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You are probably wondering where your membership fees go. Aside from the usual costs - travel and accommodation for the Hochstetter Lecturer and the President's tours to branches, accountants, and printing Newsletter costs, etc., the GSNZ committee have this year implemented a number of changes formulated around raising member benefits. Members should be receiving a semi-regular "Newsflash" about activities and events in the society, compiled and distributed by our administrator, Nicki Sayers, who spends (at least) two days a week on GSNZ-related tasks. Our new website is up and running, and Nicki has had the challenging job of trying to manage the transition. She has included a student opportunities page (free to post if you are a member), and Matt Sagar and Sam McColl have updated the publications portion of the website. We have undertaken an over-hall of the Newsletter (name change in the future?), having contracted a graphic designer to modernise the presentation. We have negotiated a deal with Taylor and Francis to give members access to New Zealand Journal of Geology and Geophysics via the membership portal. We have awarded small grants to support University student groups running fieldtrips, with the trade-off that they report their trip in the Newsletter. We've also continued to heavily subsidise students to attend the annual conference. Our photo-competition – which was a drive to get images for the newsletter – required prizes; we intend to run this in the coming years too. The goal is for you to see significant value in belonging to GSNZ, but these things do cost money. The main saving we have made is through having virtual committee meetings rather than face-to-face ones; however, we have doubled the number of meetings in order to keep on top of things, and this will continue into the future.

Cost-free changes this year have been largely based around the Special Interest Groups (SIGs). We have attempt to revitalize the Geoeducation, Outreach and International Development SIG and Oil and Gas SIG. We have also had a Hydrogeology SIG and an Early Career Researcher SIG established. Many SIGs have offered to run conference sessions at the Annual Conference in Christchurch in November (with over 300 abstracts submitted, there is definitely an appetite for a face-fo-face meeting; fingers crossed the COVID level remains at 1). Future work will be in developing a strategy to better support the different branches, as well as completing a strategic plan.

This year's committee has a near-equivalent gender split, and comprises a diverse range of geoscientists. However, this will be the last newsletter by the current Newsletter editor (Glenn Vallender) and the job passes to Janis Russell, who has recently produced an e-book on the Geology of the Catlins. Also, Richard Wysoczanski will not be standing for secretary in 2021, and both he and Andrew Rees are stepping down from the committee. Thanks to all these people, and indeed all the committee, for their efforts this year.

James Scott

March 2012 was the first issue I had anything to do with as a beginning editor. In fact, I didn't really know what an editor was or actually did except that I thought it would be a great opportunity on retirement from secondary school teaching to get involved in a Society from a contribution point of view. I have had a passion for geoscience and geology since my geography teacher Harold Venz introduced me to 'landforms' and Cotton's 1957 book on NZ geomorphology. It was the images and diagrams that did it, not the text.

It was a rewarding decision to volunteer for this editorial 'job' and I have had the priviledge of meeting and talking to many people who would have remained just the name on a paper or a book. However, all good things come to an end and it is time to hand the reins on as the Society enters the next adaptive radiation of its existence. It has been a pleasure to work with six different Presidents – thank you Jan, Scott, Andrew, Adrian, Jennifer and James.

Hopefully the Society will continue to adapt to meet the evolving needs of its members. And hopefully, members will evolve to meet the needs of the Society and its committee. All clubs and Societies need passionate and committed people to be successful and the baby boomers and their predecessors (the silent generation) certainly were the 'doers' who made it happen. The challenge for the millennials is to ensure that GSNZ survives, retains and grows its value as a Society for all those interested in the geosciences both amateur and professional.

Starting with founder of GSNZ Bruce Collins, there have been 21 Newsletter editors since inception for 182 issues (excluding the supplements). Twelve of these editors were shared and I take my hat off to William Asher Watters and David Smale who between them produced a large proportion of the Newsletters and kept the members up to date in a mostly non digital world. There was only one issue numbering error! Issue #151 marked the end of Kerry Stanaway's work in 2010 and issue #31 marked a new updated version of the A5 model started by Andrew Gorman. It has been my privilege to be added to the list of Newsletter editors and I wish our new editor all the best in whatever role and capacity they may have. Tthere is a willing and supportive committee and membership.

Enjoy issue #32, enjoy the 2020 conference in whatever form it will be and overwhelm the next 'editor' with a hundred stored up 'shovel ready' geoscience articles. Thank you all for your support over the last ten years of GSNZ activities it has been a pleasure to compile. Hopefully you will always be able to reach out to your library shelf and drag out a real copy of the 2020 November issue #32 in another ten years time and ponder on what happened to those ten years!

Glenn Vallender

ARTICLES

A 30-50 YEAR VISION FOR THE PROTECTION OF THE VOLCANIC HERITAGE OF THE SOUTH AUCKLAND VOLCANIC FIELD

Bruce W. Hayward

The South Auckland (sometimes called Franklin) Volcanic Field is one of four monogenetic basalt fields of Quaternary age in northern New Zealand. It contains more than 84 volcanoes (volcanic centres) that erupted over a span of about a million years, between 1.6 and 0.5 myrs ago (Briggs et al., 1994). The field stretches from Papakura in the north to Pukekawa in the south, on the south side of the Waikato River, and from the Hunua Falls in the east almost to Waiuku and Port Waikato in the west **(Fig. 1)**.

The South Auckland volcanic landforms are not as crisp or well-preserved as those in the three more northern fields (Auckland, Whangarei, and Kaikohe-Bay of Islands fields) because they are slightly older and many are mantled in thick rhyolitic ash and ignimbrite (Hamilton Ash) erupted in the last 0.5 million years from the centre of the North Island. For this latter reason there is no basalt scattered over the surface of the lava fields nor drystone walls, so typical of the other basalt lava fields. Compared with their northern counterparts, the scoria of the cones is more weathered near the surface and the cones more rounded because of the mantle of thick ash and their craters are generally partly filled and less distinct. The phreatomagmatic maar craters have been filled with sediment and none remain as lakes and in many instances their surrounding tuff rings have been partly removed by erosion, especially those on the lowlands of the lower Waikato River.

Many of the volcanoes in the north eastern part of the South Auckland Field, erupted along fault lines (e.g. Wairoa and Drury faults) through the greywacke uplands of the western Hunua Ranges. Being at a higher elevation and older, these flows and scoria cones have been subjected to more erosion than those that form the low divide between the Manukau lowlands and Waikato River. Maar craters, tuff rings and shield volcanoes are more common in the South Auckland Field than in the other northern fields. At least 38 maar craters and 40 small shield volcanoes are recognised. The largest and most noteworthy craters are Onewhero, Kellyville and East Pukekohe. The largest shields are Pukekohe Hill, Waiuku, Mauku, Bombay and the three at Pukekawa. Not all shield volcanoes have scoria cone caps, but the most prominent scoria cones are Pukekawa, Klondyke Rd, Pukeotahinga, Tikorangi, Onepoto and Bombay.

Current protection of the volcanic heritage of northern NZ's young basalt volcanoes

All of the Auckland Volcanic Field is within the urban area of the city. Almost all the volcanoes that have not been mostly removed by quarrying or built over by development have the main part of their remaining volcanic landforms protected within reserves (Hayward, 2019). The most encompassing reserves are those for the whole

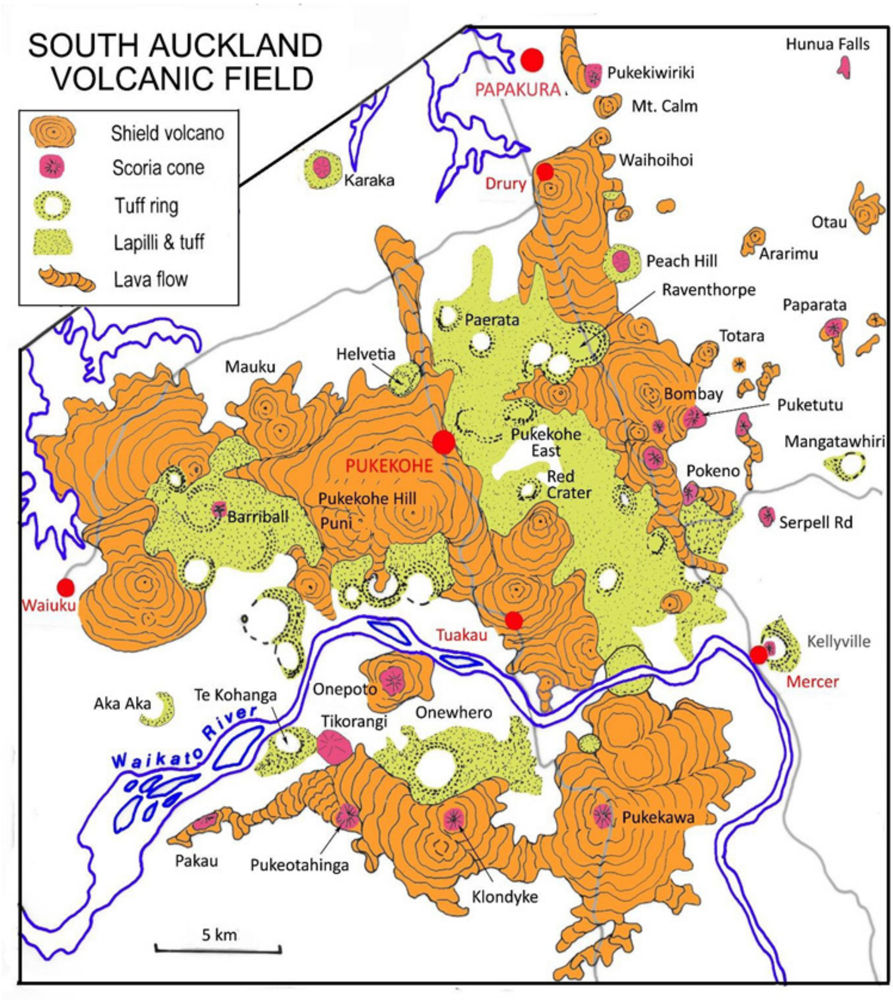

Fig.1 Map of the South Auckland Volcanic Field. Adapted from Briggs et al. (1994) and Nemeth et al. (2012).

volcanoes of Rangitoto and Motukorea. All these reserves and some private land also have some planning protection from the adverse effects of development by being scheduled as Outstanding Natural Features (ONF) in the Auckland Unitary Plan. Indeed, this is the only current protection for privately-owned Crater Hill.

All the scoria cones and the one shield volcano (Whatatiri) in the young Whangarei and all the scoria cones in the young Kaikohe-Bay of Islands volcanic fields also have some planning protection as ONFs in the Whangarei and Far North District Schemes. Only a few of these volcanoes are actually publicly-owned reserves (e.g. Hurupaki, Maungatapere, Onoke and Pukepoto in the Whangarei Field).
Only five volcanoes in the South Auckland Field have any significant parts of their landforms in reserve – the top of Pukekohe shield volcano, the partly quarried Puni scoria cone, Pukekiwiriki/Red Hill, the eroded vent and plug of Hunua Falls volcano and two sections of tuff ring of Roosevelt Explosion crater and tuff ring. The South Auckland Volcanic Field straddles the local authority boundary between Auckland City and Waikato District. Six of the volcanoes in the northern (Auckland City) part of the field are scheduled as ONFs in the Auckland Unitary Plan (inherited from the District Scheme of Franklin District). There are several other volcanoes or parts thereof in the Auckland City sector that should also be given planning protection as ONFs (e.g Patumahoe shield, Karaka tuff ring and central cone, Bombay scoria cones).

The majority of the volcanoes in the South Auckland Field occur in the southern two thirds of the field now located in Waikato District. At the time of writing three volcanoes (Onewhero and Kellyvile craters and tuff rings, and Pukekawa scoria cone) have some planning protection as ONFs (inherited from the Franklin District Plan) but the rest do not. In its revision of their plan, currently underway, Waikato District has proposed to remove ONF scheduling of these three volcanoes (opposed by GSNZ) when in fact they should be increasing the number that have some planning protection.

Potential threats to the volcanic heritage values of South Auckland Volcanoes

There is no way of predicting the size and distribution of the human population that will be living within the footprint of the South Auckland Volcanic Field by 2050 or 2070, but we can be sure it will be many times greater than at present. Already the southern limits of Auckland City residential developments are expanding around Karaka, Paerata, Drury and Pokeno in the northeastern parts of the field.
Without planning protection on the best examples of South Auckland's volcanoes, we can expect proposals to quarry away the scoria of some cones; proposals to site wind turbines or solar panel farms on the tops or slopes of some volcanoes with major access driveways up to them; proposals to plant exotic forestry blocks on the top and slopes of some volcanoes with consequent major landform modification and soil erosion when the trees are eventually harvested from these steep slopes; proposals to build private houses on the tops and upper slopes of some cones with driveways carved into the sides of these cones; proposals to subdivide the volcanoes into numerous smaller land holdings or life style blocks even if the houses are built at the foot of the volcano; and proposals for dense housing subdivisions to take advantage

A 30-50-year vision for the South Auckland Volcanic Field (Fig. 2)
My vision is that in 30-50 years' time and beyond, the landforms of all the best examples of the volcanoes of the South Auckland Field will be largely intact and retain their natural unmodified shapes that record each volcano's individual history of eruption.

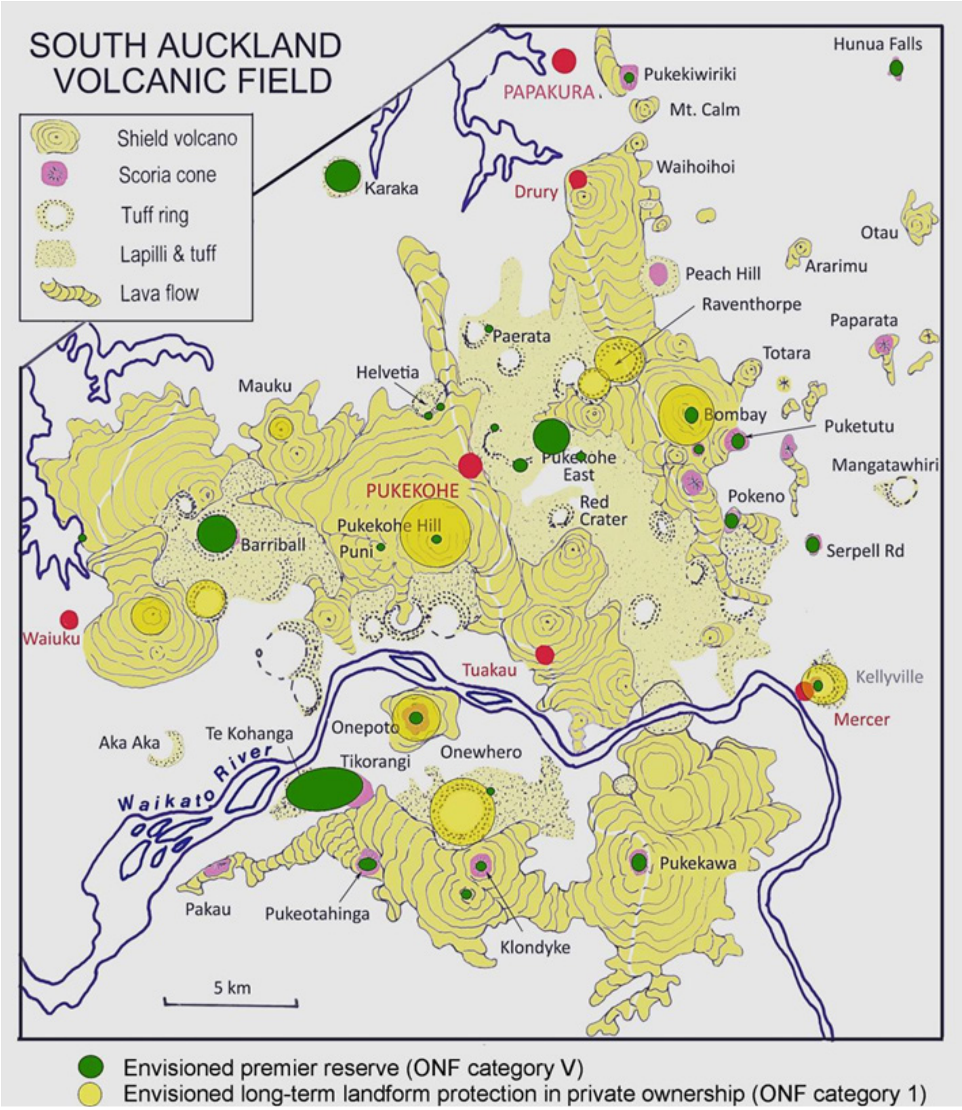

Fig.2, Map of the South Auckland Volcanic Field showing location of the volcanoes that I envision should be protected in categories 1 (large landforms) and category V (smaller volcanoes) in the 30-50 year vision.

ARTICLES

of the views and better drainage away from the surrounding lowlands.
As such, I envision that each of the major volcanic heritage features of the district will be in publicly-accessible and publicly-owned parks as THE major passive recreational reserves for the local community and outside tourists to enjoy and learn about, just as the remaining volcanoes on the Auckland Isthmus are today. Each of the possible threats mentioned above would greatly limit the ability to achieve this long-term vision for the volcanic heritage of the field.

I recognise that this vision of public ownership and parks for the largest volcanic features (e.g. Pukekohe Hill shield volcano, Bombay shield volcano, Kellyville crater, tuff ring and tholoid, and Onewhero crater and tuff ring, Patumahoe cone) and all of the gently sloping shield volcanoes is impractical. Even if it was practical, then the opportunity has already been lost because they have already been subdivided into numerous private property lots. In these instances, I advocate recognising the outstanding importance of these major volcanoes by retaining or including them in scheduled ONFs in category 1 for Large Landforms. For this category of features policies should be developed that will allow long term protection of their larger landform shape by mechanisms such as: only allowing less intense subdivision, and requiring subdivisions to build over the natural land shape rather than wholesale land reshaping as is the norm in most subdivisions today.

There are a number of smaller volcanoes in the field that if protected now, could in 30-50 years' time become the premier reserves of South Auckland, just as those that are left have become the much-cherished reserves of Auckland City (e.g. North Head, Mt Victoria, Lake Pupuke, Auckland Domain, Mt Eden, Mt Hobson, Mt St John, One Tree Hill, Mt Albert, Orakei Basin, Mt Wellington, Panmure Basin, Pukewairiki, Mangere Mt, Te Motu a Hiaroa, Pukaki Lagoon) (Hayward, 2019). Those in the South Auckland Field are listed below and comprise ~25% of the volcanoes in the field – the remaining 75% are already too weathered, eroded, subdivided or developed. I realise that the opportunity to achieve this may have already passed with several of the above (e.g. East Pukekohe Crater, Rasmussen Crater) because subdivision and private development has already been allowed to occur.

These better-preserved smaller volcanoes should be placed in another category of ONFs (category V) where planning protection would allow continued farming activities but not allow subdivision, quarrying, planting of exotic forest or significant earthworks like farm roads up their steep slopes. By this means, when the land around them comes to be developed for urban housing these volcanoes will still be well preserved and not compromised by subdivision and housing and could become reserve contributions as the features reserves of each suburb, just as they are now in Auckland.

If my vision is to be achieved, even in a much-reduced form, then NOW is the time that planning action needs to be taken to set in motion the process for the long-term survival and eventual public ownership and enjoyment of the volcanic 20Geoscience heritage of the South Auckland Volcanic Field. It is beholden on our generation to have the long-term vision to protect this heritage for the future.

What happened in Manukau is destined to be repeated in South Auckland Volcanic Field

The current situation in South Auckland is similar to what existed in the southern (Manukau) part of the Auckland Volcanic Field in the 1950s-1970s.
Twenty-one of the 53 volcanoes of the Auckland Volcanic Field occur within the former Manukau City boundaries.

Up until the 1980s there was no planning protection for any of them, except that Mangere Mt was in Crown ownership as a Domain, but even then, quarrying was allowed in the 1960s to remove one portion of its amazing cone. A public campaign by the Historic Auckland Society (forerunner of Heritage NZ) in 1957 (in part led by Ernie Searle; and supported by GSNZ) called for the cessation of quarrying and the long-term legal protection of the best remaining, unquarried or little quarried volcanic cones in the Manukau area (Maungataketake, Pukewairiki, Puketutu, Pigeon Mt, Otara Hill, Mangere Mt, McLaughlins Mt and Green Mt). The upwelling of public support resulted in the permanent cessation of quarrying on a few volcanoes in Auckland City (Mt Wellington, Mt Albert, Taylors Hill), but had no immediate results in Manukau.

In the 1950s, the Manukau district was very much like the South Auckland area today. There were several centres of suburban housing (Otahuhu, Papatoetoe, Manurewa) but mostly it was pastoral farmland. There was not the huge residential population (more than half a million people) we now have, living in and around where the volcanoes stood. If there had been it is likely that local opposition to the damage being done to their volcanoes would have stopped much of the desecration and communities that today live in a desert of modified land would have been able to focus their recreational leisure lives on such magnificent volcanic features as: Green Mount, Otara Hill and Waitomokia scoria cones nestled within their tuff ring craters, the small crater lakes of Pakuranga and Styaks Swamp; the twin cones of Otuataua and Maungataketake or the beautiful breached scoria cone of McLaughlins Mt to name just a few.

Of the 21 volcanoes in the former Manukau city boundaries, scoria cones of 10 volcanoes have been more than 50% quarried away since 1950 (many entirely) (e.g. Pigeon Mt, Green Mt, Otara Hill, Hampton Park, Puketutu, Waitomokia, Otuataua, Crater Hill, Wiri Mt, Matukutureia) and three small craters completely filled in and built over.
Of the volcanic cones, all we have left are Mangere Mt (slightly damaged), Puketutu (more than 50% removed), Pukeiti (badly damaged), Matukutureia/McLaughlins (badly damaged, pyramid remains) and Pigeon Mt (more than 50% removed).

In the last 30 years, what remains of most of the volcanoes in this area have been scheduled as ONFs. Multi-millions of dollars of public money have been spent trying to achieve some long-term protection for some of them (purchase of Pukaki Lagoon crater and tuff ring, purchase of Otuataua and Pukeiti lava flow fields, restoration of Mangere Lagoon crater and small scoria cone, defence in the Environment Court of the ONF status of Crater Hill to prevent dense subdivision inside the crater). Much of this huge expenditure could have been avoided if there had been planning vision 50 or more years ago. Having ONF status over Pukewairiki crater (Highbrook) in the

1990s did result in it being set aside as a reserve as part of the obligations of subdivision of the land that has now taken place. This is the kind of result I envision for South Auckland's volcanic heritage.

Recommended planning protected status of the best-preserved volcanic heritage of the South Auckland Volcanic Field (Fig. 3)

A. Schedule as ONF, Larger volcano category 1 (* = currently an ONF)
1. Pukekohe Hill shield volcano, 2. Bombay shield volcano, 3. *Kellyville crater, tuff ring and tholoid, 4. *Onewhero crater and tuff ring, 5. Patumahoe cone, 6.*Raventhorpe tuff ring, 7. Rasmussen Rd tuff ring, 8. Waiuku volcanic c.one

B. Schedule as ONF, Smaller volcano category V (* = currently an ONF);
long term goal for each is public reserve.
1.*Barriball Rd tuff ring and cone, 2. *Hunua Falls volcanic neck, 3. *Ingram Road III tuff ring, 4. *Pukekohe East tuff ring, 5. *Red Hill volcanic centre, 6. *Waitangi Falls, Glenbrook over lava flow, 7. Karaka volcano, 8. Puni Domain shield volcano, 9. Paerata tuff ring bluff, 10. Rooseville Park tuff bluffs, 11. Cape Hill Reserve tuff bluffs, 12. Helvetia tuff ring knolls, 13. *Pukekawa sco ria cone,14. Pukeotahinga scoria cone, 15. Onewhero scoria cone, 16. Kauri Rd scoria cone, 17. Onepoto volcanic cone, 18. Te Kohanga tuff ring/Tikoran gi cone, 19. Pokeno scoria cone, 20. Serpell Rd tuff ring and cone, 21. Bald Hill cone, 22. Jericho volcanic cone.

opposite page: Fig. 3. Photos of ten of the South Auckland volcanoes mentioned here.

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Bariball crater, tuff ring and cone
Bombay cones
Onewhero Crater
Karaka Volcano
Pukeotahinga scoria cone
East Pukekohe Crater
Onepoto scoria cone
Pukekawa scoria cone
Serpell Rd scoria cone
Tikorangi scoria cone

Fig. 3

THE PETROLEUM INDUSTRY IN NEW ZEALAND IN 2020 AND BEYOND

Mac Beggs: Convenor, Oil & Gas Special Interest Group

New Zealand's petroleum industry may be relatively small in comparison to most countries, but it has existed and drawn on geoscience expertise for many decades (even before the first truly commercial discovery at Kapuni in 1959-60), and will undoubtedly continue to do so for some time yet.

The Society's Oil & Gas Special Interest Group includes well over 100 members across a wide spectrum of professional situations. In a survey undertaken earlier this year to canvass their views and expectations of the Society and the Group, several common themes emerged. One of these is to establish links between academia and industry professional counterparts. Another is to provide up to date information on exploration and development activities in New Zealand.
The following is in response to the latter theme.

There is of course a politically charged overlay on the petroleum sector of the national (and global) energy system as it accomplishes a transition to net zero greenhouse gas emissions implying diminished reliance on carbon-based fuel. Our survey strongly endorsed a position that we should "inform public debate about oil and gas in New Zealand". Hopefully this article also contributes to that end, leaving readers to test and refine their particular views.

April 12 2018 is a significant historical milestone for the petroleum sector in New Zealand: on that date the government announced a ban on new petroleum exploration permits throughout its jurisdiction with the exception of onshore Taranaki. However, existing exploration permits remained in force and although some have been relinquished in the meantime, several have continuing exploration effort. Likewise, development investment continues in many of the producing fields (within mining permits or licences). These activities are reviewed by "theatre".

Onshore Taranaki

Taranaki was the birthplace, and remains the mainstay, of New Zealand's petroleum industry. In the map (page 14) (from http://data.nzpam.govt.nz/permit-webmaps/?commodity=petroleum), mining licences are in darker blue and contain the developed (producing) oil and gas fields. There is significant diversity in this set of oil and gas fields, including in terms of their size, and extent of depletion, as well as in their geological particulars. Each has a fascinating life story!
Julie Palmer will present a first person perspective on the McKee oilfield at the 2020 Geoscience Society conference.

McKee is one of the three large fields operated by Todd Energy, the largest New Zealand-owned company in the industry, and a fascinating case study in its own right, having evolved from an entrepreneurial family enterprise which identified the promise of petroleum in the 1950's and participated in its realisation, first at Kapuni, in a joint venture with Shell and BP.

When a large volume of natural gas was discovered at Kapuni in 1959/60, New Zealand was of course devoid of any infrastructure to make its production available to energy markets. It took 10 years while the field was appraised and initially developed with a few highly productive wells, to have the processing and pipeline facilities also designed and constructed. The natural gas industry - which accounts for 20% of New Zealand's primary energy consumption today (49% of non-transport consumer energy) and supplying a significant petrochemical industry - 71 years ago, was in a similar situation to that of the hydrogen industry today, perhaps.

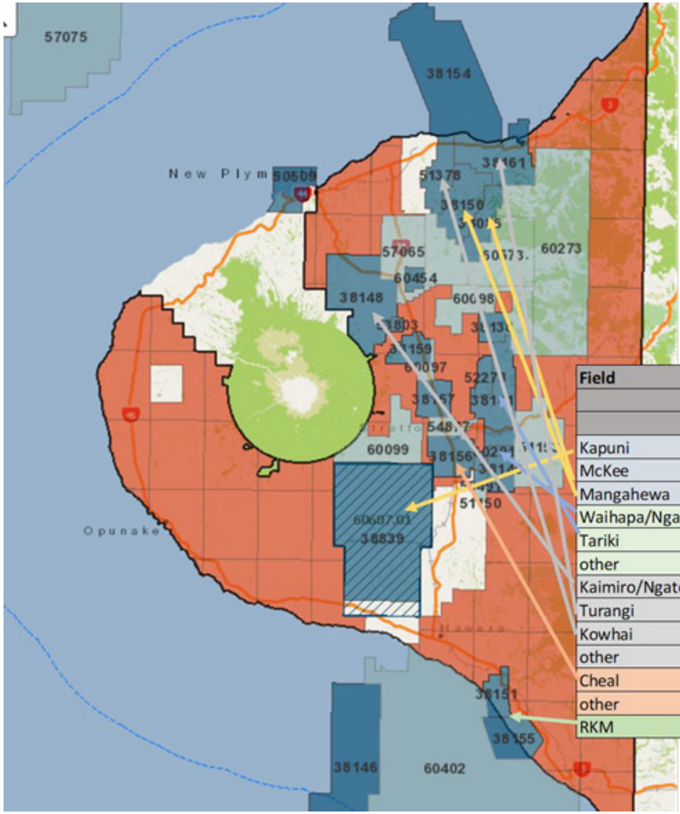
The map on page 14 shows the mining (dark blue) and exploration (lighter blue) permits in force across Taranaki as of August 31, 2020. The onshore exploration permits are all held by ventures which also operate producing fields. The most recent exploration wells away from the fields were Te Kiri North-1 – the 3rd test of a faulted anticlinal structure southwest of the maunga / national park (drilled by Todd in 2016), and Kohatukai-1 drilled just east of New Plymouth by AWE (owned by Mitsui) in 2018; both targeting gas prospects at the Eocene "Kapuni" level: neither was successful, and the permits have been relinquished. The orange blocks are open areas on offer for bids in a pending Block Offer. Recent "annual" Block Offers have seen very few permits granted. Don't expect then to see a lot of exciting exploration action on the Taranaki peninsula for the foreseeable future. But there has been plenty of action on most of the producing fields (especially the larger gas fields), and this is set to increase. These fields are a highly important component of New Zealand's energy system as it exists today.

Oil (including condensate – the liquid by-product of gas production) and natural gas reserves of the onshore Taranaki fields are tabulated as the operators' official estimates of "ultimate" (to be produced over the whole of field life) and "remaining" (as of 1 January 2020), at a 50% confidence level, and the degree of depletion by the same date is calculated in the table. Most of the fields also have "contingent resources" reported, and these values have tended to increase quite dramatically in recent years. Contingent resources are gas or oil accumulations which have been discovered and at least provisionally evaluated, but cannot immediately be produced due to one or more impediments – which may be either technological or commercial - to their development. There is no general public disclosure of the specific obstacles in relation to the contingent resources reported for Taranaki fields, but it is likely that in several cases at least, poor reservoir quality (and hence low rates of production per well) are largely responsible. Ultimately this may be addressed by a combination of higher gas prices, to compensate for more wells being required for the same volume of production, and perhaps relatively costly specialised technology to stimulate and enhance production.

For the past decade, about 200PJ of gas has been produced each year from Taranaki. [footnote: a petajoule (1015 joules) is a quantity of energy more or less equivalent to that released from combustion of a billion cubic feet of natural gas – depending on its specific composition and calorific value. But MBIE in its recent 2020 edition of Energy in New Zealand (https://www.mbie.govt.nz/dmsdocument/11679-energy-in-new-zealand-2020) forecasts, based on statutory reports from field operators, that the production of developed reserves will fall short of that steeply from about 2026. Unless some significant market segments disappear, the large onshore fields will need to have quite aggressive further development to sustain the level of production.

Todd Energy has indicated plans for a reasonably high level of operational activity in the next year or so, including permanent abandonment of some McKee field wells; two development wells in Mangahewa field; and development drilling in the Kapuni Field. This is a particularly interesting case considering the very long life of the field to date; the advanced depletion of its official reserves (see the table); and the large quantity of its contingent resources. The further development of Kapuni is being informed by a new 3D seismic survey undertaken in 2015-16 (when Shell Todd Oil Services was operator, prior to Shell's divestment from New Zealand), deploying 30,000 recording nodes across 450 km2. The project employed up to 215 people, of which "geophysicists worked around the clock to ensure the data was accurate", according to press coverage at the time. The Mangahewa permit has also been covered with a new 3D seismic survey, acquired in 2016-17.

Greymouth Petroleum - also with private New Zealand ownership – is the second largest onshore production operator. Having acquired the Kaimiro and Ngatoro oil fields in 2000, Greymouth discovered and developed important gas fields (Turangi, Kowhai) adjacent to the north and west of Mangahewa in the subsequent decade. Greymouth's fields produced about 16PJ of gas (8% of New Zealand's total) in 2019. Production from their aging Miocene-reservoired oil fields now runs at about 150,000



The map shows the mining (dark blue) and exploration (lighter blue) permits in force across Taranaki as of August 31, 2020.

Field	Operator	oil/condensate (mmbbls)				gas including lpg (PJ)			
		reserves (2P)		depletion	contingent	reserves (2P)		depletion	contingent
		ultimate	remaining			ultimate	remaining		
Kapuni	Todd	72.71	5.92	92%	19.15	1212.91	197.19	84%	735.13
McKee	Todd	47.30	0.00	100%	33.00	263.13	55.18	79%	32.70
Mangahewa	Todd	15.65	8.59	45%	24.05	729.43	449.63	38%	1200.60
Waihapa/Ngaere	NZEC	25.03	1.01	96%	0.00	35.23	4.11	88%	0.00
Tariki	NZEC	1.89	0.00	100%	0.00	64.38	0.00	100%	0.00
other	NZEC	0.78	0.20	74%	0.00	2.78	0.45	84%	0.00
Kaimiro/Ngatoro	Greymouth	10.81	0.73	93%	10.26	64.41	17.60	73%	28.12
Turangi	Greymouth	14.29	10.12	29%	2.21	447.99	342.79	23%	70.77
Kowhai	Greymouth	2.15	0.49	77%	2.17	70.07	22.14	68%	64.90
other	Greymouth	0.57	0.28	51%	0.69	73.20	24.01	67%	0.90
Cheal	Tamarind	7.39	3.23	56%	0.00	13.97	6.54	53%	0.00
other	Tamarind	0.44	0.23	47%	0.65	4.27	3.17	26%	0.00
RKM	WestSide	5.14	2.61	49%	98.24	41.27	7.66	81%	351.10

barrels per year. Holding a handful on onshore Taranaki exploration permits as well as their producing fields, Greymouth generally drills a well or two each year, utilising drilling rigs owned by associated companies.

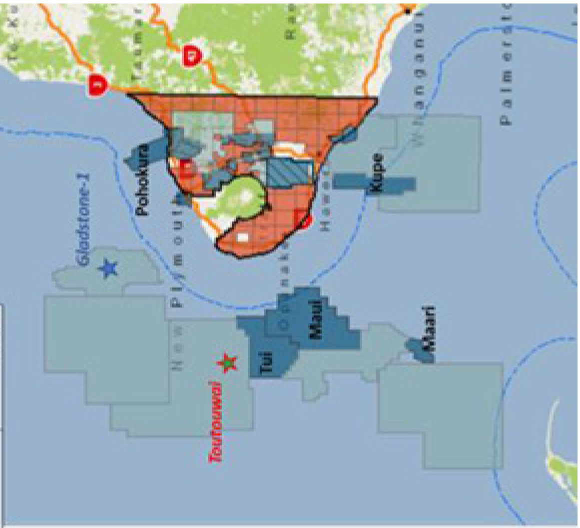
New Zealand Energy Corporation operates a set of heavily depleted oil and gas fields (Tariki and Waihapa/ Ngaere: "TWN") east of Stratford, which were mostly discovered and developed by the former state oil company Petrocorp in the 1980's (following their play-opening McKee discovery) and acquired by NZEC from Origin Energy in 2012. Initially a listed Canadian company, NZEC ran an aggressive exploration programme including pursuit of "shale"-hosted resources on the East Coast, from its inception in 2010 and ran into liquidity problems following the TWN acquisition, and a controlling shareholding was acquired by interests associated with Greymouth. Waihapa/Ngaere is notable as the only limestone reservoir in New Zealand; Tariki (and the Ahuroa gas field which was converted to gas storage, now owned by the gas pipeline system operator First Gas, in 2011) have a locally developed Oligocene deep-water sandstone reservoir. NZEC also operates the small Copper Moki oil field, a Mount Messenger (late Miocene deep water sands) reservoir on the SW edge of Waihapa. Copper Moki produced close to 50,000 barrels of oil in 2019.
The other active shallow oil fields are mainly those operated until last year by TAG Oil (another Canadian listed company) and then divested to Singapore- owned Tamarind Resources – in particular the Cheal field south of Stratford, which produced about 370,000 barrels in 2019. Tamarind also has the Puka oil field east of Waihapa, which is incompletely appraised with its wells shut in since 2015.

Finally, a set of fields on the southeast coast of Taranaki which were discovered and developed by American company Swift Energy 20 years ago in the Rimu and Kauri permits have since 2016 been operated by Westside Corporation – an Australian coalseam gas developer/producer owned by private Chinese interests. These fields in the thrust system forming the eastern basin margin are largely depleted apart from contingent resources, but with significant oil in place in the late Miocene Manutahi sand in the hangingwall.

Offshore Taranaki
The main company operating oil and gas production and exploration in the offshore Taranaki Basin is OMV, a Vienna-based global enterprise, active in 17 countries. OMV developed the Maari oil field in 2009. This asset is currently being transferred to Jadestone Energy, based in Singapore. Previously a partner in the Maui and Pohokura fields, OMV acquired Shell's interests in those fields in 2018 and became the operator.

The Maui field, (Map and table opposite) comprising two production platforms on separate "A" and "B" crests of a broad 157km2 anticlinal structure up-thrown to the Cape Egmont Fault, with paralic sandstone reservoirs in the Eocene Kapuni Group, is drawing to the end of an illustrious life as New Zealand's largest petroleum field, brought into production in 1979. An oil pool in the Paleocene "F" Sands (below the gas reservoirs) produced about 22 million barrels to a floating production, storage and offloading vessel between 1996 and 2006. In its heyday, the Maui field produced

Field	Operator	oil/condensate (mmbbls)				gas including lpg (PJ)			
		reserves (2P)		depleti	contingent	reserves (2P)		depletion	contingent
		ultimate	remaining			ultimate	remaining		
Maui	OMV	229.08	5.66	98%	6.84	4395.06	148.85	97%	165.55
Pohokura	OMV	59.58	10.91	82%	3.34	1415.70	498.00	65%	105.69
Kupe	Beach	20.84	6.41	69%	2.96	641.61	336.19	48%	30.53
Maari	Jadestone (1)	45.12	4.42	90%	0.00	20.98	3.82	82%	0.00
Tui	Crown (2)	41.53	0.00	100%	0.00	0.00	0.00		0.00
Karewa	Todd	0.00	0.00		0.00	0.00	0.00		155.32



The Maui field

the majority of the natural gas consumed in New Zealand, about 140 billion cubic feet annually until 2002 when field reserves were redetermined downwards and production curtailed to about 40 bcf per year in recent years.
The field has been kept in production many years beyond expectations through a succession of infill wells drilled from the platforms to draw from previously bypassed gas in lower permeability and thinner reservoir beds, and from structurally isolated pockets. OMV has recently commenced yet another drilling campaign on the Maui A platform. The most recent public forecast is for production from the field to cease in 2026.

The Pohokura field was discovered off the N Taranaki coast in 2000 and brought into production from its Kapuni sandstone reservoirs from 2006, thereafter becoming the country's largest source of natural gas at about 60 bcf per year. With two thirds of its ultimate reserves now produced, production has been affected by reservoir and facilities challenges recently, and is forecast to decline steadily from 2022 until the mid 2030's. However, development of contingent resources could well result in a longer and/or larger life.

The other offshore gas field is Kupe, to the south of Hawera, which is operated by Australian company Beach Energy (following their acquisition of producing field and exploration assets from Origin Energy in 2017). Discovered in 1986, there was no market for Kupe gas until the downward redetermination of Maui field in 2002, and it was developed and brought into production from three wells, in 2009. Kupe produces about 20 bcf per year, which can be sustained through 2028 according to official projections. There are two offshore oil fields in the Taranaki Basin, which were developed over a decade ago. The Maari field, like Kupe a 1980's discovery which was considered sub- economic until higher oil prices and new technology enabled its development 20 years later, produces mainly from middle Miocene deep water sand reservoirs in an inversion anticline associated with the Cape Egmont fault zone south of the Maui field. Its new owner (pending government approval), Jadestone, focusses on relatively depleted ("late-life") fields.

The Tui oil fields were discovered in 2003-04 and developed with extended reach wells producing to a floating production storage and offloading vessel. The Paleocene "F Sands" reservoir produced from a thin oil column in three very low relief anticline crests at high flow rates with steady increase in water co- production. In 2016 having produced over 40 million barrels of oil, the field was purchased by Tamarind, a recently-established company also purporting to specialise in management of late-life oil and gas fields. By 2018 annual oil production from the 5 wells was down to about 635,000 barrels, but Tamarind had a new interpretation of the structure at the reservoir level suggesting undeveloped areas along the northern flank with 6-8 million barrels to be won. A drilling rig was deployed in 2019 to drill three new development wells, but with the first a failure the company had largely exhausted its working capital and was put into liquidation, with production suspended.

The Tamarind default has created an awkward situation for the government, which has taken over the permit and has to arrange (and pay) for its decommissioning – estimated to cost about $150 million.

Offshore Taranaki exploration has contracted as a result of the 2018 ban on new permits (as well as the lack of discoveries from substantial campaigns over the past 17 years, and low oil prices internationally), both in terms of the number of permits and of participants. A major immediate casualty of the exploration ban was the multi-client seismic industry, which had invested about $100 million in surveys in Taranaki and other New Zealand basins between 2013 and 2017 in the expectation of licencing the data to existing and new permit holders.
A number of offshore Taranaki exploration permits have been relinquished since the ban, and the remaining permits are mostly operated by OMV with its partners Mitsui and Sapura (Japanese and Malaysian companies: Sapura's exploration and production business is 50% owned by OMV as SapuraOMV), in a belt to the south and north of the Maari-Maui-Tui producing fairway. OMV drilled two prospects in 2019-20 and has announced a potential oil discovery in late Cretaceous sands at Toutouwai, north of Tui. This well was completed somewhat hurriedly at the beginning of the Covid19 lockdown, the prospect is scheduled to be further evaluated with further drilling in future. Further NE, the Gladstone well was unsuccessful. A well to test an oil prospect within the Maui permit was deferred.

There are also a handful of active exploration permits in the east of the offshore basin. Westside was granted a block containing the Kaheru prospect on the thrusted basin margin adjacent to the south of their Kauri field, in 2017. Todd Energy holds a permit to the south of Westside's and the Kupe field, and also two permits in the north of the basin west of Raglan: one containing the small undeveloped Karewa gas field which was discovered in 2003 in a Pliocene sand, and an area adjacent to the north and northwest in a joint venture with Beach.

Frontier basins

In the second half of 2014, oil prices fell from over US$100 to less than US$40/barrel. Deep water wells drilled by Anadarko in the Canterbury (Caravel-1) and outer Taranaki (Romney-1) basins in 2013-14 had been unsuccessful. A period of unprecedented interest in New Zealand's extensive offshore frontier basins from major international exploration companies started to come to an end.
Anadarko departed followed by Equinor (formerly Statoil) and then Chevron, leaving the northwestern frontiers devoid of active (or future, given the 2018 ban on new permits) exploration; with the northeastern basins (including the Raukumara to the north of East Cape, and the Pegasus in the south) limited to a single permit held by OMV (formerly with Equinor and Chevron) since 2015. Most of the remaining activity is off the eastern South Island, with four active exploration permits. OMV, Mitsui and Beach drilled Tawhaki-1 earlier this year, the first well in the Great South Basin in 36 years, culminating an exploration programme with several substantial seismic surveys which was initiated in 2007. Unfortunately, this well was not successful in discovering oil or gas.

The remaining prospect for which a well is committed is Wherry, in deep water about 120km east of Oamaru in the Canterbury Basin. The Operator is Beach Energy, which also holds an interest in the adjacent (shoreward) permit operated by NZOG and containing the Barque prospect. NZOG also holds the southernmost active exploration permit in New Zealand, in deep water to the SE of Stewart Island.

Conclusion

Petroleum exploration in New Zealand is at a low ebb after a second heyday 10- 20 years ago, though activity and investment levels are still above that of the 1990's. The legacy of the initial post-Maui (1970s-80's) heyday and that of a decade or so ago is a diverse set of oil and gas fields in the Taranaki Basin which are in late (and in some cases middle) stages of life. This may be the local manifestation of the permanent sunset many envisage for petroleum industry; or, a prelude to a 3rd cycle of success, if the exploration ban were to be overturned and conditions for investment to improve. We shall have to wait to see..

NEW ZEALAND PETROLEUM COMPANY LIMITED 1962-1972

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Following Mac Beggs' article in the June 2020 Newsletter (Issue 31) the Editor included a photo and excerpt from the Gisborne Herald noting that in 1944 the New Zealand Petroleum Company Limited was discontinuing further exploration.

Now I have to add to this historical note with the record that the New Zealand Petroleum Company Limited (head office Dallas, Texas) did return and saw fit to list on the New Zealand Stock Exchange 1 January 1962 and to (re)embark on an ambitious exploration programme. What promoted this flush of activity is not immediately apparent but it may be connected with the extremely high birth rates (baby boomers) during the early Holyoake years which could have persuaded the owners to take out exploration licences adjacent to major conurbations, namely Auckland, Hamilton and Dunedin. Or indeed the impetus may have come from the discovery, a few years before (1959) of the Kapuni Gasfield in Taranaki.

During the ensuing ten years after 1962 geophysical surveys were conducted in the above onshore areas plus Southland and offshore Westland and Northland (Kaipara). Wells were drilled by the operator New Zealand Petroleum Exploration Co. Ltd. during 1963 to 1965 at Puketaha-1, River Road-1 and Te Rapa-1 in the Waikato and at J.W. Laughton-1, J.T. Benny-1 and T.E. Weily-1 in Southland. Harihari-1 was drilled later in 1971 in Westland. Christchurch was also well provided for in the drilling at Leeston-1 and J.D. George-1 in 1969, the company having farmed into licences held by BP Shell Aquitaine and Todd Petroleum Development Ltd. So far, no discoveries, although further exploration was promoted in Westland and Southland.

However, the most important and interesting operation (for me) was onshore Northland with the drilling of Waimamaku-1 in 1969 and Waimamaku-2 in 1972. The focus on the South Hokianga came with the mapping of a large four-way dip anticline (14 x 5 miles) with hydrocarbon seep; possibly the dream of all exploration geologists having pored over similar features described from the Zagros in Persia. This pericline is oriented W-E and has the Waimamaku River along its axis. Mapping within the Early Miocene volcaniclastics of the Waipoua volcano shows the southern limb to be contiguous with the regional SW dip (as affects all of West Coast NI) while the northern limb truncates against a buttress formed by the Tangihua Complex of the Waima Range, probably faulted.

Waimamaku-1 was drilled by the Ministry of Works T12 rig between 10 January and 7 April 1969 and terminated at 4,175' (1.3 Km). During the next month several zones were tested and methane was recovered after swabbing, but no natural flow could be established. Micropaleontology by Dr N.de B. Hornibrook relied 'on a good deal of guesswork' and suggested extreme structural complexity with 'a wedge of Eocene sitting in the middle of an Upper Cretaceous-Paleocene sequence'. Trading in shares was buoyant at the news of hydrocarbons in the well.

It may be of some historical interest that during the same time interval, January to April 1969 Shell BP Todd were drilling Maui-1 which was suspended after flowing oil at 1645 BPD. Interest in petroleum was at an all-time high! Following the acquisition of 14 miles (22 Km) of single-fold and 7 miles (11 Km) of three- fold land seismic, which moved the crest of the structure further west, Waimamaku-2 was drilled 24 October 1971 to 16 February 1972. The original plan of terminating the well at around 12,000' (3.6 km) was remarkably accurate when compared with the actual TD of 11,010' (3.3 Km). However, all other geological data was at extreme variance with the prognosis, most disappointing of which was the lack of any commercially significant hydrocarbons. The completion report highlights "a predominantly shale section encountered with a major time stratigraphic reversal and basal sediments of age and facies previously unknown in Northland".

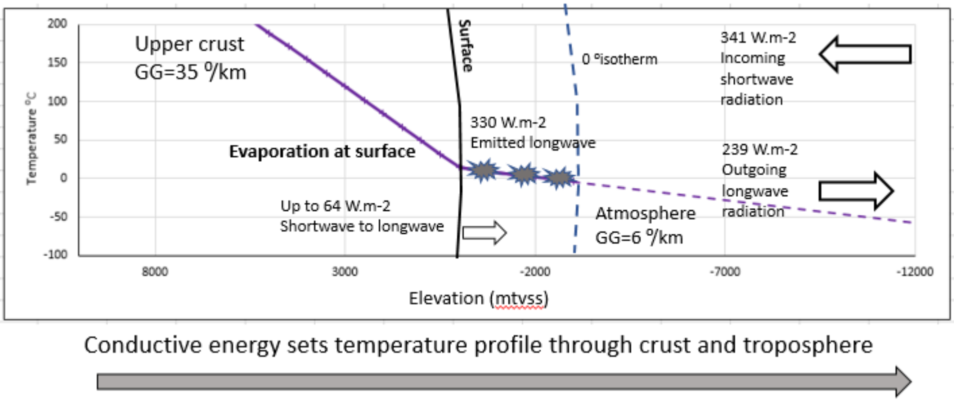
Quality of data, including cores and logs from Waimamaku-2 was a considerable improvement on the earlier well, although its analysis has continued to cause much anxiety and controversy. The geological story of how these results were pivotal in conceiving the 'Northland Allochthon' are well told by Bruce Hayward in 'Out of the Ocean, Into the Fire' (e.g. pp 65-75) and its reading is thoroughly recommended.

When our family moved to live in Waimamaku in 1987 there was rumour that in my capacity as a petroleum geologist I intended to continue the search for oil that had been abandoned in 1972. To the disappointment of some and the joy of others this has not eventuated, although relatively high geothermal gradients in the Waimamaku wells do indicate a potential energy source that may be worth investigating.

GEOSCIENCE AND CLIMATE CHANGE

Mark Webster. Director, Kauri Oil & Gas info@kaurioilandgas.co.nz

Current climate models disregard energy input from crustal heat flow because the thermal conductivity, and therefore heat flow, of rock is low (the average heat flow of the earth is only 87 mW.m-2). The Greenhouse model therefore attempts to amplify solar radiation via storage and re-emission by Greenhouse gases to account for the warmth of earth's atmosphere. A detailed review of the Greenhouse model can be found at www.kaurioilandgas.co.nz. The Greenhouse model requires 64 W m-2 of incoming shortwave solar radiation (the amount that is available at surface) to somehow be transformed into 396 Wm-2 of outgoing longwave radiation.
This infrared radiation is largely, in fact, energy from the earth's crust, not solar radiation. An alternative model that incorporates the geological component of climate, here called the Rutherford model, is summarised below.



As shown in the above figure, the temperature profile through the upper crust and troposphere is a continuum, with rates changing from a rock/water medium to an air/water vapour medium. This temperature equilibrium at the interface is evident at all latitudes. Because temperatures in the crust have remained relatively constant over the human timeframe, there is very little heat flow recorded between subsurface and atmosphere. The heat flux however is apparent when non-adjoining points are connected eg deep mines in which rocks are exposed to atmospheric conditions. Increasing atmospheric temperatures over the last 150 years have been attributed to

increasing concentrations of greenhouse gases, notably carbon dioxide and methane. This is based on the capacity of these gases to absorb and emit infrared radiation. Logically, more gas means more emissions, leading to higher temperatures.
Carbon dioxide is heavier than air, and isotopic data confirm atmospheric carbon dioxide is largely derived from thermal sources (volcanism, geothermal and burning of fossil fuels). Carbon dioxide ascends rapidly as a plume then falls back through the atmosphere, absorbing energy. A minor component is derived from the breakdown of methane in the troposphere. Methane is ubiquitous on the surface and in the sub-surface, and is lighter than air, so the atmosphere should be rich in methane, yet it is present in ridiculously low concentrations (1500 ppb).

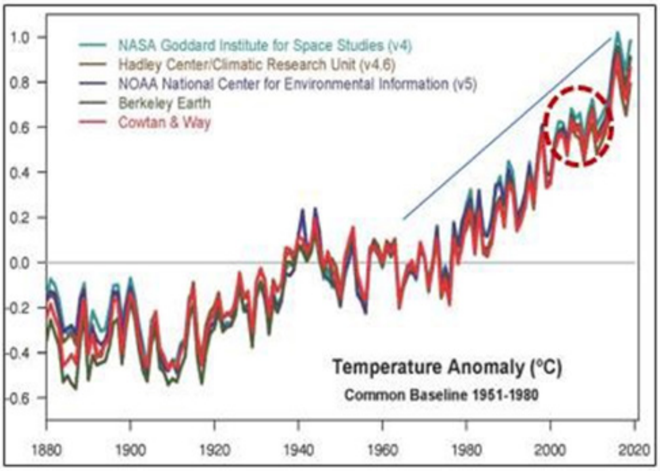
The Rutherford Model
The transfer of heat from the subsurface to atmosphere is complex. Rock generates heat (through radiogenic decay), water stores it (in oceans and in pore spaces), and air dissipates it. Evaporation is an important part of the climate, cooling the surface by transferring warm water into the atmosphere. Evaporation is caused by incoming short wavelength radiation (UV) being absorbed by oxygen molecules, which then lift water molecules to form vapour. Ultraviolet radiation is also absorbed by ozone. As water vapour rises, it cools by emitting long wavelength (infrared) radiation in all directions – this energy is what climate science claim as evidence of the Greenhouse Effect.

Ozone reacts with methane rising from the surface to generate water and CO_2.

$$\mathbf{CH_4 + O_3 \rightarrow CO_2 + H_2O + H_2}$$

Chlorofluorocarbons (CFCs) deplete ozone, allowing more UV radiation to reach the surface, increasing evaporation and transferring more crustal heat into the atmosphere (global warming).The use of CFCs for refrigeration began in 1867. Ozone depletion started in the southern hemisphere in the 1950s and increased until the 1990s. CFCs were banned under the Montreal Protocol of 1987.
China resumed illegal emissions around 2008 and these have been increasing. In the presence of UV radiation, chlorine in the CFCs reacts with ozone and methane to generate water, carbon dioxide and hydrochloric acid (leading to ocean acidification).

$CH_4 + O_3 + Cl \rightarrow CO_2 + H_2O + 2HCl$
Methane + ozone + chlorine ➔ carbon dioxide + water + Hydrochloric Acid



The current trend of increasing temperatures started in the 1950s and continues to the present day at a rate of around 0.12 ^{0}C per decade, except for the period 1998 – 2012 (referred to as the temperature hiatus) when it slowed to 0.05^0 C per decade. Climate scientists in NZ, Australia, UK, USA and elsewhere have been "correcting" pre-1950s temperature measurements to fit the steadily rising CO2 curve.

It is not Greenhouse gases that are to blame for rising temperatures and falling ocean alkalinity. Ozone depletion is the cause of accelerated temperature increase since the 1950s. The Greenhouse Effect is slight, if it exists at all, and carbon dioxide produced from combustion of fossil fuels is not responsible for current trends in climate.

The world has embarked on a costly, unnecessary, and ultimately futile mission to decarbonise the environment and thereby accelerate the ultimate extinction event. Geoscientists, and particularly those in the southern hemisphere, need to step up and educate the public and policymakers. Crustal heat flow contributes to atmospheric climate and climate science must integrate earth science.

(Ed Note: Views expressed are those of the author(s) and are not the official views of the editor or the Geoscience Society of New Zealand).

ALAN MASON AWARD FOR HISTORICAL STUDIES

Hartly Travers Ferrar (1879-1932) and his geological Legacy in Antarctica, Egypt and New Zealand

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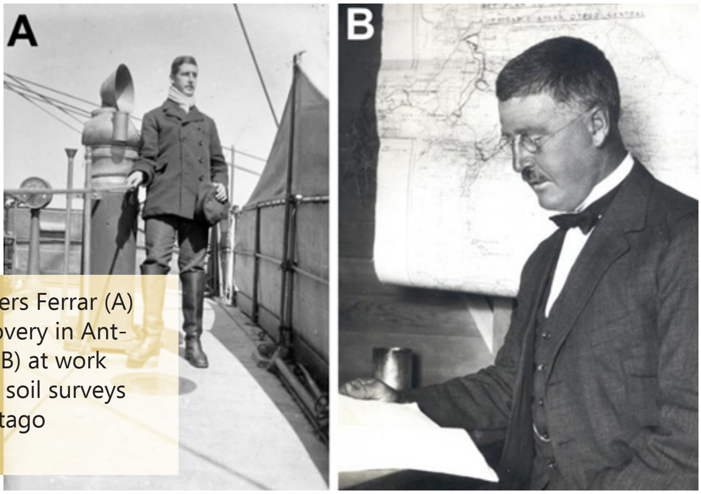
Progress report

The above paper was finalised and published in the journal Earth Science History (2019, vol. 38, p. 43-58).

This work was the culmination of several years of research and dialogue with members of the Ferrar family, who provided a wealth of anecdotes and source information. Sue Ferrar (Hartley Ferrar's granddaughter) provided photographs and ideas to help finalise the paper. In the end, the article provided a synopsis of Ferrar's life, which ended prematurely aged 53. The paper included reference to 72 of Ferrar's publications, and further provided the context and background for his career. Hartley Travers Ferrar was the geologist on Scott's first expedition to the Antarctic (the 'Discovery' Expedition) in 1901–1904. Ferrar undertook the first geological surveys in the Transantarctic Mountains, which he mapped to 83°S, and made some discoveries of major scientific importance, such as fossil leaves, later identified as Glossopteris indica. He then worked in Egypt, Palestine and New Zealand, and was Acting Director of the New Zealand Geological Survey when he died suddenly in 1932. Little has been acknowledged about Ferrar's other contributions to geology, which were vast, and included pioneering work on irrigation and hydrogeology in Egypt, as well as a series of geological mapping campaigns in New Zealand. The latter extended to systematic soil surveys in New Zealand, in particular in Central Otago, where soil types and their properties were characterized in the field and laboratory. This paper outlines some of Ferrar's key contributions to New Zealand geoscience, as well as some of his notable overseas achievements.



Hartley Travers Ferrar (A) on the Discovery in Antarctica and (B) at work undertaking soil surveys in Central Otago (circa 1928).

S. J. Hastie Award Report

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MSc Thesis

Expanding the Footprint of Orogenic Gold – Trace Elements in Sulphides

Cordilleran-style orogens during the Neoproterozoic and Phanerozoic have been responsible for 22,000 tonnes lode and 15,500 tones placer gold deposits (Goldfarb et al. 2005b). The deposit at Macraes, Otago, New Zealand hosts 125 tonnes of Phanerozoic (refractory) orogenic gold concentrated along the Hyde-Macraes Shear Zone (HMSZ) in the Otago Schist (Goldfarb et al. 2005a; Pitcairn et al. 2006; Allibone et al. 2017). The primary aim of this ongoing study is to determine the existence and extent of spatial dependency in trace element concentrations (within sulphides) in the vicinity of a known ore zone. If a spatial dependency becomes apparent it would have implications for gold exploration within large, discontinuously mineralised structures such as the HMSZ. In the process of determining the above, this study can also characterise the deposition of the gold itself, particularly how it relates to arsenic concentration, sulphide characteristics and structural setting.
Core logging of Macraes ore and surrounding material (27.6 m of the 6037-01 core from project: 2XD4) showed that the highest sulphide abundances (up to 10%) occurred between 212.50-217.80 m (within the assay-defined ore zone) with most sulphides occurring along shears and veins. A new methodology that this study will assess is the use of ITRAX in assessing whole-rock trace element abundances in gold ore and surrounding material. The rationale behind using the ITRAX is to determine the reliability of the pathfinder relationship between As and Au at an intermediate mm-scale, this relationship is well established at m-and nm-scales (e.g. (Craw et al. 2007; Vikentyev 2015)) but there is a dearth of investigations into the mm-scale (whole-rock). Work with the ITRAX found that a count time of 50 seconds and a sampling interval of 0.5 mm allowed for accurate Au count distributions, this could accelerate the procurement of whole-rock assay data from core extracted during exploration programs since As can be measured at relatively rapid count times (10 seconds or less) and nicely denotes the ore zone. Scanning electron microscopy (SEM) was used to characterise the gold content of sulphides, either as invisible, lattice bound Au1+ or nano/micro-nugget Au0 and like the ITRAX, provide an indicative, qualitative measure of trace element abundances. Following qualitative analyses, laser ablation-induced coupled plasma-mass spectroscopy (LA-ICP-MS) has been employed to provide ppm concentrations within sulphides.

Over the last year and a half, investigations into sulphide trace element abundances have revealed that Macraes gold is both lattice-bound and nano/micro-nugget/particulate in nature. Most importantly, the higher the arsenic content, the rarer the nuggets, this was likely the manifestation of the Au1+ – As relationship detailed in Reich et al. (2005). Sulphides associated with structures were also found to be richer in gold than disseminated examples. An example of note was that of an arsenian pyrite (apy) and arsenopyrite (aspy) situated next to each other that when ablated showed little change in gold concentrations when passing from the apy to the aspy, despite the concentration of As increasing by two orders of magnitude. This and the reduction in As near nugget gold suggests that the gold-arsenic relationship is not perfect and assaying should go beyond a handheld XRF. The data from the LA-ICP-MS at the single-sulphide scale has been plotted with assay and depth data in Figure 1 showing that this study could form the basis for expanding exploration footprints of individual ore shoots within larger structures, such as the HMSZ.

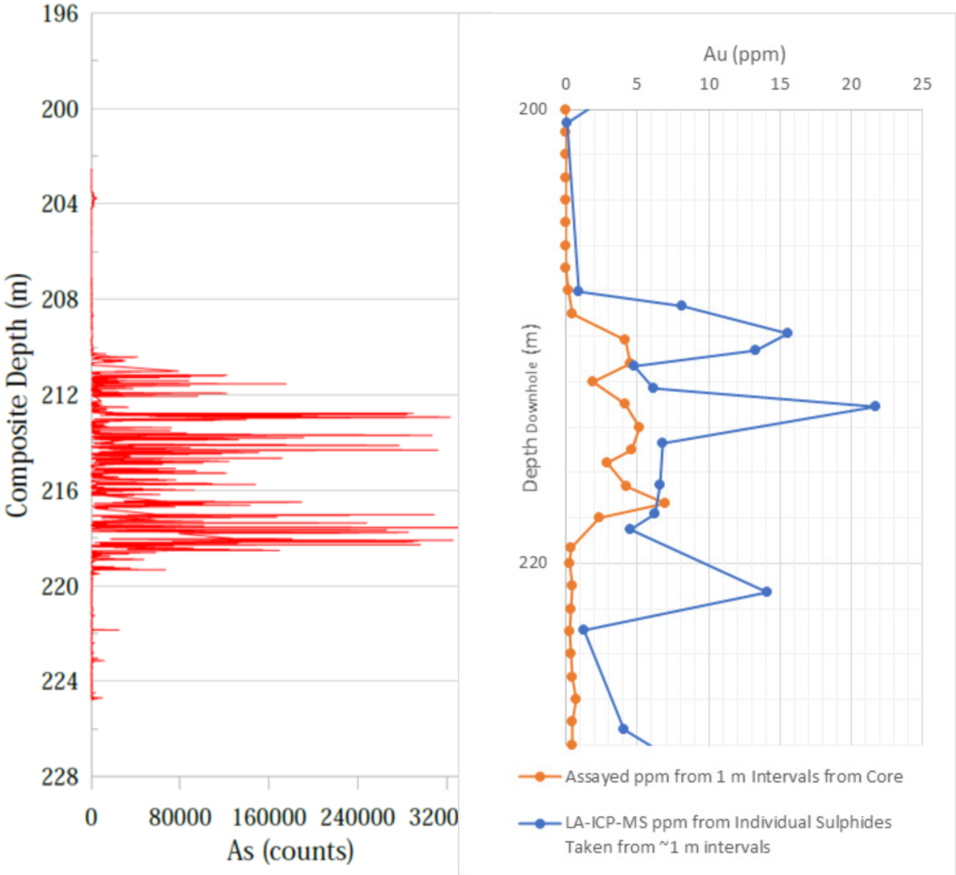

Figure 1 – (Left) ITRAX-derived As counts scanned from the same material as in the depth and ppm concentrations plot (right) with the expanded exploration footprint from LA-ICP-MS, with greater sampling from shallower and deeper material, this footprint could be more reliably extended. Also note how the ITRAX As matches with the Au assay data, suggesting that there is potential for ITRAX as a rapid, non-destructive assay method.

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Taranaki GS Field Trips Report

April 2019 - March 2020

From 12th April 2019 to March 2020, TGS has run 6 Field Trips. Numbers attending ranged from 3 to 11.

12.4.19

Todd Energy oil well drill site at Mangahewa, Tikorangi. 8 attended. 2 hours on site, appropriately dressed, shown round by many staff. A 'walking' rig moves to next drill site when completed, only 8 metres away. 24 hours a day running.

July 2019

Mt Egmont, east and south sides.
4 TGS members, leader Jonathon Proctor, Annika and daughter (7). 1sr site was East Egmont carpark with an overview of the mountain's profile. Down the road, 2 sections showed pyroclastic deposits of the Manganui, Inglewood and Kaupokonui tephras. These sections demonstrated that there could have been up to 15 cone collapses. The last stop at Kaupokonui Beach has excellent exposures of tephra layering from earliest to latest. Thankyou Diane, for organising this informative Field Trip.

11.8.19

Waverley, Waihi beaches. 5 TGS members, Leader Kyle Bland assisted by Angela GSNZ. At the 1st site, we observed shell beds wedged between sea floor sands and mud. Kyle encouraged us to deduce the history of events from what we could see – (a tightly-packed shellbed and its base with a sharp distinct surface, the species within the shellbed and their distribution, sandy mudstones, burrows, plant roots, the depth of deposition of the sandy muds) - a change from deep water conditions to a beach environment and back to deep water. These global sea level changes represent changes in the 40,000-year glacial-interglacial cycles, deposited in the Pliocene. The 2nd site was at Waihi Beach where we looked at the boundary of lower muddy sandstone and a shell-packed loose sandstone. The 125,000-year- old vertical shells have burrowed into the sediments below, that was sea floor 3.5 mya.

21.9.19

13.30 – 15.00. Followed Colleen's 'N.P. Geological Walk' from **Richmond Cottage up to end of Cathedral**. Sunny. 11 participants. Open to public. (Advertisements in Fitzroy Community Board & Facebook) Leader, Colleen. Assistant, Steve Thorstensen.

Sat Nov. 9th/Sun Nov.10th

overnight **Bushy Park**. (Was an official TGS FT., cancelled then reinstated)
3 participants. Mr Keith Beautrais, Whanganui, led a guided walk, discussed marine terraces and Brunswick formation. Sediments have been laid down by glacial and interglacial cycles. Nukumaran limestone shell beds are exposed in accessable road cuttings approaching Bushy Park.

7.12.19

Day trip to **Waitotara** to collect ventifacts from private farm. 3 attended from TGS., 4 from our host Taranaki Lapidary and Mineral Club.
Most ventifacts are covered by pasture but are easily located and then dislodged. About an hour was sufficient to collect and reject a good number, then after lunch, we headed to the Waitotara river mouth to see the drowned totara stumps. There are numerous outcrops of shell rock in the general area, as well.

9.3.20

Hector's Day.
Picnic at Wai-iti Beach, rained off.

Oil and Gas SIG

I was very pleased to see we now have a new convenor for our Oil and Gas Special Interest group. Mac Beggs is a great person to fulfil this role having been around the industry for many years as well as spending time in GNS as Manager Geoscience Research and now being a Consultant Petroleum Geologist in his own right.

Understanding the Oil and Gas industry and all the complexities of the corporate world that intertwine earth science, economics and government control, with company policy, is vital for all of us in this time of massive change which many see as too difficult to comprehend and get their head around. Especially when we are told that Oil and Gas is a "sunset industry" and it is time for us to move on and change our energy habits. Buy electric vehicles, use less plastic and reduce your fly miles.

Personally, I am upset we are regarded as riding into the sunset, and that the Oil and Gas industry is doomed.
I cannot agree with that. In fact we need to explore for, and develop new Oil and Gas resources to satisfy our anticipated energy use for quite some years yet. Like many others who really understand the total picture, we were very upset when our government scuppered the exploration industry two years ago. It was the wrong decision. I believe there is a good chance we could discover more vitally needed gas especially in our deepwater basin regions. Many agree with me.

Lets hear more about this in the near future within our new SIG group. It will be interesting to see and read contributions. And do support Mac Beggs proposed Petroleum SIG session at our forthcoming Petroleum Conference at Christchurch this year. Get involved, understand whats going on, and ask questions.

Don Haw
(ex BP, SIG Convenor and Todd Corporation)

New GSNZ ECR SIG

Early Career Researcher SIG

Yes, not only do we win the prize for being the newest SIG on the block, but we also win the prize for the SIG with the most acronyms(+initialisms) in our name. The newly formed Geoscience Society of New Zealand (GSNZ) Early Career Researcher (ERC) Special Interest Group (SIG) had its first official meeting on the 17th August 2020 via an online platform (ok, it was zoom).

Formed and chaired by Dr Jenni Hopkins (VUW) the group brought together ECRs from a range of institutes across the country (UoA, VUW, UoO, UW, GNS, NIWA) to discuss the ways in which GSNZ could support, and be supported by, our ECR community.

Our SIG page on the new GSNZ website is now up and running, and soon we hope it will include a link to message boards on various important ECR related topics, such as constructing funding proposals, publishing, collaborations, projects, jobs, lecturing etc.

Following our productive first meeting, the group lobbied the National Committee for better representation of ECRs on the branch committees and more unambiguous inclusivity for ECRs in the current awards and grants on offer. We also proposed a ECR development fund, which will be discussed early next year, and potentially a cost reduction for ECRs at the next (2021) annual conference. The hope is this will encourage attendance for unfunded ECRs, allowing them to maintain national contacts and network with the New Zealand Geoscience community. We hope our next meeting will be in person at GSNZ conference in Christchurch 2020 and will have a more social theme.

If you identify as an ECR please sign up to the ECR SIG through your profile on the GSNZ website (-> subscriptions -> SIG: Early Career Researcher)– its FREE – and we would love to increase our number with a range of ECR scientists. We promise not to spam you with lots of emails, just the odd important document, deadline, social event or item of interest.

Jenni Hopkins (Convenor)
jenni.hopkins@vuw.ac.nz

New Zealand wide model 2.2 seismic velocity and Qs and Qp models for New Zealand

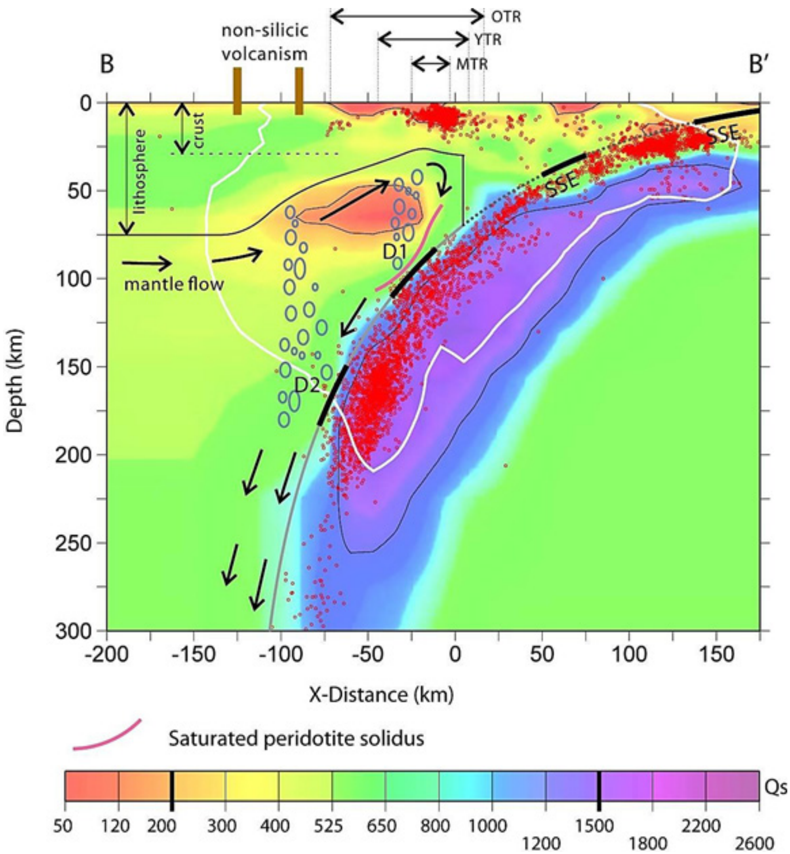
Donna Eberhart-Phillips, Stephen Bannister, Martin Reyners, Stuart Henrys
GNS Science

In 2010, we published a New Zealand wide seismic velocity which has been used by many researchers, for locating earthquakes, for defining rheology in modelling slow slip, and as a regional initial velocity model in more detailed seismic analyses. Since then we have completed several other local earthquake studies which have updated portions of the NZwide model. This notice reports the latest version. This also includes 3-D model of attenuation as parameterized by Q (1/attenuation).

New Zealand Wide model 2.2 has a seismic velocity model for New Zealand developed from local-earthquake tomography studies. It is updated, from nzwide2.1 (zenodo.org/record/1043558), to incorporate results from the western North Island (Eberhart-Phillips and Fry, 2017) and the southern Hikurangi Cook Strait region (Henrys, et al., 2020). The Cook Strait results were interpolated and merged into the NZwide model and then additional inversion including some Kaikoura aftershocks was carried out to assure the model is appropriate for regional use.

The Qp model 2.2 is updated from Qpnzw1 (Eberhart-Phillips et al., 2015), to incorporate results from the eastern North Island (Eberhart-Phillips et al., 2017) and southern South Island (Eberhart-Phillips et al., 2018).

There has not been New Zealand wide Qs coverage until this year, and the NZwide 2.2 Qs model is the first complete Qs model. We are using the version name nzw2.2 to denote all the seismic property models since many applications require all the parameters. The Qs model 2.2 incorporates results from the eastern North Island (Eberhart-Phillips et al., 2017), western North Island and mantle wedge (Eberhart-Phillips et al., 2020), northern South Island (Eberhart- Phillips et al., 2014), and southern South Island (Eberhart-Phillips et al., 2018). The models are provided in tables, where the Spread Function (SF) shows the resolution, such that where SF<4, there is little information.



The figure shows a cross-section of Qs across the North Island, illustrating the high attenuation in the mantle wedge beneath the super-volcanoes of the Taupo Volcanic Zone, with seismicity as red circles. Between shallower eastern slab and overlying plate, the weak decoupling zone has aseismic slip (dotted), slow- slip (SSE), and locked zones (further offshore). Under the volcanic arc, the subducting plate is coupled to overlying asthenosphere producing mantle corner flow and releasing fluid, as shown schematically (blue ovals) for zones D1 and D2, which ascends in reactive porous flow and evolves partial melt.

References:

Eberhart-Phillips, D., S. Bannister, and M. Reyners (2017), Deciphering the 3-D dis tribution of fluid along the shallow Hikurangi subduction zone using P- and S-wave attenuation, Geophys.J Int., 211, 1032–1045, doi:doi.org/10.1093/gji/ggx348.

Eberhart-Phillips, D., S. Bannister, and M. Reyners (2020), Attenuation in the mantle wedge beneath super-volcanoes of the Taupo Volcanic Zone, New Zealand, Geophys. J. Int., 220, 703-723, doi: 10.1093/gji/ggz455.

Eberhart-Phillips, D., and B. Fry (2017), A new scheme for joint surface wave and earthquake travel-time inversion and resulting 3-D velocity model for the western North Island, New Zealand, Phys. Earth and Plan. Int., 269, 98–111, doi:10.1016/j.pepi.2017.05.014.

Eberhart-Phillips, D., M. Reyners, and S. Bannister (2015), A 3-D Qp attenuation model for all of New Zealand, Seis. Res. Lett., 86, 1655-1663, doi:10.1785/0220150124.

Eberhart-Phillips, D., M. Reyners, P. Upton, and D. Gubbins (2018), Insights into the crustal structure and tectonic history of the southern South Island, New Zealand, from the 3-D distribution of P- and S-wave attenuation, Geophys. J . Int., 214, 1481-1505, doi:10.1093/gji/ggy194.

Eberhart-Phillips, D., S. Bannister, and S. Ellis (2014), Imaging P and S attenuation in the termination region of the Hikurangi subduction zone, New Zealand, Geo phys. J . Int., 198, 516-536, doi: 510.1093/gji/ggu1151.

Henrys, S., D. Eberhart Phillips, Bassett, D., Sutherland, R., Okaya, D., Savage, M., et al. (2020), Upper plate heterogeneity along the southern Hikurangi Margin, New Zealand, Geophys. Res. Let., 47, e2019GL085511., doi:10.1029/2019GL085511.

CONGRATULATIONS to Carolyn Boulton

Martha Savage
martha.savage@vuw.ac.nz

Victoria University of Wellington's new Lecturer Carolyn Boulton has received the prestigious **Jason Morgan Early Career Award** from the Tectonophysics section of the American Geophysical Union.

The Jason Morgan Early Career Award is presented annually to an early career scientist for outstanding and significant contributions to tectonophysics through a combination of research, education, and outreach activities. Successful nominees are no more than six years past the completion of their Ph.D. or highest terminal degree by the nomination deadline.

This international award has been given every year since 2009 and Carolyn is the first recipient from New Zealand. Previous recipients have been from the USA, Europe, Australia and Japan.

Citation from the nomination letter:

Dr. Boulton is "an exceptional, multi-talented tectonophysicist who has made significant contributions to our knowledge of the processes that generate earthquakes... Dr. Boulton is innovative in integrating diverse scientific data including experimental, field, petrological and geophysical data sets to generate key advances in understanding chemical-mechanical interactions during—and after—fault slip. "

The announcement is here:https://eos.org/agu- news/2020-agu-section-awardees-and-named- lecturers?utm_source=eos&utm_medium=email&utm_term=sections&utm_ca mpaign=093020

Warm GSNZ welcome to NEWSLETTER EDITOR JANIS RUSSELL

Kia Ora,

I'd like to take this opportunity to introduce myself as your soon-to-be editor of the GSNZ Newsletter. Glenn has already indicated his intention to step down from the role and I have agreed to take on this new challenge beginning with the first newsletter of 2021. He certainly has done a stellar job and I aim to uphold the high standard he has set and eventually add a few touches of my own.In the meantime, I'll get the ball rolling by sharing a bit about me with the hope of getting to know many more of you over the coming months/years.

Firstly, I am a Scottish-born Kiwi who is passionate about the natural world. I like to get 'hands on' in wild places, to indulge my love of rock, whether dangling from the end of a rope on a vertical rock face, or armed with my camera — always striving to capture an expansive landscape as well as its exquisite intimate details.
I have been a member of GSNZ, albeit inactive, on and off for the past 6 years.
My introduction to geosciences began when I enrolled, extramurally, for a B.Sc. in Physical Geography, from Massey University. It was there that I deepened my appreciation for Earth Sciences both as the fundamental basis for life and the systems-level thinking they engender. This interconnectedness is reflected in an undergraduate degree that is liberally peppered with papers from across the natural science fields, including Zoology and Ecology, as well as from other disciplines.

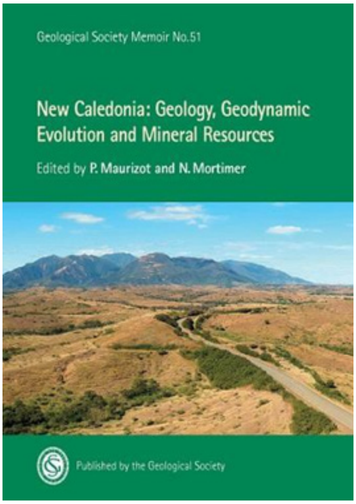
More recently, I undertook postgraduate study in Science Communication, at the University of Otago, which allowed me to explore and expand these wider connections. The study culminated in the creation of a substantial project informed by my research into geotourism as a vehicle for science communication. As a result, I graduated with a Master of Applied Science (Science in Society) for "Murihiku Rugged Rocks Geotrail"— an interactive, multimedia e-book on the geology of The Catlins. On a more personal note, I have three adult children and two pre-school grandchildren. The older of the two has already started her own rock collection and asks lots of interesting questions to keep me on my toes. In my spare time, if there is such a thing, you can most likely find me pursuing photography, running, tramping, listening to music, catching up on writing projects, or searching for elusive Scottish ancestors. My partner and I have had the privilege of spending up to six months at a time, every few years, in my original homeland. There, the denuded landscape speaks volumes to me. The idea, of reaching across the great expanse of geological time merely by placing my hand on an outcrop of 3-billion-year-old Lewisian gneiss, still thrills me. I'm full of gratitude for its abiding longevity thus allowing me the opportunity to undertake such a feat.
In a year that has been far from kind to us I am also very grateful for the opportunity to play a far more active role within the GSNZ community. I will be attending the upcoming conference in November, where I hope to meet some of you, in person, so don't be shy— come and say hello!

Ngā mihi, Janis Russell

BOOK ANNOUNCEMENT

All you ever wanted to know about New Caledonia

Nick Mortimer



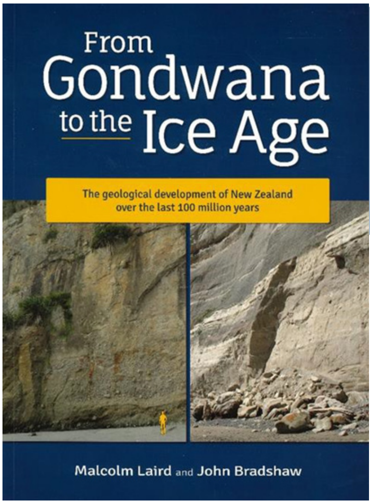
Earlier this year a memoir, five years in the making, was published by the Geological Society of London: Maurizot, P. and Mortimer,

N.(eds) 2020. New Caledonia: Geology, Geodynamic Evolution and Mineral Resources. Geological Society London Memoir 51. 285 pp. https://doi.org/10.1144/M51

New Caledonia is the main emergent part of northern Te Riu-a-Māui / Zealandia. It occupies only about 18,000 sq km - about the same area and elongate shape as the Northland Peninsula and Greater Auckland combined. Grand Terre and the Loyalty Islands have a diverse geology including an overthrust ophiolite, ultra high-pressure metamorphic rocks, Permian-Cretaceous Gondwana terranes, and Cenozoic intraplate basalts. One of the world's major lateritic nickel deposits - important to New Caledonia's economy - has developed on the ultramafic rocks of the ophiolite. The memoir summarises the current knowledge of New Caledonia's geology, geodynamic evolution, and mineral resources. It was conceived by Pierre Maurizot, New Caledonia's pre-eminent field geologist, and co-edited by Pierre and by Nick Mortimer. In 10 chapters, the memoir's 28 authors address pre-Late Cretaceous basement terranes, Late Cretaceous to Eocene cover, the Eocene subduction-obduction complex, the Loyalty Islands and Ridge, the post- obduction Neogene assemblage, paleobiogeography, mineral resources, and SW Pacific geodynamic models. The memoir supersedes a 39-year-old French volume on the same topic. It is hoped the new memoir will be the 'go-to' reference on New Caledonia geoscience for many years to come.

Book Review

From Gondwana to the Ice Age



by Malcolm Laird and John Bradshaw

Matthew W. Sagar , m.sagar@gns.cri.nz and Mark J. F. Lawrence, GNS Science, Lower Hutt

The subtitle of From Gondwana to the Ice Age, "The geological development of New Zealand over the last 100 million years", accurately encapsulates the content of the book. Over 294 pages, the book provides a comprehensive account of the geological history of Te Riu-a-Māui/Zealandia as recorded in the Cretaceous–Cenozoic sedimentary basins.

The book starts by outlining the scope, major sources of information, conventions and rationale for things such as stratigraphic units and geographic names, and the long history of the book. By 2008 Malcolm had written the bulk of the manuscript, drawing on his own expert observations and interpretations, and the large number of studies exploring different aspects of outcrop, subsurface, and ocean floor geology through geological, geophysical and geochemical means. Due to a variety of reasons, both related and unrelated to the manuscript, the book remained unpublished at the time of Malcolm's sudden and untimely death in 2015. Fortunately, John had agreed in the months prior to help Malcolm finish the book and, subsequently, has honoured this commitment by generously spending considerable time and effort in his retirement to make essential updates and improvements to ready the manuscript for publication.

Following the Introduction, the book is divided into nine chapters, starting with three providing overviews of basin stratigraphy and evolution, and basement geology. Each of chapters four, six and eight are each dedicated to the three major unconformity-bound assemblages previously outlined, starting with the mid-Cretaceous extension assemblage. Interspersed, in chapters five and seven are tectonic summaries of the Cretaceous–Paleogene and Miocene– Pliocene. Chapter nine deals with global and regional events recorded in the sedimentary successions, such as the K–Pg extinction and the Marshall Paraconformity.

These chapters are where the value of the book lies. Several important topics are explicitly addressed, including the age of the oldest cover rocks and the timing of mid-Cretaceous Gondwana margin subduction termination. Chronostratigraphic diagrams help in visualising the relationships between the numerous stratigraphic units and serve to break up the text. Although, some of the lengthy descriptions and interpretations would have been helped by the addition of summary diagrams, but this is to some extent alleviated by the concise and well-written prose.
The book would have also benefitted greatly from a full suite of Cretaceous–Neogene paleogeographic maps at key time points (e.g., late Oligocene–early Miocene).

However, such reconstructions, especially those beyond the late Eocene, have proven problematic over many years for the wider New Zealand geological community and are the subject of current concerted effort at GNS Science led by Hannu Seebeck and Dominic Strogen. While 16 colour plates (e.g., photos key units in outcrop) appear at the front of the book, it would have been nice to see similar plates dispersed throughout the text. Nevertheless, these are minor issues as overall the book is logically arranged, uses several levels of well-chosen sub-headings, has a comprehensive and easy-to-read table of contents, and provides good locationinformation and an index, all of which make it quick and easy to find information of interest.

The book is highly recommended reading for anyone needing a knowledge and understanding of the geological evolution of Te Riu-a-Māui/Zealandia for research, resource exploration, and/or teaching—namely postgraduate students, resource industry geologists, and university and Crown Research Institute geoscientists. The technical nature of the book means it is not well suited to the general public.

Bibliographic details

Laird, M. and Bradshaw, J. D. (2020), From Gondwana to the Ice Age: The geological development of New Zealand over the last 100 million years, 294 pp., Canterbury University Press, Christchurch, New Zealand, ISBN 9780908812981

OSGS Southland Trip 2020

On the 29th and 30th of August 2020, OSGS departed Dunedin for Southland. The first stop on our trip was the Curio Bay Petrified Forest in the Catlins. The petrified forest is located on a rocky shore platform made up of Jurassic volcanic sediments and silicified tree stumps, logs and leaves from when New Zealand had a much more tropical climate. Bands of ancient vegetation are well preserved in the cliffs and indicate several periods in time where the forest was swept away by volcanic debris. Further southward, we arrived at Slope Point, the southernmost point of mainland New Zealand, known for its terrible weather and trees that are blown almost horizontal from the wind. A great section of the southern extent of the Southland Syncline outcrops at Slope Point and shows an interesting cross section of alternating beds of sandstone and conglomerate.

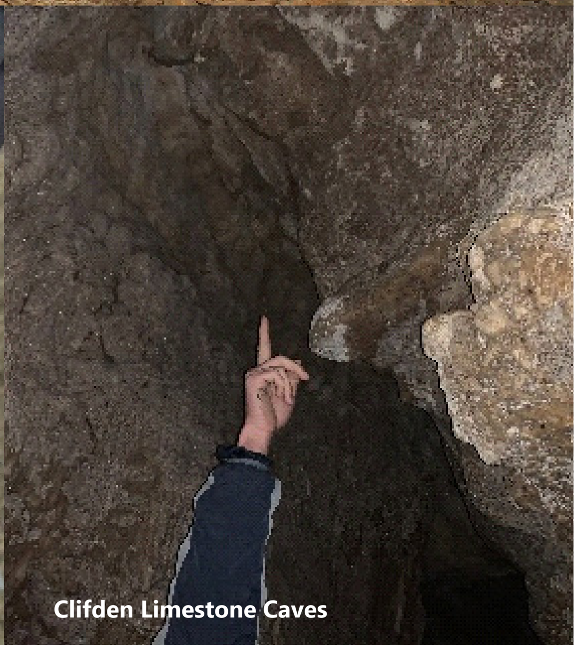
We travelled through Southland along the coast, through Riverton and Orepuki to Te Waewae Bay. Gemstone Beach is an incredible, high energy beach on eastern extent of Te Waewae Bay where ‘gemstones’ such as hydrogrossular garnets, jasper, epidote and sometimes even sapphires are washed up.

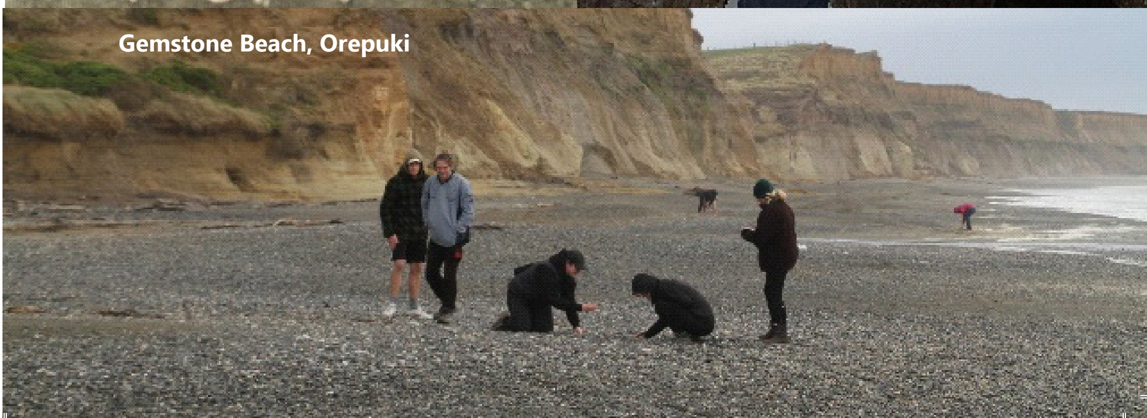
After staying overnight in Tuatapere, we drove north to the Clifden Limestone Caves. The caves were formed during the Miocene when the area was submerged beneath a shallow sea. Calcium carbonate from shell remnants is dissolved by acidic groundwater, forming the cave system and impressive stalactites and stalagmites. Glow worms and endemic Weta are also found in these caves.

Our last stop was the Forest Hill Scenic Reserve where there are incredible views of the Hokonui Hills and the Southland Syncline from central Southland all the way to the east in the Catlins.

OSGS is immensely grateful to GSNZ for sponsoring our trip, we had an amazing time and learnt a lot about the awesome geology of Southland.


Slope Point


Clifden Limestone Caves


Gemstone Beach, Orepuki

16TH BIENNIAL MEETING

SGA 2021

THEME

THE CRITICAL ROLE OF MINERALS IN THE CARBON NEUTRAL FUTURE

The meeting will feature presentations on topics related to mineral deposit research, exploration, sustainable development and environmental and social aspects related to mineral deposits.

WHEN

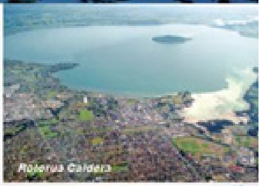
15 – 18 November 2021, plus pre- and post- conference field trips and short courses.

WHERE

Rotorua Energy Events Centre in Rotorua, New Zealand.

WHO SHOULD ATTEND?

Delegate representation includes academia, industry, government research organisations, consultants and service providers.



KEY DATES

Call for Field trip & Short Course Submissions	Deadline 2 November 2020
Call for Abstracts	Opens 2 November 2020
Pre-Early Bird Registration	Deadline end December 2020
Online Registration	Opens April 2021

FOR MORE INFORMATION CONTACT CONFERENCES & EVENTS LTD
sga2021@confer.co.nz | www.sga2021.org

16th SGA Biennial Meeting 2021

The critical role of minerals in the carbon-neutral future

15-18 November 2021

ROTORUA

Here is the link
to the conference website:
https://confer.eventsair.com/sga2021/

Geoscience Society of New Zealand

GEOSCIENCE QUIZ 32

by Aenigmatite

Geoscience and music

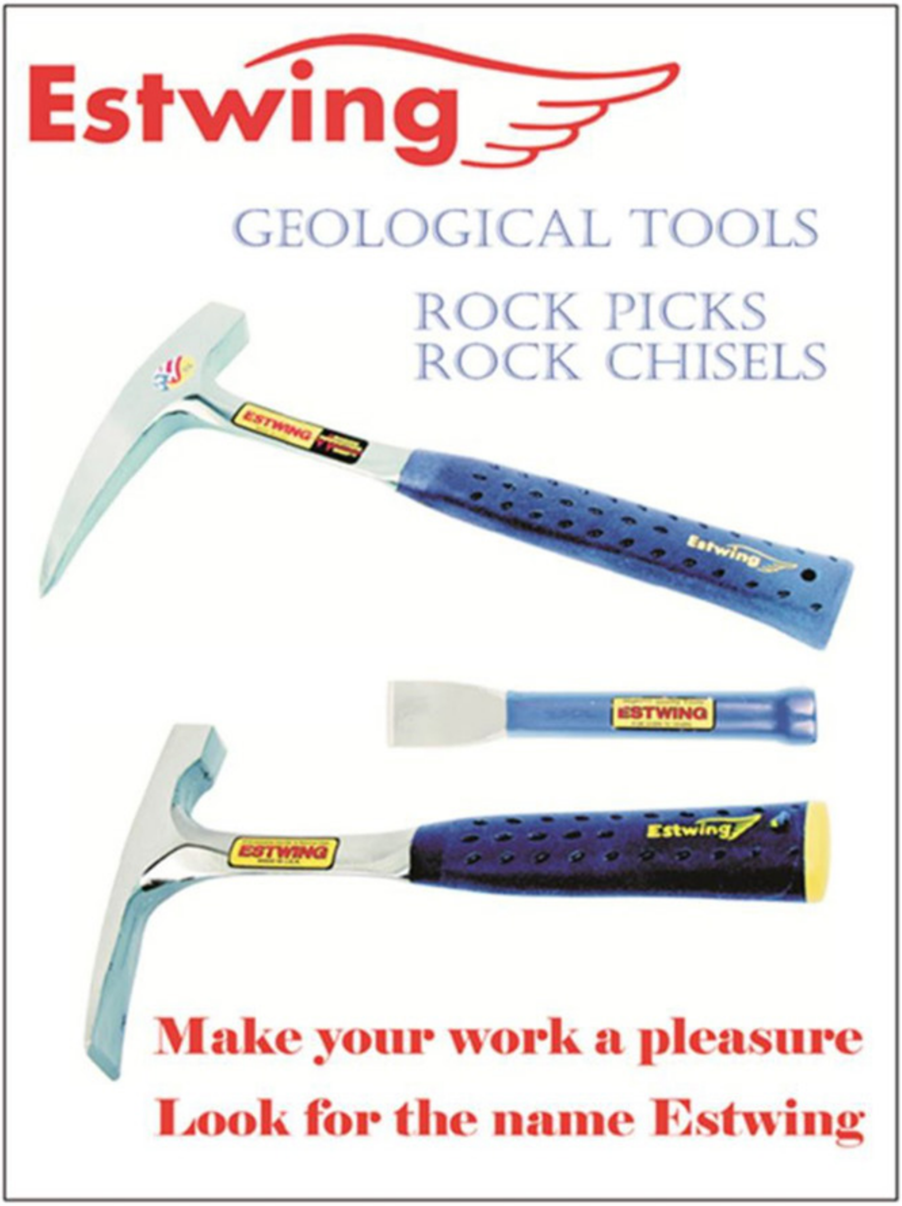
Whenever it's played, the Hebrides overture or Fingal's Cave by Felix Mendelssohn generates images of columnar basalt and supercontinent breakup in Aenigmatite's mind.
And this delightful Youtube video: https://www.youtube.com/watch?v=trTDTCixA_c (h/t Marco Brenna) is worth a minute of anyone's time.

Below are some tenuous examples of geoscience enshrined in 20th century popular music.

Can you connect these songs with their performers?

Diamonds are a Girl's Best Friend	Carole King
I am a Rock	Dolly Parton and Kenny Rogers
I Feel the Earth Move	Doobie Brothers
Islands in the Stream	John Denver
Livin' on the Fault Line	Johnny Cash
Papa was a Rolling Stone	Marilyn Monroe
Ring of Fire	Simon and Garfunkel
Rocky Mountain High	Temptations
White Cliffs of Dover	Vera Lynn

Diamonds are a Girl's best friend - Marilyn Monroe
I am a Rock - Simon and Garfunkel
I feel the earth move - Carole King
Island in the Stream - Dolly Parton and Kenny Rogers
Livin'on teh fault line - Doobie Brothers
Papa was a Rolling Stone - Temptations
Ring of Fire: Johnny Cash
Rocky Mountain high - John Denver
White Cliff of Dover - Vera Lynn


Estwing
GEOLOGICAL TOOLS
ROCK PICKS
ROCK CHISELS
ESTWING
Estwing
Make your work a pleasure
Look for the name Estwing

PHOTOCOMPETITION 2020

Photocompetition for all geoscientists

All members of the Geoscience Society of New Zealand were invited to show off their photographic talent. The competition was split into three categories to commemorate the centennial of Milutin Milanković's astronomical theory: Théorie mathématique des phénomènes thermiques produits par la radiation solaire.

The categories are:

- **Milankovich: Geological Cyclicity**
- **Macro- and micro-scale geoscience**
- **New Zealand Geoscience**

WINNER in the category: Geological Cyclicity

Rewanui Conglomerate by Tim Moore
Interbedded sandstone and conglomerate of the Cretaceous Rewanui Formation, West Coast, South Island

WINNER in the category: Macro- and micro-scale geoscience

Bromo National Park by Bambang Achmad, East Java, Indonesia in 2015

WINNER in the category: New Zealand Geoscience

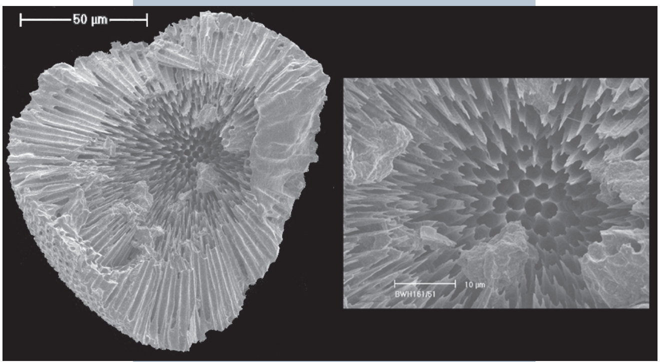
Te Mari Fumarole by Murray Baker, Te Mari Upper Crater Fumarole, Tongariro, 2020

PHOTOCOMPETITION RUNNER UPS 2020

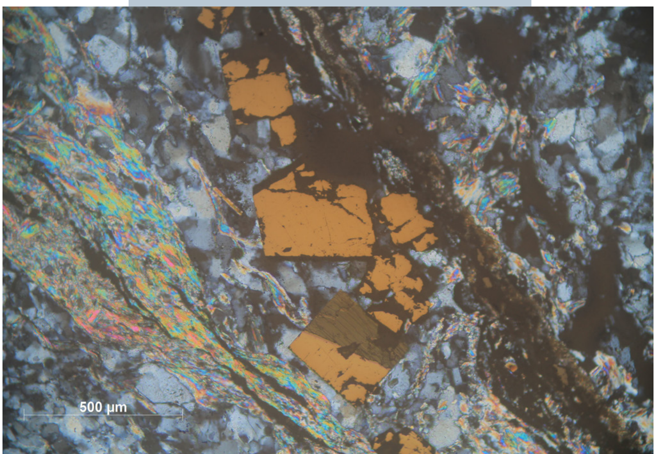
Geological Cyclicity

Glacial meltwater,
by Glen Uig W. Lewis,
2016

Macro- and micro-scale geoscience



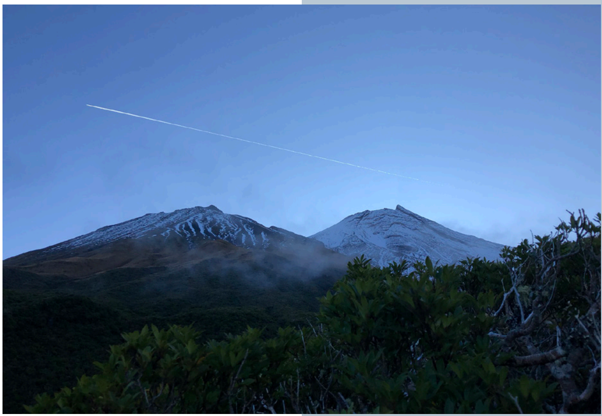
Geodiidae
sponge sterraster



Sulphite

Coreful

Dragonfence



Mt Taranaki

Retirement of Professor Peter Kamp

University of Waikato

Cam Nelson and David J. Lowe
campbell.nelson@waikato.ac.nz;
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Petrus Johannes Jozef Kamp, or simply Peter Kamp to his many friends and colleagues, retired on 30 June 2020 after 43 years on the Earth Sciences academic staff in the School of Science at the University of Waikato. Out of Edmund Rice College high school in Rotorua, Peter came to Waikato University in 1972 to undertake a BSc degree in Earth Sciences, and followed this up in 1975 with MSc research on the stratigraphy, sedimentology and paleoenvironments of the Pleistocene conglomerates and associated tuffaceous and fossiliferous mudstone deposits spectacularly exposed along the Kidnapper's cliff section on the south coast of Hawke Bay between Clifton and Black Reef (Kamp 1978). After being made a Junior Lecturer in Earth Sciences in 1977, he completed his MSc degree and soon after embarked on a novel PhD study for the day, soon after the 'birth' of plate tectonic theory, of attempting to unravel the Cenozoic tectonic development of New Zealand in the southwest Pacific region (Kamp 1984). During his PhD, in 1980, Peter applied for and won a tenured Lectureship in Earth Sciences, and thereafter over the years he rose quickly through the academic ranks to become a full Professor in Earth Sciences in 1999.

Peter's teaching role over more than four decades covered mainly the fields of stratigraphy, sedimentology, structure/tectonics, sedimentary basin analysis and petroleum geology at second and third year undergraduate (BSc) and post- graduate (MSc) levels. His extremely wide personal knowledge of New Zealand geology enabled him to bring these topics alive through his many own field and research experiences, with well-illustrated examples in lectures and 'real-world' New Zealand practical exercises in laboratory classes. Perhaps Peter's most persuasive teaching contribution was during the many dozens of field trips and field courses that he was associated with or led to places like the Port Waikato, North Taranaki, Hawke's Bay and Whanganui regions. He always emphasised the need for both appreciating and documenting in detail the nature, context and relationships of rock units in the field, before returning to the analytical 'black boxes' back in the laboratory. For many students it was Peter's field tuition that provided the catalyst for cementing their interest to pursue geological science as a profession and for going on into MSc and/or PhD research programmes. He was Chief Supervisor of 57 completed MSc theses and 11 PhD theses, and a second supervisor in numerous other completed theses in Earth Sciences.

Peter's standout contribution in the School of Science over at least the past 25 years or so has undoubtedly been in establishing and leading very substantial research groups and in attracting very significant funding to support them. In this time, through extremely hard work, discipline, will power, and his strong ability to develop and convey ideas effectively in writing and orally, he has attracted about $25 million of research funding from both contestable government (e.g. FRST, MBIE, MSI) and private sources, a record for any academic at the University of Waikato. The funding allowed Peter to supervise numerous post- graduate students and early-career researchers, to mentor them and employ some, and to provide opportunities for them to advance their careers and ultimately take up positions in academia, geological surveys and geo-resource industries, both in New Zealand and overseas.

Peter established and led two contrasting research groups at Waikato. The first, 'The Sedimentary and Petroleum Geology Research Group', was established in 1994 and encompassed his personal principal geological research interests of understanding the exhumation history in orogenic belts, and the thermal history and stratigraphic architecture and fill of sedimentary basins. It involved projects in the fields of geochronology, low-temperature thermochronology by U-Pb, fission track and U-Th/He dating methods, stratigraphy (including sequence stratigraphy), sedimentary geology (including basin analysis) and tectonics, many of which were of particular relevance to petroleum exploration companies active in New Zealand with whom Peter had longstanding interaction. To achieve innovative goals in these fields, Peter developed new research facilities and instrumentation at Waikato, including a laboratory for fission-track dating and for U-Th/Helium dating, one of only ten globally that produce credible results. This work led to strong links and active research interaction and joint projects with collaborators in leading overseas geoscience groups and institutions, notably in China, but also in USA (Penn State), Germany (Tubingen, Bremen Universities) and UK (Durham University).

Peter's second research group, 'The Industrial Energy Efficiency Research Group', was established in 2003 and led by him until 2017. While the theme was outside his immediate research area of expertise, the effort demonstrates his willingness to take research risk, to have the confidence to step into a different discipline area (engineering), to apply sound science leadership skills, and to work with and motivate emerging researchers. The initiative helped the development and research recognition within the School of Engineering at Waikato in the area of industrial energy efficiency, ensuring that it achieved impact for the New Zealand industry processing sector, particularly in dairy processing capacity, energy efficiency and greenhouse gas emissions reduction. Notably, apart from a few instances, Peter did not add his name to the many publications arising from the Energy Efficiency Group because he was 'not an engineer'.

To date, Peter has authored or co-authored 125 refereed journal articles and book chapters, including papers in Nature (e.g. his very first publication was in 1980 during his PhD research; Nature 288:659-664), Science, PNAS, and JGR, 28 refereed conference proceedings papers, and 19 substantive technical reports. Since about 2006, most of the latter have been published as New Zealand Petroleum Reports (PRs) with the Ministry of Economic Development (Crown Minerals) in order to make the vast amount of information and data arising from his 'sedimentary' research group available to others in a timely manner. For example, the Kamp et al. (2015) Petroleum Report PR4885 (http://hdl.handle.net/10289/9286), 335 pages long, presents a robust model of the Cenozoic evolution of the modern plate boundary system through New Zealand, accompanied by paleogeographic maps depicting the changing topography and basin development in the New Zealand region in 1 million year steps for the last 65 million years. It is also noteworthy that Peter has been a co- author on two of the excellent QMAP geological bulletins (Taranaki, Hawke's Bay) published by GNS Science. Incredibly, Peter is currently seeing through to final publication no fewer than 26 geological maps at a scale of 1:50,000 from the pioneering and very detailed stratigraphic studies and mapping he and his students have undertaken in the Whanganui, Taranaki, King Country, and Hawke's Bay basins.

Outside of Earth Sciences at Waikato, Peter has made substantial contributions to a number of University of Waikato committees, including the Academic Board, the Honours Committee of the University Council, the University Research Committee, and the Library Committee. In these administrative roles Peter was always extremely well prepared, articulate, and supportive, carrying with him an unwavering ethos of respect for the people around him, but at the same time being unafraid to speak out when he felt that was needed. He served as Deputy Dean in the Faculty of Science and Engineering from 2001–2007, and was for 15 years (1992 - 2007) Associate Dean (Research) in the Faculty. In this capacity he had the onerous task of running the first two rounds of PBRF assessment for the Faculty. Wider afield, Peter has a record of service on competitive research funding panels both in New Zealand (e.g. Marsden, FRST, Energy and Minerals Advisory group, National Energy Research Institute) and abroad (e.g. European Science Foundation), and in journal editorial roles (e.g. NZJGG, Island Arc journal). He has held Visiting Fellow/Professor positions for short periods at each of the University of Melbourne (1986/7 and 1992/3), Kyoto University (1993), the Free University of Amsterdam (1997), and Utrecht University (2015). He is an active member of the Geoscience (formerly Geological) Society of New Zealand (including having convened national conferences in 1988 and 2019, and led numerous conference field trips), the New Zealand Society of Soil Science, the Australasian Quaternary Research Association, the Geological Society of America, and the American Geophysical Union. Over the years Peter has received a number of awards, including (with Mark Tippett) 'Best Paper of the Year' in the journal Earth Surface Processes and Landforms (1995), a University of Waikato Staff Merit Award (1996), the prestigious McKay Hammer Award of the Geological Society of New Zealand (2002), and in 2017 Lifetime Achievement Awards from the Hamilton Science Excellence Awards Trust (Kudos) and the University of Waikato. Most recently, in the global citation analysis scheme developed by Ioannidis et al. (2019, https://doi.org/10.1371/journal.pbio.3000384), Peter was very highly ranked as lying within the top 1% of all researchers (almost 7 million) globally across all research fields, providing clear evidence of the major international impact his research has made in the geological sciences discipline.

A retirement function for Peter, attended by many present and past colleagues and research students, was held in the School of Science on Friday 26 June, a few days before his official retirement date. The accompanying photo shows the Dean of Science, Margaret Barbour, presenting Peter with a couple of farewell gifts: she holds a framed retirement certificate in which are embedded two large crystals of zircon and apatite, acknowledging Peter's research career interest in fission-track dating, while Peter holds a packaged drone he will use for capturing outcrop images in those otherwise inaccessible cliff rock exposures.

Having taken time to build and set up a brand-new office at home, it is very clear that Peter will continue to involve himself in his geological activities over the coming years. He has so much field and laboratory data tucked away in largely unpublished reports and in 'bottom drawers' that many more papers will be written 'part-time in retirement'. Also, at least until the end of 2020, he will continue to oversee the activities of remaining staff attached to his 'sedimentary group', and to assist with student supervision projects where applicable. Regrettably, at this stage it appears there is no planned replacement position for Peter, potentially leaving a huge gap in what has otherwise been a long-term and an extremely successful venture in Earth sciences at Waikato. On a brighter note, we can report that in late July the University of Waikato awarded Peter the honorary title of Emeritus Professor, a most thoroughly deserved accolade.

Selected publications

A selection only of six significant publications (with dois) involving Peter Kamp from within each of the four decades he has been on staff at the University of Waikato follows:

2019-2010 (selected six only)

Lang K, Ehlers TA, Kamp PJJ, Ring U. 2018. Sediment storage in the Southern Alps of New Zealand: New observations from tracer thermochronology, Earth and Planetary Science Letters. 493:140-149. https://doi.org/10.1016/j.epsl.2018.04.016

van de Lagemaat SHA, van Hinsbergen DJJ, Boschman LM, Kamp PJJ, Spakman W. 2018. Southwest Pacific absolute plate kinematic reconstruction reveals major Cenozoic Tonga-Kermadec slab dragging. Tectonics. 37:2647–2674. https://doi.org/10.1029/2017TC004901.

Lindow J, Kamp PJJ, Mukasa SB, Kleber M, Lisker F, Gohl K, Kuhn G, Spiegel C. 2016. Exhumation history of the Amundsen Sea coast, West Antarctica, revealed by low-temperature thermochronology. Tectonics. 35:2239-2257. https://doi.org/10.1002/2016TC004236

Kamp PJJ, Tripathi ARP, Nelson CS. 2014. Paleogeography of Late Eocene to earliest Miocene Te Kuiti Group, central-western North Island, New Zealand. New Zealand Journal of Geology and Geophysics. 57:128-148. https://doi.org/10.1080/00288.306.2014.904384.

Furlong K P, Kamp PJJ. 2013. Changes in plate boundary kinematics: Punctuated or smoothly varying – Evidence from the Mid-Cenozoic transition from lithospheric extension to shortening in New Zealand. Tectonophys ics. 608:1328-1342. https://doi.org/10.1016/j.tecto.2013.06.008.

Wang E, Kirby E, Furlong KP, van Soest M, Xu G, Shi X, Kamp PJJ, Hodges KV 2012. Two-phase growth of high topography in eastern Tibet during the Cenozoic. Nature Geoscience. 5:640-645. https://doi.org/10.1038/ngeo1538

2009-2000 (selected six only)

Furlong KP, Kamp PJJ. 2009. The lithospheric geodynamics of plate boundary trans pression in New Zealand: Initiating and emplacing subduction along the Hi kurangi margin, and the tectonic evolution of the Alpine Fault system. Tect onophysics. 474:449-462. https://doi.org/10.1016/j.tecto.2009.04.023

Kamp PJJ, Vonk AJ, Bland KJ, Hansen RJ, Hendy AJW, McIntyre AP, Ngatai M, Cart wright SJ, Hayton S, Nelson CS. 2004. Neogene stratigraphic architecture and tectonic evolution of Wanganui, King Country, and eastern Taranaki Basins, New Zealand. New Zealand Journal of Geology and Geophysics. 47:625-644. https://doi.org/10.1080/00288306.2004.9515080

Garver JI, Kamp PJJ. 2002. Integration of zircon colour and zircon fission-track zo nation patterns in orogenic belts: application to the Southern Alps, New Zea land. Tectonophysics. 349:203-219. https://doi.org/10.1016/S0040-1951(02)00054-9

Kamp PJJ. 2000. Thermochronology of the Torlesse accretionary complex, Welling ton, New Zealand. Journal of Geophysical Research. 105:19253- 19272. https://doi.org/10.1029/2000JB900163

Kamp PJJ, Liddell IJ. 2000. Thermochronology of northern Murihiku Terrane, New Zealand, derived from apatite FT analysis. Journal of the Geological Society, London. 157:345-354. https://doi.org/10.1144/jgs.157.2.345

Xu G, Kamp PJJ. 2000. Tectonics and denudation adjacent to the Xianshuihe Fault, eastern Tibetan Plateau: Constraints from fission track thermochronolo gy. Journal of Geophysical Research. 105:19231-19251. https://doi.org/10.1029/2000JB900159

1999-1990 (selected six only)

Kamp PJJ. 1999. Tracking crustal processes by FT thermochronology in a forearc high (Hikurangi margin, New Zealand) involving Cretaceous subduction termina tion and mid-Cenozoic subduction initiation. Tectonophysics. 307:313-343. https://doi.org/10.1016/S0040- 1951(99)00102-X

Naish TR, Kamp PJJ. 1997. Sequence stratigraphy of 6th order (41 ka) Pliocene-Pleis tocene cyclothems, Wanganui Basin, New Zealand: A case for the regressive systems tract. Bulletin of the Geological Society of America. 109:978-999.

Tippett JM, Kamp PJJ. 1995. Quantitative relationships between uplift and relief parameters for the Southern Alps, New Zealand, as determined by fis sion track analysis. Earth Surface Processes and Landforms. 20:153-176. https://doi.org/10.1002/esp.3290200206

Tippett JM, Kamp PJJ. 1993. Fission track analysis of the late Cenozoic vertical kine matics of continental Pacific crust, South Island, New Zealand. Journal of Geophysical Research. 98:16119-16148. https://doi.org/10.1029/92JB02115

Kamp PJJ, Green PF, Tippett J M. 1992. Tectonic architecture of the mountain front-foreland basin transition, South Island, New Zealand, assessed by fission track analysis. Tectonics. 11:98- 113. https://doi.org/10.1029/91TC02362

Kamp PJJ, Turner GM. 1990. Pleistocene unconformity-bounded shelf sequences (Wanganui Basin, New Zealand) correlated with global isotope record. Sedi mentary Geology. 68:155-161. https://doi.org/10.1016/0037- 0738(90)90125-D

1989-1980 (selected six only)

Kamp PJJ, Green PF, White SH. 1989. Fission track analysis reveals character of collisional tectonics in New Zealand. Tectonics. 8:169-195. https://doi.org/10.1029/TC008i002p00169

Kamp PJJ. 1987. Age and origin of the New Zealand Orocline in relation to Alpine Fault movement. Journal of the Geological Society, London. 144:641- 652. https://doi.org/10.1144/gsjgs.144.4.0641

Kamp PJJ, Nelson CS. 1987. Tectonic and sea-level controls on nontropical Neogene limestones in New Zealand. Geology. 15:610-613. https://doi.org/10.1130/0091-7613(1987)15<610:TASCON>2. 0.CO;2

Kamp PJJ. 1986. The mid-Cenozoic Challenger Rift System of western New Zealand and its implications for the age of Alpine Fault inceptionGeological Society of America Bulletin. 97:255-281. https://doi.org/10.1130/0016- 7606(1986)97<255:TMCRSO>2.0.CO;2

Kamp PJJ. 1986. Late Cretaceous-Cenozoic tectonic development of the southwest Pacific region.Tectonophysics. 121:225-251. https://doi.org/10.1016/0040-1951(86)90045-4

Kamp PJJ. 1984. Neogene and Quaternary extent and geometry of the subducted Pa cific Plate beneath North Island, New Zealand: Implications for Kaikoura tectonics. Tectonophysics. 108:241-266. https://doi.org/10.1016/0040-1951(84)90238-5

Theses

Kamp PJJ 1978. Stratigraphy and sedimentology of conglomerates in the Kidnappers Group, Hawke’s Bay. Unpublished MSc thesis, University of Waikato, Hamil ton, New Zealand.

Kamp PJJ 1984. Towards a model of the Cenozoic tectonic development of New Zea land. Unpublished PhD thesis, University of Waikato, Hamilton, New Zealand.

Retirement of Hugh Morgans

Kyle Bland, Bruce Hayward, Chris Hollis, Chris Clowes, Percy Strong, Gary Wilson

Hugh Morgans, 'grinding through samples' at his microscope. (Photo: Margaret Lowe, GNS Science)

It's said that the answer to everything is '42', and it's after that number of years that Hugh Morgans retires from GNS Science. This marks the end of a highly productive career and decades of contributions towards understanding New Zealand's Late Cretaceous–Paleogene stratigraphy, its petroleum geology, and its climatic and tectonic evolution. Hugh, and wife Val, now take a well-earned retirement to several acres of potential, back in his ancestral southern Hawke's Bay homeland and close to the geology he has spent so many years understanding.

Hugh has never been one to seek the limelight but instead has been one of those reliable scientists that toiled away ('grinding through samples', as Hugh would often say) and provided the solid data, ages, and paleoecological interpretations that are essential ingredients for many, more-glamorous interpretative projects. A key strength of his work is that his results can consistently be relied upon. This is reflected in his impressive publication list where he has been the lead author on several important biostratigraphic works (e.g., Morgans, 2009, Morgans and Clowes, 2019, Morgans et al., 1999, 2002) but more commonly has been co-author in a wide range of papers where he has been the solid support for the lead author.

Hugh completed his BSc (Hons) at Victoria University (Morgans 1977: Weber Formation, southern Hawke's Bay). Hearing word of a possible job at the New Zealand Geological Survey (NZGS), Hugh applied and joined the organization in early 1978, starting work on the same day that Kyle Bland was born. He was hired as a micropaleontology technician as part of the Muldoon-era 'Think Big' initiatives which saw the establishment of Petrocorp and government-driven search for NZ petroleum reserves after the 1970s oil shocks (think the carless- days scheme). While working as a technician, Hugh also undertook part-time foraminiferal research projects. Norcott Hornibrook's retirement from the NZGS in 1981 led to an opening for a new foraminiferal micropaleontologist, and Hugh's meticulous work on those projects led to him being promoted to that position in early 1982. Although the Geological Survey has had several name changes and evolved into the present GNS Science since that time, Hugh has remained in this position, with promotions, for his entire career.

Hugh honed his skills in New Zealand Cenozoic foraminiferal biostratigraphy on the job at NZ Geological Survey in the 1980s under the tutelage of Horni and George Scott. Right from the start, Hugh made significant contributions to New Zealand petroleum exploration, being heavily involved in providing biostratigraphic interpretations and documentation for petroleum exploration wells all around New Zealand for commercial clients. Hugh was well-site paleontologist on numerous onshore and offshore drillholes, as well as undertaking post-drill biostratigraphic analysis on countless others (working on samples from at least 200 different wells). To date, Hugh has produced 131 commercial reports for virtually all major and minor operators in New Zealand, in addition to numerous reports in his informal "HEGM" series. Each of these well reports took several weeks to months of detailed and meticulous work. Although these were initially confidential, they are now all open-file and provide a huge amount of fundamental underpinning data about the Cenozoic geology of New Zealand's sedimentary basins, much now incorporated into publications. In the late 1980s and 1990s Hugh provided detailed and summary biostratigraphic studies for many of New Zealand's sedimentary basins as part of the Cretaceous-Cenozoic Project (CCP) and these results are cemented into their respective seminal basin monographs. Hugh likes to say that his skills aren't just related to biostratigraphic work; he is especially proud to be listed as a 'Geophysical interpreter' in the Western Southland monograph (Turnbull & Uruski et al., 1993).

The composition of the foraminiferal research team at the NZGS in the 1980s meant there was an opening available for someone to specialise in New Zealand Paleogene stratigraphy and Hugh became the man. In the following years, Hugh has masterfully held the reputation as the go-to expert for anything to do with New Zealand Paleocene, Eocene, or Oligocene foraminiferal biostratigraphy and paleoecology, extending this in later decades to Cenozoic biostratigraphy, paleoceanography, and paleoclimatology of New Zealand and the South Pacific.

His paper on the Paleocene–Eocene Hampden section in north Otago is a key work (Morgans, 2009), and he has recently been lead-author on a paper proposing a new stratotype for the middle Eocene Porangan/Bortonian boundary (Morgans and Clowes, 2019).

Hugh's main field companion for many years was Phil Moore. The two of them logged, sampled, and documented Late Cretaceous and Paleogene sections throughout the East Coast Basin, resulting in many reports that are still heavily cited and utilised (e.g., Moore and Morgans 1989). From this work they established much of the stratigraphic

nomenclature still used today. Hugh maintains that there were only two rules in their stratigraphic scheme: the formation name had to start with a "W", and there had to be a nearby pub (Waipawa, Wanstead, Weber, Whangara, Whakataki). The exception was the Whangai Formation, named after the Whangai Range but lacking a Whangai pub; however, the nearby Wimbledon Tavern (still in keeping with the "W rule") was readily nominated as the de-facto 'type pub' as it is built atop Whangai Formation, and also only a few kilometres from the Morgans' family farm. One of these formations, the Waipawa Formation, has been an abiding interest of Hugh's not only because of its reputation as a potential petroleum source rock but also because of some of the best outcrops of the formation are located on the family farm
(Rogers et al., 2001; Naeher et al., 2019).

Something unusual often occurred on field trips with Hugh: we've been regaled with tales of biker gangs and house-burning Rastafarians, and of four-wheel- drive exploits and difficult field companions. In the mid-1980s, Hugh was part of a fieldtrip with a group of Japanese researchers to Akitio River in southern Hawke's Bay. It was a blazing hot afternoon and the vehicle was left parked on uneven ground. Climbing back into the vehicle to come home, somebody – possibly Hugh – barely touched the windshield with their geological hammer.
There was a tiny 'tink' … a second's silence … and then the whole windscreen went opaque. It was a breezy drive back to Dannevirke. Another memorable moment involved the infamous Dead Horse Gully, named after a rented pack horse shot when escaping with a Geological Survey field party's food supplies. Apparently, according to the horse's owner when seeking compensation, that horse was a future Grand National winner. Many years later, Hugh and Percy Strong were walking up the same gully. Hugh suddenly reached down, grabbed a rock and hurled it. Twenty metres away, a scampering rabbit somersaulted and lay still. It was a head shot. Somehow, the gully was never renamed Dead Rabbit Gully, and the station owner never complained.

During the 1990s, Hugh's increasing expertise in New Zealand Paleogene biostratigraphy and the geology of the Raukumara, Hawke's Bay, Wairarapa, north Canterbury, and north Otago areas was becoming increasingly recognised and he was invited to be a member of several high-powered research teams. In the early 1990s he became the New Zealand member of a large Japanese team investigating the global deep-sea benthic foraminiferal extinction event (BFEE) in what was then the latest Paleocene. Subsequent papers put New Zealand on the map as the first onshore exposure of the "Late Paleocene Thermal Maximum" was reported in a rather unpleasant little gully on the banks of the deeply incised Akitio River at Tawanui, southern Hawke's Bay (Kaiho et al., 1993, 1996). Hugh knew early on that this event had special significance for New Zealand stratigraphy, marking the boundary between the Teurian and Waipawan stages.

Micropaleontology Section of the NZ Geological Survey, on the occasion of Norcott Hornibrook's retirement in October 1981. **Back row**: Bruce Hayward, Bob Hoskins, Tony Edwards, Janice Brooks, Hugh Morgans, Sylvia Jackson, Adrian Trask. **Front row**: Barry Burt, Ron Brazier, George Scott, Norcott (Horni) Hornibrook, Percy Strong. (Photo: Lloyd Homer, NZGS/GNS Science)

Sampling action at the base of the Whangai Formation, Angora Stream, beside the Morgans' family farm. (Photo: Kyle Bland, GNS Science).

Field trip incidents! Hugh fixing a vehicle during the 2009 CBEP field trip, watched on by Ben Andrews. (Photo: Henk Brinkhuis).

Hugh surveying the geology and scenery at Castlepoint, central Wairarapa. (Photo: Kyle Bland, GNS Science).

Below: New office accommodation for Paleontology staff at the New Zealand Geological Survey, State Insurance Building. Clockwise from top-left: Dallas Mildenhall, John Simes, Alma McGregor, Hugh Morgans. (Photo: Lloyd Homer, NZGS/GNS Science).

Above: Multidisciplinarity in action, and a feature of Hugh's career. Hugh offering thoughts on the Waipawa Formation on Old Hill Road, Porangahau, to Reinhard Kozdon (geochemist), Chris Hollis (micropaleontologist), Erica Crouch (palynologist), and Edoardo Dallanave (paleomagnetist).
Photo by Carolyn Boulton (geophysicist).

The rest of the world eventually caught up and the definition of the Paleocene/Eocene boundary was shifted to coincide with the BFEE, which happened to also coincide with a global burp of greenhouse gases and pronounced global warming, marking what is now referred to as the Paleocene- Eocene Thermal Maximum or PETM. International interest in this geological analogue for global warming and the more prolonged warming through the early Eocene stimulated a successful phase of international collaboration that resulted in several high-profile papers (Burgess et al., 2008; Hollis et al., 2009, 2012; Creech et al., 2010; Hines et al., 2017; Dallanave et al., 2016, 2020; Crouch et al., 2019). A highlight of this research was co-leading South and North Island field trips as part of the international conference on the Climate and Biotic Events of the Paleogene hosted by GNS in 2009. Many of the leading lights in paleoclimate research, both world authorities and up-and-coming researchers and students, benefitted from Hugh's insights in the field and after-dinner yarns.

In the late 1990s early 2000s, Hugh and Graeme Wilson participated in a joint GNS/University of Oxford programme with Gary Wilson, to investigate the Cenozoic sequences in Chile. Hugh took part in two expeditions – one to the Arauco region and the other to southern Patagonia (Morgans, 2000). The trip to Southern Patagonia was perhaps the most memorable for him. This was partly due to the parallels between the Paleogene sequences he mapped and sampled and the sequences he was already familiar with from southern Hawke's Bay and South Canterbury, but also due to the challenges of doing fieldwork in some very remote locations. It was on this trip that much of the fieldwork involved driving on almost non-existent tracks, taking ex-WW2 beach landers reconfigured to run as ferries from beach to beach across the Chilean fiords (when they ran) and fording rivers in rental vehicles. It was whilst fording one of these rivers to get back to Punta Arenas late one night, that the inevitable happened… the engine was flooded. Hugh took the carburetor apart, got out his emergency roll of toilet paper and proceeded to dry it out — enough to get a couple of cylinders firing and get the expedition back on track, only to find the next bridge washed out. Hugh again came to the rescue and reassembled the timbers for the bridge and the vehicle was able to get across and back to Punta Arenas. Though it should be noted – he chose to walk across the bridge rather than ride in the vehicle.

Over the past three decades, Hugh has been the key Paleogene biostratigraphy expert for several iterations of revisions and recalibrations to the New Zealand Geological Timescale (e.g. Morgans et al., 1996; Cooper, 2004; Hollis et al., 2011; Raine et al., 2015). Over this time, Hugh also provided the underpinning biostratigraphy input for several Neogene studies on stratigraphy, sea-level cyclicity, and tectonic evolution (e.g., Delteil et al., 1996; Kamp et al., 1998; Morgans et al., 1999, 2002; Naish et al., 2005; Turner et al., 2007; Field et al., 2009; Browne et al., 2016; Grant et al., 2018).

In 2017, as a foram micropaleontologist, Hugh was one of four New Zealand scientists on IODP Cruise 371 exploring the tectonic and climate history of the Tasman Frontier area of Northwest Zealandia. Publications from this successful cruise are now starting to appear (e.g., Sutherland et al., 2020), and once again Hugh is a key contributor to many of them and likely they will continue to appear for some years after Hugh's retirement.

Hugh has been dedicated to his support for others' projects throughout his career. Early on he was secretary for the Geological Society of New Zealand during Steve Weaver's presidency (1986–88) and looked after Society publication sales for several years. He has willingly undertaken analysis of samples for countless students, whether they were based in New Zealand or overseas. In more recent years, Hugh's local knowledge was a significant help during fieldwork as part of petroleum systems research in central and southern parts of eastern North Island. These fieldtrips remain highlights for those on them, as Hugh passed on his insights to another generation of geoscientists, kept them entertained with stories, and made sure that they were well fed and watered at the Wimbledon (Whangai) Tavern. In 1981 Hugh joined Bruce Hayward to describe and name a new foraminiferal genus and species Finlayina hornibrooki to honour their two predecessors and in 2012 Hugh's contribution was in turn recognised with Bruce naming an Eocene foraminiferal species in his honour as Epelistoma morgansi.

Hugh's contributions to the social aspect of work has also been significant. He's provided council and support for many colleagues during the decades, and, with Val, has provided accommodation and meals for colleagues when they were between houses. Many will know Hugh as a cheerful bartender and regular participant at GNS's Friday Happy Hours. Beyond that, he has been a hospitality industry, hosting, along with Val, numerous legendary BBQs, dinners, and rugby evenings at their homeHugh is a very keen sports fan, especially for rugby. A question to new arrivals at GNS was often "do you like rugby?". If the answer was "yes!", an invite around to the Morgans house to watch a game often followed Many firm friendships with the Morgans' started that way, and the regular attendees have become part of their whanau. Things would inevitably get raucous during a game: Hugh could become extremely unrestrained if the Hurricanes or All Blacks stuffed up, or if the commentators uttered one of their usual cliched lines. Hugh's comments and critiques have become legendary, and could keep T-shirt printers in production for many years.

Hugh now moves into an Emeritus Scientist position at GNS, and will continue his much-valued research at the 'Dannevirke Micropaleontological Research Centre', at a pace that suits him and Val. Happy Hours at GNS have become just that little-bit quieter with Hugh's departure.

Hugh Morgans significant publications

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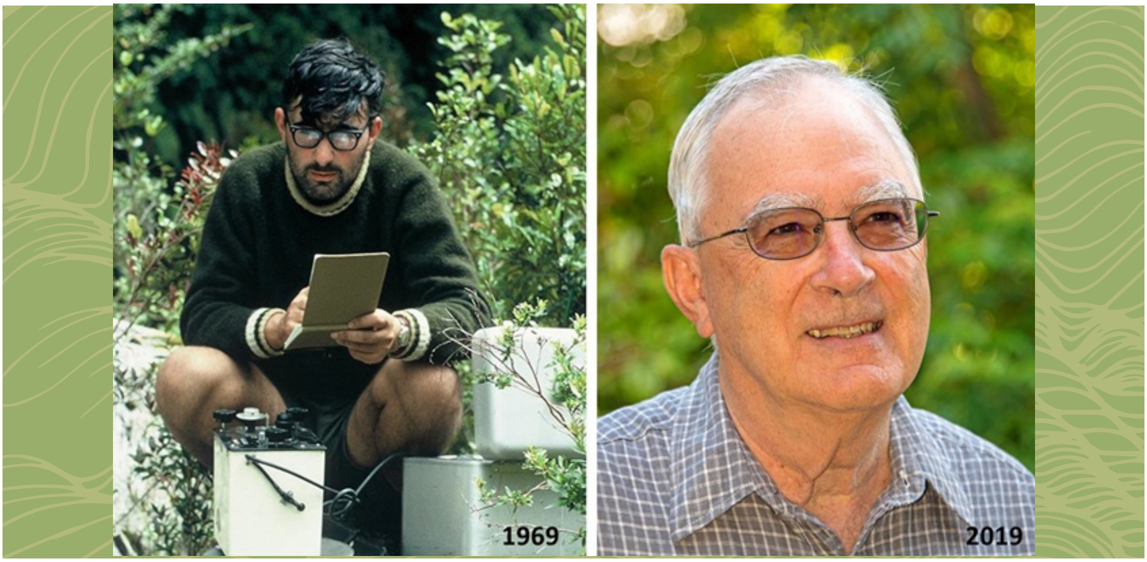
Retirement of Simon Nathan

Nick Mortimer



In June 2020, Simon Nathan retired as an emeritus scientist at GNS Science, age 77. This article presents a short summary of his 55-year career. Biographical information was mainly contributed by Simon, and there are personal thoughts from three colleagues.

Biography

Simon graduated from Canterbury University in 1966 with an MSc and joined the Greymouth office of the NZ Geological Survey in 1967, initially to search for uranium. His geological mapping in and around the Paparoa Range included the first identification of individual granitoid plutons in the region. He also spent time deciphering the complex Cretaceous and Tertiary geology of south Westland to assist offshore oil exploration and was involved in investigations of the 1968 Inangahua earthquake.

In 1971 his interests moved to volcanic geology when he transferred to the Rotorua office. By coincidence it was a period of exceptional volcanic activity, with multiple eruptions of Ruapehu, Ngauruhoe and White Island. He and Ted Lloyd had several trips to the Kermadec Islands when they mapped the geology of Raoul and Macauley Islands. The oil crisis in the 1970s led to the start of the Cretaceous-Cenozoic Project (CCP), aimed at describing the major sedimentary basins around New Zealand. Simon led the first project, synthesizing the history of the West Coast basins. Published in 1986, it set the pattern for studies of other regions over the next decade.

A move to Lower Hutt in 1987 saw Simon take up an NZGS management position under Ian Speden. It was a difficult period, with constant reorganization, funding cuts and redundancies. He became acting Director of the Geological Survey at the time it celebrated its 125th anniversary in 1990, immediately before it became DSIR Geology & Geophysics and later GNS Science. He did not apply for further senior management positions, but concentrated on science administration, speeding up the publication of maps and monographs and initiating the QMAP programme. He also completed a long-term project, an updated geological map of the Buller Coalfield.

In a major career move in 2003, Simon joined the staff of Te Ara, the Encyclopedia of New Zealand (www.teara.govt.nz) as Science Editor responsible for the science content of this major online publication. As well as commissioning and editing over 250 articles, he wrote several himself, including regional articles on the West Coast and Kermadec Islands.
After leaving Te Ara, Simon rejoined GNS Science in 2010 as an emeritus scientist, concentrating on the history of New Zealand geoscience. Freed from other responsibilities, it has been a productive writing period, with published biographies of Harold Wellman and James Hector. In recent years he has become interested in the use of photography in geoscience, with completed projects on the photographic careers of Alexander McKay, Joseph Divis (mining town photographer) and Lloyd Homer. In 2020 he published a historical review of women in New Zealand geoscience.
Among Simon's awards and accolades down the years are the McKay Hammer (1979), a DSc from Canterbury University (1989) and Honorary Life Membership of the Geoscience Society (2012). Simon has had a long connection with the Geoscience Society of New Zealand and one of its predecessors, the Geological Society of NZ. As well as local branch committees, he served on the national committee for periods in the 1970s and 1990s, and was editor of the GSNZ newsletter for several years. During his period as president (1999-2000) he initiated a campaign against building across active faults that resulted in guidelines that have been widely accepted by local authorities. He is currently convenor of the GSNZ Historical Studies Group.

Personal thoughts:
Mike Johnston: Having joined the Geological Survey at about the same time as Simon, our paths were to cross many times despite having undertaken no collaborative work outside of broad scientific programmes we were participants in. Whereas I was to spend most of my career in the one district office Simon embarked early on to seek experience in various offices, each of which had its own geology and related problems and challenges. As far as geology was concerned Simon's move from Greymouth to Rotorua could not have be more marked. This was to give him on many levels a detailed understanding of New Zealand science. Simon also early on demonstrated his considerable talent for persuasion in getting the hierarchy in DSIR to send him to a course in the Netherlands at what was the International Institute for Geo-Information Science and Earth Observation (ITC) at Enschede. This was at a time when financial support for overseas travel was hard to obtain. The expertise he acquired was soon disseminated to that now almost extinct species who were known as field geologists and who were high up in the pecking order of the survey. Simon also showed his

considerable ability as an administrator, rising to the rank of assistant director of the geological survey. However, in this and to the admiration of his colleagues he did not lose sight of the need to ensure that the maximum amount of productive time should be devoted to science. Simon also make sure that the institutional memory of GNS Science and its predecessors was kept alive, a highly important but particularly challenging task when in the 1980s changes in science (and the broader the community) began to accelerate. This ability has been expanded into the history of geology with the writing of articles and books of not only well-known New Zealand geologists but also those who in one way or another have made a significant but previously largely unacknowledged contribution to geology. The geological community (and New Zealand generally) is indebted to Simon. Not only from the scientific productivity arising from his outstanding career in GNS Science and its predecessors but also his involvement in the Geoscience Society (including the Historic Studies Group) and as an editor of Te Ara. Hamish Campbell: Simon has served GNS Science and New Zealand geology brilliantly and tirelessly at many levels for almost six decades. I have greatly enjoyed sharing an office with Simon for much of the past decade (2010-2020) of his long career at GNS Science. It has been a pleasure and a privilege, and I greatly admire his considerable mix of professional skills: thoughtfulness, clear mindedness, scholarship, attention to detail, collegiality, loyalty and remarkable productivity. He knows exactly how best to get things done in the most efficient and effective way possible. In this regard his natural organizational and leadership instincts have flourished. But most of all I have come to appreciate what an outstanding science communicator he is! Our science has benefitted from his great interest in chronicling key aspects relating to the technological, cultural and social evolution of earth science as a profession. So much of his professional work is now indelibly set in the permanent record. I can't imagine Simon not working on a research project but now that he has actually stopped coming to GNS Science on a regular basis, life is no longer the same. He has been an institutional beating heart and social conscience for my generation of geologists and those prior to mine.

Nick Mortimer: To me, Simon is one of the quiet, pragmatic, unassuming heroes of New Zealand geoscience. He has always been the institutional memory of, and 'go to' person for, West Coast South Island regional geology - from Greenland Group basement to lamprophyre dikes to Oligocene limestones to magnetic anomalies and earthquake ruptures. I have indelible memories of bouncing and floating across the Inangahua River - against the imbrication - with Simon in a Toyota Land Cruiser in February 1994. We successfully sampled the Pliocene Old Man gravels for schist clasts. Simon deserves a lot of credit for initiating GNS's successful QMAP regional mapping programme and was senior author for QMAP Greymouth. In recent years Simon has been rightly lauded for his prolific output of geoscience-related datasets and biographies, and history of geology activities, including recording several oral histories. Simon is a shaker, a mover and a dogged prodder - as anyone who has heard him say 'Could I have a few minutes of your time?' will know. His calm, selfless and insistent demeanour means he's a tough person to turn down. He's kept the wheels of NZGS and GNS turning throughout his career, leaving a solid legacy of publications, influencing science directions and, latterly, keeping past memories alive for the future.
We hope to still see you at GSNZ conferences, Simon. Enjoy your second retirement.

Peter B. Andrews

(1935-2020)

Simon Nathan and Julie Palmer

Peter Andrews, a long-term member of the Geoscience Society, died recently at home in Cromwell. He will be remembered for his contributions to different aspects of sedimentary geology and later for his work in the petroleum industry around New Zealand.

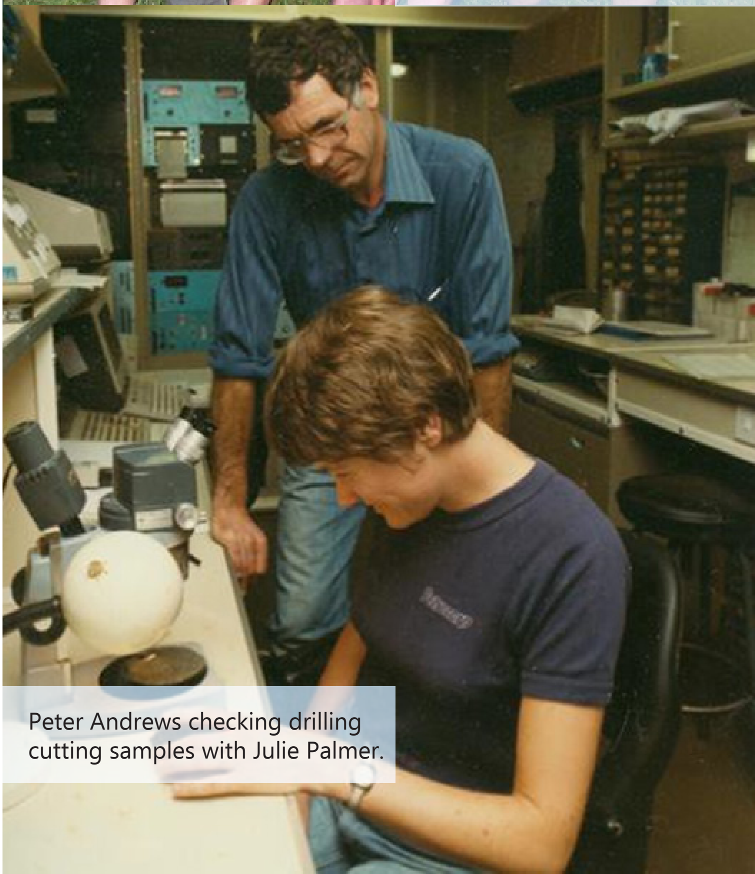
Peter's early days
(by Simon Nathan)

Peter studied science at Canterbury University college in the late 1950s, majoring in geology, and his lecturers included Doug Campbell and Max Gage. He completed an MSc in 1960 with a regional study of early Miocene sediments in Canterbury and joined the Christchurch office of the Geological Survey. Hewas subsequently awarded a scholarship to study overseas for a PhD. In those days it was normal to head off to the UK, but Peter opted to study at the University of Texas in Austin under leading sedimentologist Bob Folk. He later recalled that his two years of course work at Texas was one of the most demanding periods of his life, but under Folk he gained wide experience in different aspects of sedimentology. On his return to New Zealand his paper advocating the Folk classification of sedimentary rocks (Folk, Andrews and Lewis 1970) has become one of the most commonly referenced papers in the New Zealand Journal of Geology and Geophysics.

Peter worked in the Sedimentology Laboratory with Ko Kingma and Gerrit van der Lingen on a wide variety of topics, including sediments on the Otago shelf, the depositional environment of Torlesse sediments, Canterbury stratigraphy and the Deep Sea Drilling Project (DSDP). He was always keen to work co- operatively with others, and colleagues often commented on his enthusiasm to see projects through to completion and publication. He clearly had leadership potential, and when the Survey Director, Pat Suggate, wanted to get the Cretaceous-Cenozoic Project underway he selected Peter to lead it. He was also given the job of coordinating a survey of the Chatham Islands involving a large group of specialist staff, and this remained a major research interest for the next decade. His guide for recording field observations of sedimentary rocks (1978 & 1982) has been widely used throughout the geoscience community.

In 1977, when the government set up Petrocorp, a state-owned exploration company, Pat Suggate invited Peter to move to Wellington to lead the Geological Survey's petroleum group. At that time Peter had little experience within the petroleum industry, but he provided the leadership necessary, and quickly gained the confidence of colleagues, and led an effective team that provided advice and assistance to New Zealand's rapidly growing exploration industry.

Group of ex-Christchurch geologists taken at the 2002 GSNZ conference, Back row: Greg Browne, Simon Nathan, Peter Andrews. Front row: Malcolm Laird, Brad Field, David Smale



Peter Andrews checking drilling cutting samples with Julie Palmer.

Oil exploration geologist
by Julie Palmer

In 1983 Peter was persuaded to join Petrocorp Exploration Limited as Chief Geologist. Peter was a huge asset to Petrocorp Exploration. He managed his team of young petroleum explorationists with encouragement and tact, and I have the fondest memories of working with him. He was inspirational, honest and had the highest integrity. Most importantly he kept me, and my colleagues, levelheaded during the heady time of exploration success. An enduring memory I have is Peter wanting to come wellsite so he could experience the day-to- day routine as we approached a zone of interest and where on the spot decisions were crucial. The attached photo was taken during the drilling of an offshore exploration well. One of my former colleagues spoke at Peter's farewell saying "I looked back and couldn't remember him ever telling me what to do. He encouraged, discussed, suggested but never directed, so I thought I was coming up with new ideas when he was steering me in a certain direction." He went onto say "Peter was by far the best manager I saw in the industry." These words are a credit to a truly great geologist.

In 1988 Fletcher Challenge Petroleum bought Petrocorp Exploration and established the Fletcher Energy Group which retained the exploration team and prospect portfolio. A couple of years later Peter, and wife Wendy, moved to Bangkok with Fletcher Energy. Peter's gentle nature and great sense of humour were well-received by the Thai employees who had huge respect for him. Shortly after his return to New Zealand Fletcher's moved all the exploration operations to New Plymouth. Peter too was relocated there and that's where he stayed until his retirement in 1994. After retiring Peter and Wendy moved to Auckland and some years later relocated down to Cromwell where they could be closer to family.

Selected publications by Peter Andrews (in chronological order)

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