopark?

Our Geopark covers the entire Waitaki District and tells the story of our whenua (land) and how the landscapes have shaped the lives of its people, animals, and plants. The Waitaki Whitestone Geopark is aiming to become New Zealand's first UNESCO Global Geopark – a recognised area of international geological significance. Geoparks connect the geological heritage of a region with its cultural, social and natural heritage.

Waitaki Whitestone Aspiring Global Geopark

Stay up to date with the Waitaki Whitestone Geopark's journey – follow us on Facebook (@waitakiwhitestonegeopark) and sign up to our monthly newsletter

(www.whitestonegeopark.nz/newsletter)

UNESCO evaluators during the pōwhiri at Moeraki marae

Duntroon Community Lunch with UNESCO evaluators

UNESCO evaluators Nickolas and Anchel visiting Te Kaihīnaki-Moeraki Boulders

UNESCO visit

Aerial view of Waitaki River

FIELD TRIPS 2021

AUCKLAND GEOLOGY CLUB/BRANCH OF GSNZ

Bruce W. Hayward

Once again in 2021 Covid struck the Auckland Branch and Auckland Geology Club harder than other parts of the country, with house lockdowns, restrictions on meetings and closure of the borders to Northland and Waikato. In spite of these disruptions the Auckland Geology Club and Branch of GSNZ managed to get out and about and see some of the northern North Island's exciting geology. The biggest casualty was our planned Nov 2021 field trip to the Wairarapa which has been postponed till later in 2022, hopefully.

We managed to run 12 field trips during the year, compared with 10 in 2020, and once again none of our trips were cancelled because of bad weather.

These trips were:

- Upper Huia Dam walk (Feb, Bruce Hayward, 15)
- Piha spring low tide exploration of the seaward side of Lion Rock and a new beach through the Blowhole (Mar, Bruce Hayward and Peter Crossley, 17)
- Mathesons Bay basal Waitematas (Mar, Bruce Hayward, 17)
- Boat trip to Tamaki Strait and back (Apr, Bruce Hayward and Bernhard Sporli, 37)
- King Country and Taranaki geohighlights (4 days May, Bruce Hayward, 27)
- Whatipu, Miocene stratovolcano (May, Bruce Hayward, 26)
- Kidds Beach Pliocene (Jun, Wendy Goad and Bruce Hayward, 12)
- No field trips July-Oct because of Covid
- Musick Pt Waitematas (Nov, Bruce Hayward, 19)
- Wattle Downs Pliocene (Nov, Bruce Hayward, 20)
- Mt St John and Mt Hobson volcanoes (Dec, Bruce Hayward, 17)
- Mangere Pliocene fossils fossick (Dec, jointly with Shell Club, Nathan Collins, 15)
- Wenderholm Waitematas, Christmas BBQ (Dec, Bruce Hayward, 12).

The average attendance on all field trips was 20, slightly down on last year's 21. One change we had to institute after the major lockdown was the insistence on pre-booking, double vaccinations and wearing of masks on November and December trips. Those attending the Mangere fossil field trip in an open paddock were also required by the landowner, Watercare, to have a negative covid test within 48 hrs of attending —surprisingly 15 complied and turned out.

Unfortunately another casualty of the lockdown was the cancellation of the 2021 Auckland Heritage Festival where we were to offer ten geoheritage trips for the general public — maybe they will go ahead in 2022. Since the mid-year lockdown all our evening meetings have been run by zoom with an encouraging number of our non-Auckland members able to attend. Because of the reduced activities in 2020-2021, the annual subscription was waived for 2020 and also again this year and replaced with voluntary donations. We made a small profit in 2020 and expect to do so again this year.

Examining slumped Triassic strata at Kiritehere, King Country, May 2021.

Marakopa Falls unconformity at the Waipounamu Erosion Surface, King Country, May 2021.

Mohakatino sea stacks and sea tunnels, north Taranaki coast, May 2021.

Airedale Reef fossil forest, Waitara, May 2021.

TRIPS & TRAILS

▲ Examining the building stones in Te Henui Vicarage, New Plymouth built 1845.

▲ Oakura debris avalanche deposit, Taranaki coast, May 2021.

◀ Discussing unusual Holocene beach rock, Musick Pt, East Auckland, Nov 2021.

▼ Masked up and double vaxed for Wattle Downs field trip, South Auckland, Nov 2021.

Geoclubbers climbing Auckland's Mt Hobson, Dec 2021

Top left: Lake Rotoroa, Nelson Lakes National Park. ▶
Top right: Hawks Crag, Buller Gorge.
Bottom left: Hole in the Hill.
Bottom Centre: Constant Bay.
Bottom right: Students observing the accident sea floor at Cobden Beach.

TRIPS & TRAILS

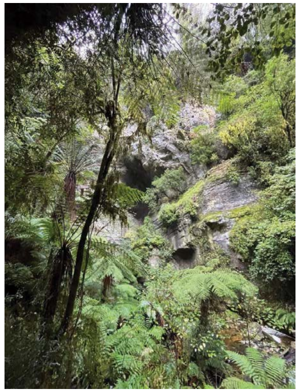
WEST COAST TRIP 2022

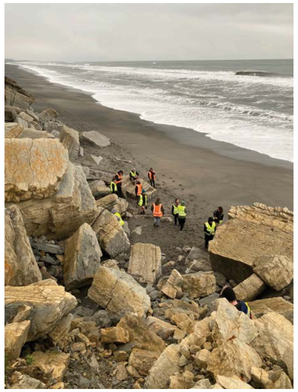
VICTORIA UNIVERSITY OF WELLINGTON GEOLOGY SOCIETY

Rochelle Lowe, President—2022

Between the 27th June and 1st July, the Victoria University of Wellington Geology Society took 25 members on an educational field trip to the West Coast of the South Island with the support of GSNZ. The trip aimed to educate geology students on New Zealand supergroups and the evolution they record, faulting, glaciers and mining history.

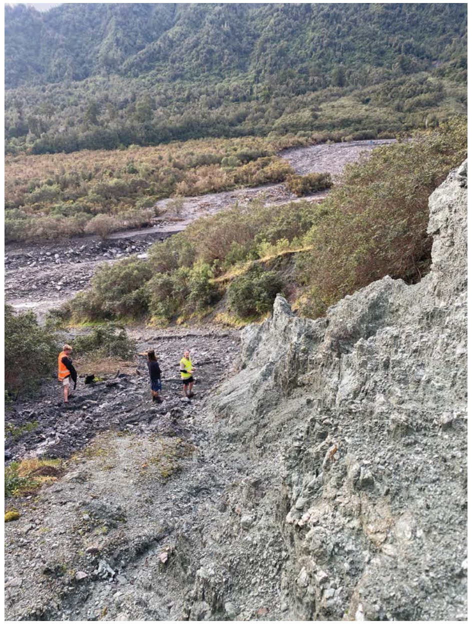
Day one's itinerary included a ferry ride to the South Island and a drive to Westport, stopping at Lake Rotoroa and Hawks Crag along the way. These stops were a chance for people to stretch their legs and take in some of the views the South Island had to offer. Day two involved travelling from Westport to Greymouth. We had many stops this day including Hole in the Hill (Charleston), Constant Bay to look at the Charleston Gneiss, Pancake Rocks (Punakaiki), Coal Creek Falls (Runanga) and Cobden Beach (Runanga). This day really showcased the geology the South Island had to offer, and we were fortunate to have Dene Carroll from VUW to walk us through each stop's geological significance.





On day three, we travelled through glacier country, making stops at Gaunt Creek, Franz Josef Glacier and Dorothy Falls on the way back up to Westport for the night. Many thanks to Gray and Vicki Eatwell for allowing us access to the Gaunt Creek site and talking to the students both as a group and answering any individual questions about the site.

The Eatwells have had geology groups from all over the world come visit the Gaunt Creek outcrop so were able to give an unique insight into what is occurring along the Alpine Fault. We then headed south the Franz Josef Glacier where we walked to the viewing platform. Being at the glacier first hand put a lot of things into perspective regarding climate change for the students. After this, we turned around and headed back north to Westport, stopping at Dorothy Falls for a quick swim.



▲ Top left: Students looking out at Pancake Rocks blowhole.
Centre left: Pancake Rocks.
Bottom left: Coal Creek Falls.
Bottom right: Students at Gaunt Creek outcrop.

▲ Top left and top right: Students at Gaunt Creek outcrop
Bottom left: Gray Eatwell sharing his knowledge of Gaunt Creek and the Alpine Fault.
Bottom right: Franz Josef

On day four we drove to the Denniston Plateau and saw the remains of the historic coal mine. This gave students a new appreciation for how mining was once executed. After this, we headed towards Blacks Point, a small town just out of Reefton to meet with Ian Ladds. Ian has amazing knowledge of fossils and geology in the area due to his many years being involved with the Nelson Rock and Mineral Club. He led the group down Stony Creek in search of marine fossils, where we were extremely successful. Ian took some samples home with him to clean up and identify. These are pictured below. This was a unique experience for our students, both hunting for fossils and Ian helping to identify what they were in the field.

After some time down at the creek, we visited Ian's home where he showed us his life's collection of rocks, minerals and fossils. This was by far one of the most impressive collections our students had seen.

Before heading back to Wellington on the Friday we met Ian again at Nuggety Creek just out of Murchison. Here, he showed us an outcrop abundant in terrestrial fossils where every student was able to find something. Again, Ian's vast knowledge of the area enabled a unique learning experience for the students.

This trip helped stimulate discussions of New Zealand geology that students in their BSc at Victoria University don't often get to see. It gave undergraduates the opportunity to talk with postgraduates and staff about future endeavours and learnings. On behalf of the VUW Geology Society, I would like to thank GSNZ for your ongoing financial support. Your contribution enables us to continuously provide unique opportunities to our members, something we are extremely grateful for.

▲ Top left: Dorothy Falls. Top right: Students exploring the Denniston Historic Area. Bottom left: Dene Carroll and Ian Ladds explaining the geological significance behind the Stony Creek area. Bottom right: Photo by Ian Ladds of the group at Nuggety Creek.

AT LONG LAST!

JOSHU MOUNTJOY RECEIVES THE MCKAY HAMMER

▲ Better late than never, for Joshu, who endured several delays due to Covid and a skiing accident before finally being presented with his award at a NIWA staff meeting in early October.

◀ Phil Barnes congratulates Joshu, after providing an introduction and background to the award presentation, while Mike Williams (Chief Scientist—Oceans) waits to hand over the hardware.

S J HASTIE AWARD

SUPERVISOR'S SUPPORT LETTER: GEORGE YOUNG

Faculty of Science

School of Earth and Environment
earthandenvironment@canterbury.ac.nz

UNIVERSITY OF CANTERBURY
Te Whare Wānanga o Waitaha
CHRISTCHURCH NEW ZEALAND

12 October 2022

Tēnā koe

George Young was a recipient of a Hastie Prize for 2022 to undertake his MSc thesis research. I can confirm that George enrolled, completed his research, and in fact has just submitted his thesis titled "A Cretaceous ichthyosaur from North Canterbury". George gave a talk to the School earlier in the year and acknowledged his funding and support in that talk.

Nāku iti noa, nā,

Associate Professor Catherine Reid
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Te Kura Aronukurangi | School of Earth and Environment
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S J HASTIE AWARD REPORT

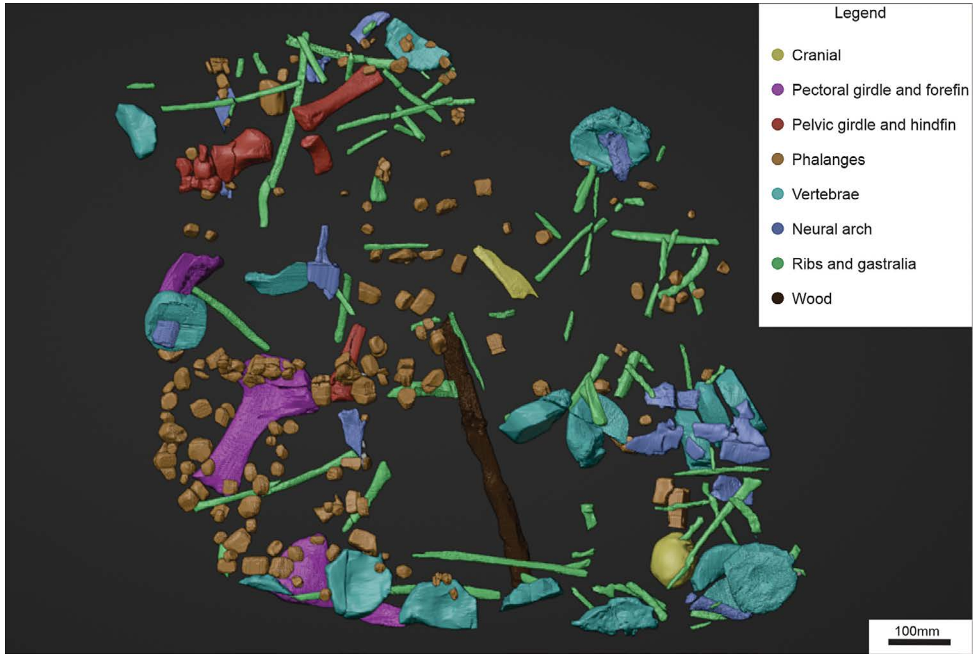
Thesis title: A Cretaceous Ichthyosaur From North Canterbury

George Young: 2022 recipient

Supervisors: Catherine Reid and Paul Scofield

Ichthyosaurs were a group of secondarily aquatic marine reptiles that colonised the marine realm shortly after the Permian-Triassic mass extinction and were major components of Mesozoic marine ecosystems for more than 150 million years. The partial skeleton of an ichthyosaur has been discovered in a concretion from the Split Rock Formation in North Canterbury. This concretion dates from the Cenomanian approximately 98 million years ago, only four million years before the final extinction of the ichthyosaurs. The concretion, having been broken into several blocks, was CT scanned to image the interiors of the concretionary blocks, and identify bones within the rock matrix.

The blocks were also subject to physical and chemical preparation to produce better CT imaging results, as well as revealing the bones themselves. The CT data allowed for digital reconstruction of the skeletal elements of GS15687 and their 3D distribution within the concretion. The skeletal elements of GS15687 were described and measured using these reconstructions, and this morphological data was used to conduct a phylogenetic analysis. A large number of bones were discovered to be within the concretionary blocks, including a complete basioccipital, left scapula, left pelvic girdle, and much of the proximal left hindfin. In addition, a partial nasal, left coracoid, left humerus,



A digital reconstruction of the concretion illustrating all the identified bones without the rock matrix. The bones have been separated and coloured by their type and body region.

and right ischiopubis have been recovered, as well as multiple vertebrae, neural arches, ribs and gastralia from the posterior trunk of the animal. The heavy disarticulation of the skeleton suggests that GS15687 was subjected to significant disturbance, including scavenging, before fossilisation.

The phylogenetic analyses place GS15687 within the derived ichthyosaur subfamily Platypterygiinae, with results suggesting that GS15687 is a new taxon of ichthyosaur. This finding is supported by a number of unique apomorphies, including a protrusion on the ventral surface of the scapula and a depression on the anterior ischiopubis face.

The complete left pelvic girdle of GS15687 is one of the few well preserved Cretaceous ichthyosaur pelvises and adds to the data set of known derived ichthyosaur ischiopubes. The phylogenetic results generated in this thesis produced a topology similar to many other recent analyses and finds that the derived platypterygiine taxa are divided into two clades and that GS15687 is a basal member of one of these clades. The two clades additionally appear to show different biogeographic patterns, with potential origins in South America and Australasia. GS15687 represents the most complete ichthyosaur specimen known in New Zealand and is the first one that can be described to a valid genus and species. ■

GEOID UPDATE

GEOEDUCATION, OUTREACH, AND INTERNATIONAL DEVELOPMENT

GeOID

GeoEducation, Outreach and International Development Special Interest Group
Geoscience Society of Aotearoa New Zealand

Jenny Stein: GeOID convenor

Kia ora koutou,

It's been a busy winter for GeOID…Our monthly online seminar series "GEOTalks" continues to attract interested members to learn about a range of different outreach initiatives going on around the motu. While live audience sizes are small, the talks have been excellent and only matched by the quality of the questions and discussions that have taken place with audience members afterwards. It's been especially good to see some valuable networking going on during these discussions too!

Thank you to all our members who have been attending and contributing to the GEOTalk sessions, and especially to all the speakers we've had so far this year:

Suzanne Bull, GNS Science
Sriparna Saha, University of Canterbury
Georgia McCombe, East Coast LAB
Sasha Morriss, Waitaki Whitestone Geopark
Kyle Bland & Malcolm Arnot, GNS Science
Jane Hoggard & Chris Duggan, House of Science
Marion Tan, CRISiSLab
Sophia Tsang, Soil Safe Kids

Thanks also to the GSNZ National Committee whose purchase of a GSNZ Zoom licence means that if you're interested in catching up on some of these talks, you can find ones with publicly accessible recordings on the GEOTalks playlist on the GSNZ YouTube channel ("GeoScience NZ").

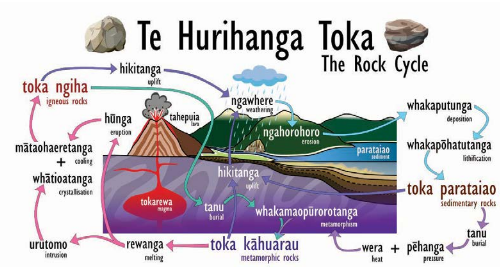
TAURANGA STEM Festival

By far the biggest event we've participated in this year has been the Tauranga STEM Festival on October 2nd. Representing the GSNZ, we joined ~40 other exhibitors that set up around the Waikato University Durham St campus for the 1-day festival which attracted over 5,000 members of the public. While COVID inevitably prevented us from presenting everything we had intended (sadly an activity featuring an earthquake shaker table had to be called off), we managed to fill our double-booth with multiple activities: Volcano Explorer (featuring the University of Canterbury's MagmaPop game, informative videos, and a range volcanic rocks and equipment to test rock weights and whether or not they could float on water), Rock Detectives – Stories in Stone (featuring a range of different rock specimens and their origin stories), and Let's Make a Landscape (featuring GNS Science's augmented reality sandbox). We also provided some volcano-themed colouring-in worksheets for the really little kids, and a dress-up box of field gear and simple equipment kids could use to get their photo taken in front of a large poster of Tongariro Maunga's Emerald Lakes. Hopefully some of them caught a glimpse of their future selves!

Our exhibit proved very popular, with no let up in the crowds any time from 10am until 4pm when the festival finished (and even then there were stragglers reluctant to leave). A huge thank you to GNS Science, the National Petrology Reference Collection, the National Paleontological Collection, East Coast LAB, the University of Canterbury, the University of Auckland and the Rapid Characterisation of Earthquakes and Tsunami (RCET) programme for providing rock specimens, materials and equipment, and an absolutely ENORMOUS thank you to the GSNZ members who volunteered their time to help run the exhibit: Sally Potter, Ben Simons, Terry Boyle and Sophia Tsang. We virtually never got a break all day but I hope you will all agree it was worth it!!

Also, a quick shout out to the festival organisers, the STEM Wana Trust, for hosting an outreach event that in the words of one attendee was the "Best organised & most informative free event I've ever taken my kids to!". The event is certainly something other regions should be aspiring to!

Finally, some members may have noticed the small social media campaign we ran for Te Wiki o te Reo Māori in September. It consisted of a series of seven simple infographics sharing various geoscience-related kupu, and culminated in an illustrated Reo-dominated version of Te Hurihanga Toka – The Rock Cycle. Shockingly, this seems to be the first



One of the posters created for our social media campaign for Te Wiki o te Reo Maori, in September.

readily available Reo-version of this cycle! Even the Ministry of Education doesn't seem have one (at least, not one readily availabe online). Since understanding te Hurihanga Toka is a fundamental component of understanding the origins of different types of rocks, we printed out a large poster version of it to display as part of our Rock Detectives activity at the Tauranga STEM Festival.

Imagine my surprise (and joy) a couple of days later when I was forwarded an email enquiry from a festival attendee wanting to know where they could get a copy. I emailed them the file and was delighted to recieve an email back saying "we love these resources...It was nice to see and hear my son's response to the reo Māori resources and for him to feel "included". He has aspirations to study paleontology, and it's encouraging for us to see the effort being put in to support all tamariki".

Warm fuzzies all round, and confirmation that the few hours it took to research and draft the infographics was time well spent. Outreach often gets discounted as taking too much time, or being too much effort to be worthwhile, but there's no denying that it does make a difference. Kia kaha to all the GeOID and other GSNZ members out there giving it a go!

Mā te wā,
Jenny

PETROLEUM

HOW SHOULD GEOSCIENCE INFORM THE ENERGY TRANSITION?

Mac Beggs: Retiring Convenor, Petroleum Special Interest Group

The Society's Special Interest Group for Petroleum had its origins in a sub-committee of the Geological Society of New Zealand, established during a previous period of disruption to and expansion of energy systems in 1970's. As now, a time when energy security, reliability and affordability were of significant public concern. Following its establishment at the 1976 AGM of the GSNZ, the Petroleum Sub-committee prepared a detailed submission to government, which was presented to the Minister of Energy in June 1977 (see Newsletter 1977-10). The thrust of the Society's position was that geoscience expertise was inadequate (and in some cases absent) within the numerous government entities involved in government investment into oil and gas exploration and development, and that numerous obstacles including perceived and actual conflicts of interest precluded effective deployment of the relevant expertise which did lie within the DSIR.

Some, at least, of the recommendations of the Society's submission did come into effect in the subsequent times, and have contributed to strong legacy systems such as the open file report systems and core and sample library, and the impressive outputs of government-funded basin analysis programmes undertaken by GNS and Waikato University.

The modern energy transition has been gaining pace and government attention, especially since the change of government in 2017. Numerous elements of New Zealand's future energy system require and benefit from high levels of geoscience expertise, in development and operations as well as in research. New classes of geothermal energy, and geostorage, are prominent examples. Lines of geoscience also benefit from the availability of new analytical technology, which can find valuable applications to facilitate such energy developments as will be required in the decades ahead. I believe the Society should actively promote the potential for the expertise of our profession to be involved in addressing the opportunities and challenges which are to be encountered. As outgoing Convenor for the Petroleum Special Interest Group I am proposing that this be a topic for discussion at the scheduled lunch time meeting. Perhaps, this group could be broadened in scope to help ensure appropriate roles for geoscience in the whole area of energy systems ■

GEOSCIENCE QUIZ

GEOCRYPTIC CROSSWORD 05

by **Cryptonite**

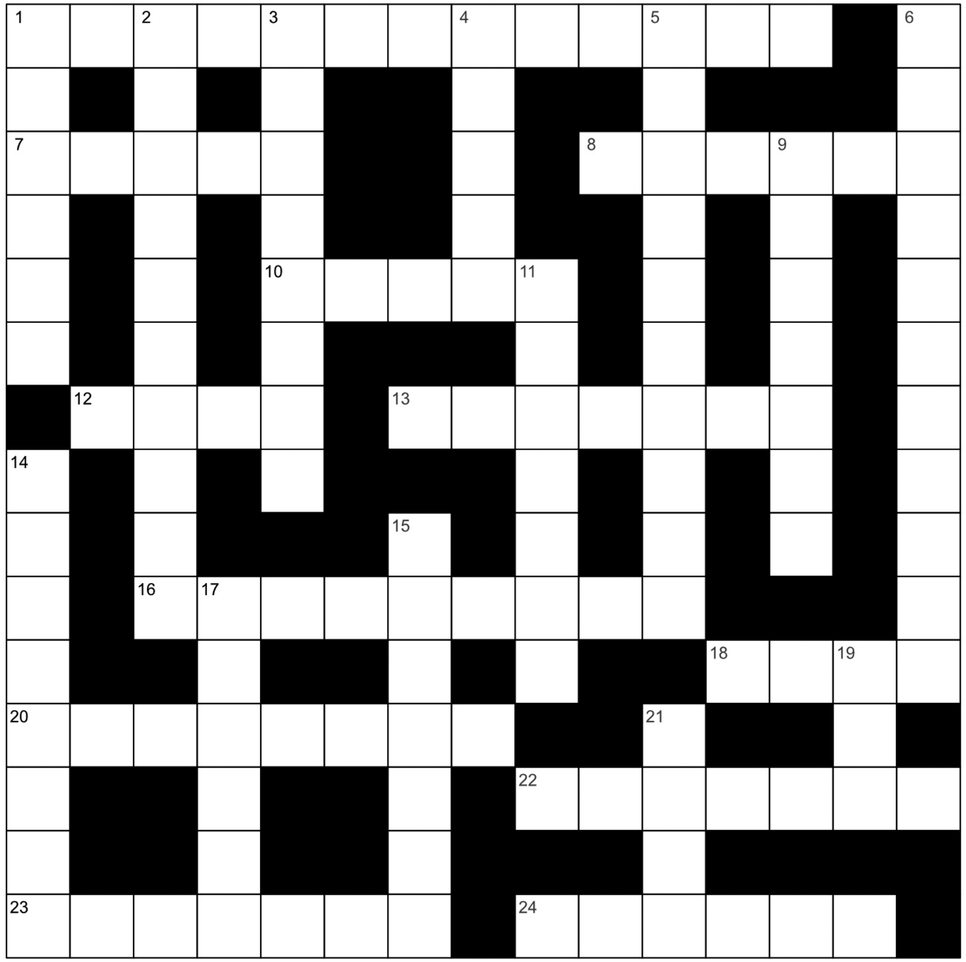
ACROSS

1. 10 after tungsten ID guy immediately reveals extra-terrestrial pattern (13)
7. This sedimentary structure is on fire! (5)
8. "All the Earth"…in one landmass (6)
10. High ground has faults in author's tale (5)
12. What sediments sleep in…? (4)
13. Ode to lithology from Spanish lost in a fish's ear (7)
16. Seer embraced quest to store CO2 (9)
18. & 1D. Theropod tail finder breaks nine off jaw (4,6)
20. & 19D. 30 million years old, for example (8,3)
22. What the glacier and the laser did (7)
23. Illegally setting fire to things is gross, we hear…and it's toxic! (7)
24. In short, Bachelor's in Seasoning is volcanic (6)

DOWN

1. (see 18 Across)
2. First book after Department of Internal Affairs converts sediments into rock (10)
3. Thy steam pulverised impure quartz (8)
4. Catches and comprises 24 in flood (5)
5. I graze moth sporting an arrangement of four tail spikes (10)
6. The stage of "the long pursuit" (11)
9. X-rated exsolution texture (7)
11. Tie up after thunder god reveals rare zircon (7)
14. An eruption of this "Lake of Laughter" might be no laughing matter (7)
15. Elizabeth and Nicola briefly confused bottom-dwelling (7)
17. What organisms and magmas do to change (6)
19. (see 20 Across)
21. Friends circling high mountains (4)

Answers on p.53



CONGRATULATIONS TO OUR WINNERS!

"OUT & ABOUT"

ADULT: Bruce Hayward

TERTIARY STUDENT: Anthony Shorrock

"COMIC RELIEF"

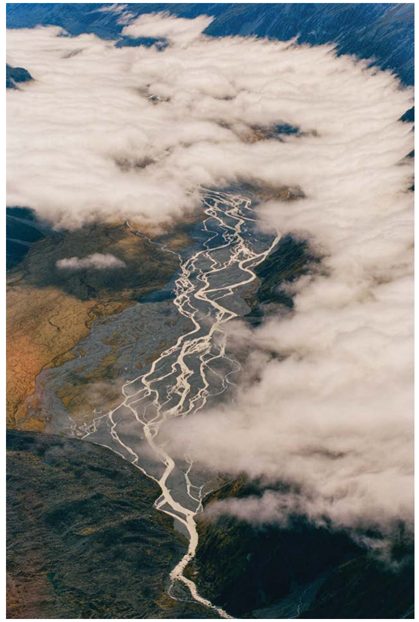
Mary Trayes

"PATTERNS"

ADULT: Mary Trayes

TERTIARY STUDENT: Anthony Shorrock

EVENTS

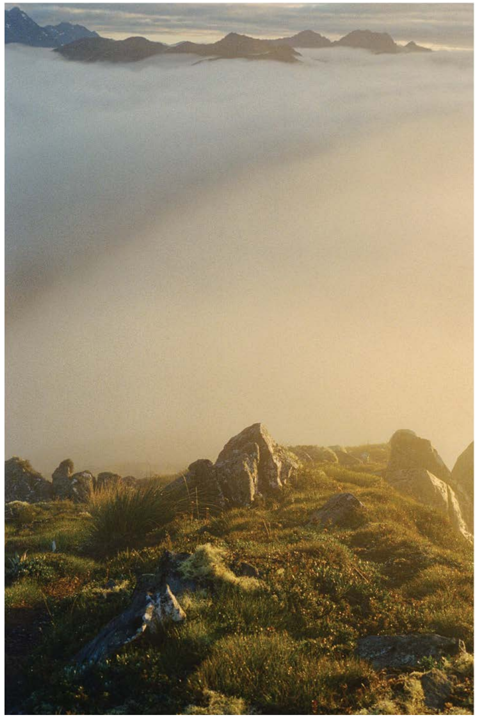


▲ **"Braided" by Anthony Shorrock**
Winner of Tertiary Student Patterns category. No better way to see a river than from up high, where the intricate weavings and windings of the channels make spectacular patterns on the landscape. Murchison River, Aoraki National Park.

▲ **"River in Garnet Sand" by Mary Trayes**
Winner of Adult Patterns category. Pink is an unusual colour in this landscape. Woodpecker Bay, West Coast.

◄ **"Puhipuhi Syncline" by Bruce Hayward**
Winner of Adult Out & About category. View north along the eroded-out axis of New Zealand's most photogenic syncline, located in the Seaward Kaikōura Ranges just north of Kaikōura. The eroded core of the 10-km long, tightly folded Puhipuhi Syncline was composed of soft Miocene mudstone with the inwards-dipping limbs made of resistant Oligocene limestone.Puhipuhi, north of Kaikoura, Canterbury.

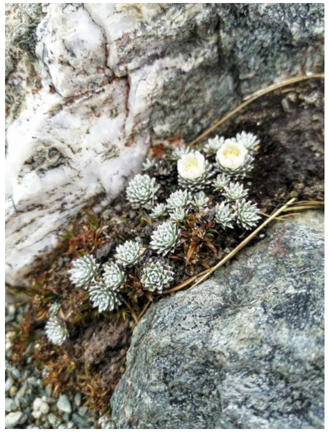
"Lickety Limestone" by Mary Trayes ►
Winner of the Comic Relief category. "A bit tongue in cheek but actually tongue in stone", Karamea Bluffs roadside, West Coast.

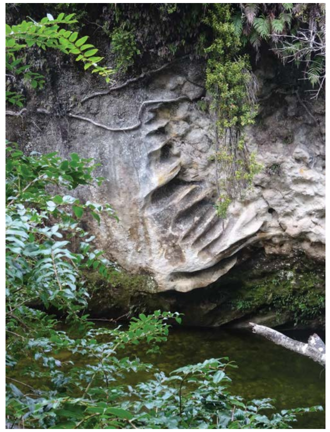


◄ **"Vertigo" by Anthony Shorrock**
Winner of Tertiary Student Out & About category. Caught the sunrise above the clouds not long after I reached the ridgeline of the Lewis Tops Track after a 4:30AM wake-up. Lewis Tops track, Lewis Pass.

Thank you to everyone who took part in the this year's Photo Competition. We look forward to more stunning entries for the GSNZ Photo Competition 2023.

▼ "Beach Processes" by Murry Cave (Adult Out & About)





TOP LEFT: "Maori Bay Sand Pattern" by Murray Baker (Adult Patterns)
TOP RIGHT: "Ngauruhoe, Waihohonu view" by Murray Baker (Adult Out & About)

MIDDLE LEFT: "Warped Layers" by Joseph Baxter (Adult Out & About)

MIDDLE CENTRE: "Lost Moss" by Jasper Hobbs (Tertiary Student Patterns)
MIDDLE RIGHT: "Karst in stone" by Mary Trayes (Adult Out & About)

BOTTOM LEFT: "Long and winding Road" by Murry Cave (Adult Patterns)
BOTTOM RIGHT: "The chilling cliffs" by Jasper Hobbs (Tertiary Student Out & About)

GSNZ IS STILL ZOOMING!

A DEDICATED PLATFORM TO HOST GSNZ ONLINE EVENTS

Take advantage of the opportunity to host GSNZ online events such as online talks, seminars, workshops and virtual fieldtrips. These may be recorded for later viewing.

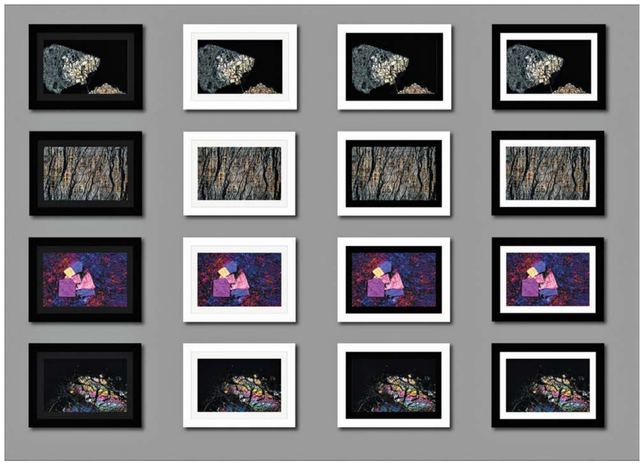
Any members wishing to host a GSNZ online event, using the GSNZ Zoom licence, please contact the Secretary, Jenny Stein, by email (secretary@gsnz.org.nz).

GSNZ ART NOW AVAILABLE

EXCLUSIVE LIMITED EDITION PRINTS BY KAMEN ENGEL

Kamen Engel, who won the GSNZ Photo Competition 2021 for the Student Indoor category, has offered GSNZ a select number of images as a limited edition set.

Generated from thousands of single thin-section images, these photographs have been painstakingly captured, processed and stitched to create stunning works of art that showcase the beauty of rock when viewed under a microscope.



Samples will be on display at the GSNZ Conference 2022.

Each A3 framed print is numbered and signed, by the photographer, and comes labelled with a description of the image.

Available with white or black mat and frame combinations to offer four options for each print.

Order from our webstore:https://gsnz.org.nz/publications-and-webstore/

GSNZ AGM 2022

THE GSNZ AGM WILL BE HELD FROM 5PM – 6PM ON WEDNESDAY 30TH OF NOVEMBER 2022 AT THE SOCIAL SCIENCE LECTURE BUILDING, MASSEY UNIVERSITY CAMPUS.

Please email apologies to Jenny Stein: secretary@gsnz.org.nz

Annual report and Accounts for the 2021-2022 year will be circulated via email two weeks before the AGM.

GEOCRYPTIC CROSSWORD ANSWERS (FROM PAGE 46):

Across
1. Widmanstätten, 7. flame, 8. Pangea, 10. horst, 12. beds, 13. otolith, 16. sequester, 18. Joan, 20. absolute, 22. ablated, 23. arsenic, 24. basalt

Down
1. Wiffen, 2. diagenesis, 3. amethyst, 4. traps, 5. thagomizer, 6. Whaingaroan, 9. graphic, 11. thorite, 14. Ōkataina, 15. benthic, 17. evolve, 19. age, 21. Alps

GSNZ ASSISTS WITH FUNDING

FIREBALLS AOTEAROA METEORITE RECOVERY PROJECT

GSNZ is pleased to support Fireballs Aotearoa, with their lofty aim of installing a large number of meteor cameras, across Aotearoa/New Zealand, in the hopes of recovering fresh meteorites.

The project will increase the chances of meteorite recovery by contributing data captured by the cameras which are then sent to a hub at Canada's Western University in Ontario, for analysis and relayed back to us. As part of Global Meteor Network https://globalmeteornetwork.org/ our Fireballs team are hoping to increase the density of our local cameras, each pointing in a different direction to increase triangulation and, therefore, accuracy and power of the network.

Everyone's cameras will be connected to the network and data is transferred, automatically. This will help scientists begin to map the trajectory of the incoming meteors, over our islands, and give them the best opportunity to access uncontaminated samples.

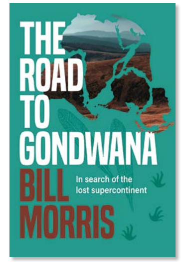
You, too, can join the Fireballs project and purchase a camera to mount on your own house! By doing so, you and your camera could help shed light into the formation, and evolution, of the solar system. Each flash across the sky is a notification that they're bringing us another message from the deep past. We just need to be able to find them and read what they have to say.

This project can be completely hands off, or on, depending on your inclination. The camera will send data regardless. But, if you're super keen, then you can follow the data collected from your camera, and view the the latest modelling, via a small dashboard. What's more, if your data is used in any scientific papers, then you get recognition for it!

GSNZ's support is acknowledged by the presence of stickers which will be affixed to the Fireballs Aotearoa cameras.

THE ROAD TO GONDWANA

IN SEARCH OF THE LOST SUPERCONTINENT



The Road to Gondwana: In search of the lost supercontinent by Bill Morris. Exisle Publishing 2022. 264 pp. NZ$39.99.

Nick Mortimer

Most books with Gondwana in their title use the supercontinent as a backdrop for other topics. In Bill Morris' book Gondwana, and its iconic Permian leaf fossil Glossopteris, are firmly front and centre.

At its simplest, 'The Road to Gondwana' could be called a popular science book, but it's much more than that. The author successfully weaves a personal travelogue to Glossopteris localities in Argentina, The Falklands and New Zealand, with an introduction to geology and geological time, an historical account of the discovery of Gondwana, and geological pen portraits of an evolving Gondwana from 750 million years ago to the present day and beyond. The latter are crafted to read as if they were written by an active observer or a reporter 'And now we are floating above the Gondwana of the Late Permian, breathing pristine air that has never tasted the soot of a human city...'. The book also touches on the industrial revolution, geological and geographical exploration, and the philosophical and practical nature of science. It highlights achievements of scientific A-listers such as Lyell, Suess, Brongniart (who formally described and described Glossopteris in 1828) Darwin, Wegener, du Toit, Hess, Alvarez, Landis and many more.

> *At its simplest, 'The Road to Gondwana' could be called a popular science book, but it's much more than that.*

This mix works exceedingly well. The combination of varied content, logical organisation, and lively and readable style make for a compelling, engaging and educational read. I think the book will satisfy geologists, armchair naturalists and anyone who likes stories of scientific discovery. Readers who have enjoyed John McPhee or Simon Winchester's books on geology and geologists, or Geoff Chapple's 2015 'Terrain' will also enjoy 'The Road to Gondwana'. The publication quality of the book is high: it is hardback and printed on good quality paper. It has tasteful illustrations, colour photographs, a glossary, references and an index.

The supercontinent of Gondwana, for all its immensity and relevance to continental drift and plate tectonics, tends to occupy the background rather than the foreground of research these days, even for us southern hemisphere geologists. Yet Gondwana is very much part of New Zealand's natural history whakapapa. Bill Morris is not a geologist, but he does a magnificent job of bringing static and inanimate rocks to life, as well as connecting the many threads that led to Gondwana's discovery. This book captures the essence of the journey to Gondwana and the destination itself. ■

'The Road to Gondwana' will be available from late November 2022. Check with your local bookstore, or online at https://exislepublishing.com

FOSSIL TREASURES OF FOULDEN MAAR:

A WINDOW INTO MIOCENE ZEALANDIA

Fossil treasures of Foulden Maar: A window into Miocene Zealandia by Daphne Lee, Uwe Kaulfuss and John Conran, Otago University Press, 216 pp, RRP $60.

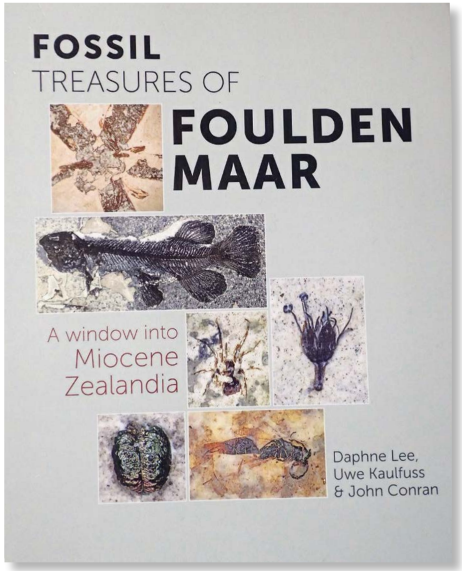
Bruce W Hayward

This is a fabulous book about New Zealand's most amazing fossil site – Foulden Maar, Otago. This site and its riches have really only come to light in the last two decades, largely through the herculean efforts of a team brought together and coordinated by Daphne Lee at Otago University in collaboration with many international experts. The book is authored by New Zealand's paleo-polymath Daphne Lee, together with two colleagues - former PhD student and sedimentologist Uwe Kaulfuss, now an international expert on fossil insects; and Australian paleobotanist John Conran who has collaborated with Daphne and others working on the Foulden flora since 2006. The extensive acknowledgments rightly recognise the role of nine additional scientists, particularly paleobotanist Jennifer Bannister, sedimentologist Jon Lindqvist, palynologist Dallas Mildenhall and paleobotanist Liz Kennedy, for their major contributions to the present understanding of Foulden Maar presented in this book.

The major strength of this book is that it brings together, synthesizes and summarises the studies undertaken on Foulden Maar and published in 40 peer-reviewed papers, more than 84 conference abstracts and six theses. They are presented in a colourful, profusely illustrated and elegantly arranged format in a writing style suited to both the scientific community and the interested public.

The values of this site and the events that took place in recent years that resulted in the prevention of the removal of the bulk of the diatomite deposit as a stock-food additive for overseas markets have already been documented in the GSNZ Newsletter (Lee et al., 2020), so I will mainly focus here on the book itself. To start, however, I repeat several sentences from the 14 May 2019 GSNZ press release on the values of Foulden Maar:

"*The diatomite sediment that infilled this crater lake, 23 million years ago, contains the most extraordinary array of exquisitely preserved plant, fish, spider and insect fossils in New Zealand. These fossils are unique and record the previously unknown history and origins of a large portion of New Zealand's present-day biota. … To date, over 100 different species of plant fossils have been identified (mostly leaves, but also fruits, seeds and wood). The plants include extremely rare fossil orchids, mistletoes, fuchsias and a host of other taxa that link NZ's biota to Australia, New Caledonia and South America. Forty fossil flowers have been found, many still containing pollen, representing 15 plant families. Fossil flowers with associated pollen are extraordinarily rare globally. Amazingly preserved freshwater fish fossils include the oldest freshwater eel fossil in the Southern Hemisphere and the oldest galaxiid whitebait in the world. More than 50% of NZ's discovered fossil insects have been found in this one deposit and include over 200 different kinds from 21 families. Four fossil spiders have also been found.*"



The major strength of this book is that it brings together, synthesizes and summarises the studies undertaken on Foulden Maar and published in 40 peer-reviewed papers, more than 84 conference abstracts and six theses. They are presented in a colourful, profusely illustrated and elegantly arranged format in a writing style suited to both the scientific community and the interested public.

The book has eight chapters. The first describes the geological setting, eruption of the maar volcano, 23 Myrs ago, that created the crater in which the diatomite sediment accumulated for over 130,000 yrs. It describes in simple language the geophysical methods used to model the diatreme shape of the maar and how the age of eruption was determined. The 180 m-thick cored sequence is described and illustrated together with dioramas that show the paleogeographic setting inferred for four phases of maar sediment fill. This is followed by a short chapter on the history of recognition and minimal mining of the diatomite and a thorough account of the growing opposition that led in the abandonment of the proposed major mining project in 2019. Chapter 3 focusses on the fossil record of the biota that lived in the maar lake starting with the dominant endemic diatom species that forms most of the deposit and has not been recorded elsewhere. It provides an interesting account of the fossilised remains of green and golden-brown algae that were abundant in the lake and perhaps surprisingly the abundant spicules of freshwater sponges that lived in the aerobic shallows around the edge of the lake, especially during a 1000-yr period when sponges outperformed the usually dominant planktic diatoms. We read of amazing information about living galaxiid fish and the over 100 fossil specimens found so far - from juvenile "white bait" to adults 14 cm long.

Chapters 4 and 5, not surprisingly, are on the plants - the most abundant fossils in Foulden. Included here are revealing explanations of how fossil pollen, spores and leaves have been treated for study. In particular, the authors acknowledge the contribution made by Jennifer Bannister who prepared the cuticles for over 800 individual leaves and discovered and prepared most of the flowers. There are descriptions and beautiful illustrations of the diversity of ferns, conifers, monocots and some of the other special plant groups found in Foulden, such as the extremely rare orchid fossils. The fossil specimens, here of plants but later also of the insects, spiders and fish, are made more real by beautiful comparative photographs of their modern relatives placed alongside the fossils. Foulden is rare in New Zealand for the fossils of various parts of the same plant occurring in the same deposit – e.g., leaves with cuticle, flowers with pollen, fruits and seeds. This chapter also highlights some of the truly special finds like the single specimen of a new extinct genus and species, Fouldenia staminosa – New Zealand's first fossil flower with petals, anthers and pollen all preserved, but lacking leaves.

In Chapter 6 the authors state that "fossil insects and spiders from Foulden Maar are completely transforming our knowledge of the history of terrestrial invertebrates in New Zealand." The insect fauna as a whole is analysed - half are complete adult specimens with at least 17 genera in 9 orders identified. Amazingly each complete specimen is of a different species – suggesting that hundreds more await to be found. 72% of the fossil insect specimens lived in rain forest and the remainder are aquatic – the latter mostly preserved as pupae that lived in the lake. The bulk of the chapter focusses on the fossils from the six most common insect orders in Foulden – beetles, flies, wasps and ants, termites, true bugs, and caddisflies. The four fossil spiders found to date, although relatively poorly preserved, were the first fossil spiders known from New Zealand and again all four are different species. I was fascinated by the numerous termite body and wing fossils. There are 9 species of termite in the modern New Zealand fauna and already 4 genera with 6 species have been identified from the 16 fossil specimens so far recovered from Foulden. The chapter finishes with an illustrated account of a wide variety of insect damage found on some of the thousands of fossil leaves.

Chapter 7 starts with an explanation of all the reasons why the annual sediment layers that accumulated in Foulden Maar lake are so exceptional for their record of Southern Hemisphere climate. These include the precise dating, as close to the Oligo-Miocene boundary, from combined radiometric and paleomagnetic methods, and the exquisite preservation of leaf fossils that can be used to reconstruct paleotemperature, seasonality, rainfall and changing CO2 levels. The detailed leaf studies indicate that Foulden was about 8 °C warmer than today (similar to Brisbane) and had about 4 times the rainfall (~1600 mm p.a.) of modern Foulden. The higher temperature may have been driven by the higher atmospheric CO2 that has now been determined from stomatal measurements in Foulden fossil leaves at 450-550 ppm.

The last chapter sets the 23 Myr-old Foulden Maar lake within the changing paleogeography of Zealandia from break up of Gondwana through to the present. This is the time of inferred maximum submergence of Zealandia and the authors argue that the rich and diverse Foulden biota shows conclusively that ancient NZ was never completely submerged as had been hypothesised by some New Zealand geologists several decades ago. Also, in this chapter the lake biota is summarised, emphasising that this biota could only have lived in the upper oxygenated water layers and was preserved untouched in the deep anoxic parts of the lake floor. The authors note the lack of bird fossils so far, but imply that they will be found in the future. There is proxy evidence for the presence of birds on the lake in the exotic quartz grains in numerous fossil coprolites. The lack of any calcareous fossils (e.g., freshwater molluscs and ostracods) is blamed on slightly acidic bottom conditions. Also summarised are how the fossil record of pollen, spores and leaves documents the recolonization of the area surrounding the lake after the eruption had destroyed it. Interestingly, the dominant leaves (Lauraceae) have no pollen record, and a common pollen component (Nothofagus, 7%) is not present among the fossil leaves.

The authors note that all fossil species in Foulden are extinct, but about half have close relatives living in N Z today. Most that have no close living representatives in NZ belong to groups now restricted to warm, wet climates. Chapter 8 provides a comparison of Foulden Maar with similar Konservat-Lagerstätten deposits overseas (those with amazingly preserved fossils). It concludes with a vision for the future of Foulden Maar in public ownership providing unhindered access for researchers but also for the general public to learn about this irreplaceable fossil heritage of New Zealand.

For me, the flowers, insects and spiders are the most remarkable fossil finds so far from Foulden, in particular the kamahi-like flower with stamens, pollen and ovary (p. 97E) and the aquatic caddisfly larva protruding from its protective tubular case (p. 137). This book is the most significant contribution to New Zealand paleontology ever published or likely to be published in the foreseeable future. I congratulate the authors and all those who have been involved in unearthing this remarkable treasure, so far. ■

Reference

Lee, D.E., Hayward, B.W., Eccles, J., 2020. *Saving Foulden Maar - GSNZ involvement*. Geoscience Society of New Zealand Newsletter 30, 16-22.

FIRE OF LOVE

FILM REVIEW: GEOLOGISTS' PERSPECTIVE

A National Geographic Documentary Film opening in cinemas around the country on 22nd September.

Jennifer Eccles & Michael Rowe

"Fire of Love", a new documentary accumulating critical acclaim on the film festival circuit, utilises the video archive of the volcanologist couple Katia and Maurice Krafft to piece together a story of their relationship, and inevitably intermingled career. The Kraffts had been famous for their pioneering work on active volcanoes around the world; particularly the communication and popularisation of volcano science producing 17 books and four full-length films, utilising astonishing video footage and still photography.

We had attended the media screening with some trepidation as A) we well knew how the story ends with their death in 1991 in a pyroclastic flow from Mt Unzen and B) as educators of the next generation of geoscientists we worried if this offering would glamorise the extreme risk taking. We were pleasantly surprised. With the backdrop of amazing footage of volcanic eruptions the tale was very humanising, giving insight into what drove them to take what we would now, especially with the technology available to us, consider to be insane risks. Even at the time they accepted that many of their colleagues thought they were nuts. Descending into, and camping for a week within, the crater of Mount Nyiragongo during the 1977 eruption, gave dramatic footage but is something that reflecting on as older and wiser they perhaps wouldn't do again. Maurice paddling about an acid lake (I assume Kawah Ijen although the narration only states Indonesia) in a rubber inflatable much to Katia's disgust was another of many moments where you reflect that it was not a surprise they died on Unzen but more of a surprise they lasted so long! The theme of death and mortality was sprinkled throughout but archival interview footage indicates risking their lives was a conscious choice. Maurice in particular claims to have made peace with one day dying doing what he loved and thought the need to better understand and make the policy makers and public aware of the danger of eruptions outweighed the personal risk. The devastation of the 1985 Nevado del Ruiz eruption (~23,000 dead) is highlighted as a major event changing the course of the Kraffts' focus from effusive to explosive volcanoes, ultimately leading to their demise. After events on Unzen the film closes with successful evacuation ahead of the Pinatubo eruption, a counterpoint of hope.

As a researcher a lot of the footage selected raised the question of what they were trying to achieve scientifically with blatant showboating for the camera, but we have all probably been guilty of hamming it up for the camera or posing for photos. Sensationalism sells and the Krafft's funded their work through books, films and lecture tours so capturing the public's imagination was crucial. This spectacular footage is often what is remembered and in particular provides a visceral reaction that conveys a respect for the power of volcanoes that technical publications cannot. Ultimately, in this modern era of risk aversion and personal liability, it is unlikely we will encounter another couple quite like the Kraffts. ■

PETER MOLNAR

25 August 1943 – 23 June 2022

Tim Stern: Victoria University of Wellington

Peter Molnar, a pioneer in the tectonics of mountain building passed away on June 23, 2022 (aged 79). Peter was a leading researcher in the area of continental tectonics and his research was closely linked to New Zealand. He visited here often and published several important papers on the deformation mechanisms for the plate boundary in South Island, New Zealand. Peter championed the idea that continental deformation does not conform to the discrete tenets of plate tectonics but instead was usefully explained within the context of distributed deformation of a continuum. He is best known for his work in demonstrating the role continental tectonics play in the vertical and horizontal motions of mountain building processes in Asia (Tibet), California, and New Zealand.

Peter was born in Pittsburgh in 1943, being the only child of Julius and Margaret. His father had a high-profile career in Bell Labs as a physicist, and it was clear that he had a profound influence on Peter. He followed his father to Oberlin College where he obtained his Bachelor degree in Physics (1965), then to Lamont (Columbia University, NY) where he graduated with a PhD in Geophysics in 1970. There, his advisor was Jack Oliver – one of the most influential grandfathers of plate tectonics. Peter used to jest that it was his bad luck to have been born 10 years too late to participate in the golden period of the plate tectonic revolution, and that his PhD work was only concerned with the mopping up stage. However, Peter did break new ground and was effectively the founder of continental tectonics, a way of understanding the tectonics of non-rigid plates. His key work in the late 1970s was with Paul Tapponier on the deformation of Asia, and the uplift of the Tibetan Plateau, and was central to continental tectonics and the idea of distributed deformation in both the crust and mantle. He extended this research with a series of detailed mathematical analyses in collaboration with Greg Houseman and others, that applied principles of fluid mechanics to Earth deformation. This study was rewarded in 2014 by the Royal Swedish Academy of Sciences with the Crafoord Prize in Geosciences (often referred to as the Noble Prize of the Earth Sciences).

Peter on Lake Te Anau on his way to the Milford Track, January 2011

I first met Peter when he came to New Zealand to participate in the South Island Geophysical Transect (SIGHT) project in the mid 1990s. Initially, SIGHT was focussed on the Alpine fault and what was happening to the crust. i.e. how is the crust being exhumed along the fault. Peter came to our initial workshops and gently nudged us into thinking about the mantle. He was gracious and generous in the way he did this and the broadening of focus was key to the overall success of the SIGHT project. In particular, he used seismic anisotropy, upper mantle seismic P-wave speeds, crustal structure and teleseismic delays to argue that the mantle under the South Island was absorbing convergent plate motion over a zone about 200 km wide, via processes of simple shear and dynamic crystallization (Science Paper 1999).

Peter had prodigious energy and a laser-like focus on his research. He was publishing right up until about a year ago, including an important paper (2020) on the maximum depth of earthquakes, the link to strain rate, and implications for the rheology of the crust and upper mantle. He made many first order discoveries, but one of the most interesting ones to my mind was an early observation linking tectonics to climate change. He carefully documented a rapid increase in global sedimentation rate since the Pliocene, that is not linked to an increase in plate motions, or mountain building. What did happen from about 5 Ma, however, were rapid changes in climate and temperature as indicated by the oxygen isotope record. Peter argued, the rapid switches in climate and erosion regimes meant the earth did not have time to "heal" between cycles. The land became more vulnerable to abrasion from ice and rainfall and erosion rates increased everywhere (Nature paper, 2001).

Peter was appointed a professor at MIT in 1974 (aged 31) but by 1986 quit because he wanted to focus his life on research. He moved to a soft money position and backed himself to live on that. In 2001, he moved from MIT to the University of Colorado, Boulder. He lived in a wonderful location high in the Rockies with his wife Sara. They were avid hikers of the Rockies, and other mountain ranges of the world. He gained great joy in having guests to stay in his "cabin" and taking them on long hikes or snow shoeing treks.

His publications, and the discoveries they document, are a legacy to the global tectonics community that will endure for generations to come.

He will be missed. ■

OBITUARIES

WILLIAM JAMES (PETER) MACDONALD

1926– 4 September 2022

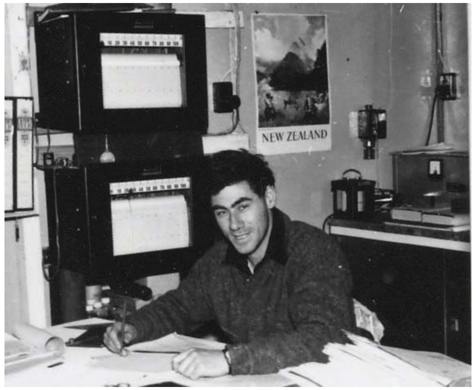
GEOTHERMAL EXPLORATION PIONEER

Fred Davey

Peter passed away on Sunday 4th September 2022 in Wellington. He was 96. He was a mainstay of the geothermal research group in Geophysics Division, DSIR, that delineated all the geothermal fields in central North Island. He was one of the (1956-58) NZ IGY Antarctic Expedition that helped set up Scott Base and was the last surviving member of the first New Zealand wintering over party in Antarctica. He was awarded the Polar Medal in 1960.

Peter's contribution to exploration for, and delineation of, geothermal fields was immense. He developed the concept of mapping ground resistivity to define geothermal fields. and embarked on a very productive career developing and using this method to locate geothermal areas in the New Zealand central volcanic region (Taupo and district) and overseas. The opportunity to develop this method for exploring geothermal fields arose from new technology (high impedance voltmeters) that had just become available. This enabled the rapid measurement of the electrical resistivity of the ground with electrode spacings of a kilometre or more – giving depth penetration of about 1 km.

Ground resisitivity is largely dependent upon the resistivity of water in the rocks. Geothermal water, hot and containing more chemicals than fresh water, has a much lower resistivity than normal groundwater. By making hundreds of measurements across a region, it was possible to show that geothermal areas were delineated by low measured ground resistivities. Drilling several holes to a depth of a kilometre in the low resistivity areas confirmed the concept when water temperatures



Peter in lab at Scott Base 1957

of 200 to 300 degrees centigrade were found. Ironically, the proof of the method came when engineers were persuaded to drill a well that was deliberately sited outside the low resistivity zone, but very close, and only sampled cold water. Peter's work was accepted thereafter without question. This mapping technique became the international standard approach to geothermal exploration and laid the foundation of geothermal exploration.

In 1969, Peter was seconded to the UN Development Programme to do some geothermal exploration in Chile, at an area called El Tatio on the Alto Plano, 4300m up, for 5 months. It was so isolated that 3 weeks at El Tatio was followed by a week in civilization (Santiago). Subsequently, he continued to fit in further geothermal consultancies in El Salvador, Chile, the Philippines, Vanuatu and Canada. Probably his greatest success was in the Philippines, where he saved the NZ MAF funded aid programme on Leyte. Before he became fully involved, seven holes had been drilled without a single success and abandoning the prospect was being considered. Based on the resistivity measurements, Peter changed the focus of the exploration and sited the first successful well of what became a 500+ MW development

Peter was born in 1926 in Kelburn, Wellington, and educated at Kelburn School, Wellington College, and Victoria College (University). After the war, he secured a cadetship with DSIR (Department of Scientific and Industrial Research) and joined the geophysics section of the Geological Survey. In 1952 he left DSIR and tried business and also teaching. In late 1954 he married Doris Thorogood and started building a house.

He returned to DSIR in 1956 as a successful applicant for one of five positions with the NZ International Geophysical Year Antarctic Expedition to Antarctica in 1956-58 to carry out research after helping build Scott Base on Ross Island. Peter was responsible for solar radiation, tide and current measurements. During the year, he also took over the McMurdo ice shelf movement/deformation project and substantially took over the meteorological observations in mid-winter from the NZTAE.

On return to New Zealand in January 1958, results were submitted to IGY World Data Centers and reported in a DSIR Bulletin. Peter authored the glaciology – ice shelf movement report and co-authored the meteorological and sea level reports. Peter returned to Scott Base in late January 2000 as part of the Millennium trip that saw 11 of the original wintering over party return to Scott Base for 3 days. At the end of 1988, Peter retired from DSIR having completed 40 years' service. He was author of 14 published scientific papers in New Zealand and overseas journals (8 on Antarctica, and 3 in Nature), and 39 Conference Proceedings and DSIR reports. A few years ago, Peter and Doris endowed a Prize for Industrial Design at Massey University and recently Peter endowed the Doris Macdonald Award for scholarship in Vocational Counselling and Practice. Peter will be remembered as a very practical and generous person. ■

The Geoscience Society of New Zealand gratefully accepts donations and bequests. These can be applied to specific funds or awards (see full list at http://gsnz.org.nz) or can go into the growing Legacy Fund, interest from which is used for general purposes. All donations and bequests will be acknowledged and a receipt sent.

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DEADLINES:	**MARCH ISSUE**	**FEBRUARY 1**
	JULY ISSUE	**JUNE 1**
	NOVEMBER ISSUE	**OCTOBER 1**

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Preference will be given to articles submitted by GSNZ members however any appropriate contributions may be accommodated depending on space. Submissions will be subject to the following guidelines for acceptance:

- Contributions for potential publication for our membership are screened carefully and with a view toward the Society's core values.
- With a view to providing balance and best informing members, any individuals or specific science programmes mentioned by name, should be accorded the professional courtesy that is offered when publishing in academic literature, which is an opportunity to view the article beforehand and be given right of reply.
- No articles will be accepted 'in confidence' and may be subject to review by the editorial committee.
- Submissions received after the deadlines have passed may be held over for the following issue.

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SPECIFICATIONS

FORMAT

Geoscientist Aotearoa is formatted for A5. Email copy in any text format is acceptable. Attributed images and graphics are encouraged.

The current two column format accommodates approximately 500-550 words per page, *without* images. We suggest a limit of four pages (including images) in the current format for most contributions with minimal but key referencing. Depending on space, longer articles suitable as feature articles with illustrations are often published. If your article will run to more than four pages please contact the editor prior to submitting.

IMAGE RESOLUTION

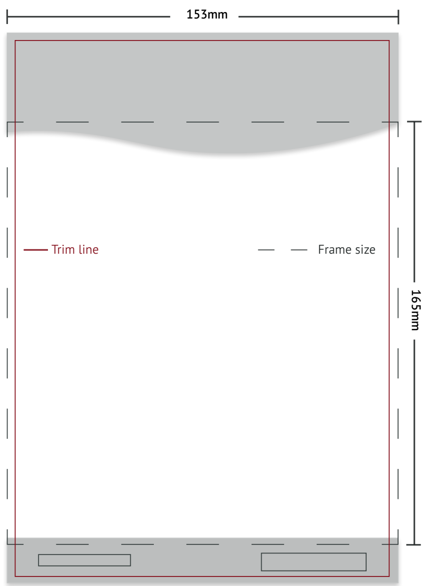
We seek to provide a high quality publication for our readership. Accompanying photos for articles must be sent as email attachments at the highest resolution possible. Please do not embed images in a Word document as they are often rendered unsuitable for the printing process. Annotation of images (numbering and descriptions on photos) is discouraged.

Any images supplied to be *considered* for front cover use must adhere to the following minimum *resolution* specifications: For A5 front cover (portrait suits best but landscape may be accommodated at the editor's discretion) 2551 x 1819 px. For A4 (full cover landscape wraparound) 3579 x 2551 px. The editor will reserve judgement on whether an image is suitable for A4 wraparound, bearing in mind that some elements may be hidden under the header, in particular (see below).

COVER IMAGES

Sizing of photos considered for cover of Geoscientist Aotearoa is not straightforward due to the variety of aspect ratios of photos provided, particularly when cropped. In many cases, the original submitted photo cannot *proportionally* fit within the allotted frame. In part, this is due to the title and footer block (shown in grey) design and some elements of the image would be hidden beneath them.

While the publication is A5, and image size in terms of resolution is already specified, proportions needed to fit the visible frame on the cover are different. Adjusting an image to fit may involve proportional resizing tweaks or "zooming in" to a specific portion of the image and is at the editor's discretion. A photo competition cover image presented "zoomed in" will be printed in its entirety inside the publication, albeit much smaller. It is recommended to have an image sized, proportionally, to fit a frame approximately 153mm wide and 165mm high for best results. ▶



Geoscience Society of New Zealand

Front cover : "BRAIDED" by Anthony Shorrock

Winner of the 2022 Photo Competition for Tertiary Student Patterns Category—Murchison River, Aoraki National Park, NZ (Zoomed in see inside for full image) .