ISSUE 31

June 2020

Geoscience Society of New Zealand

NEWSLETTER

ISSN 1179-7991

Geoscience Society of New Zealand

GEOSCIENCE SOCIETY OF NEW ZEALAND
A member body of the Royal Society of New Zealand
Mailing address: P.O. Box 7003 Newtown, Wellington, 6242

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GEOSCIENCE SOCIETY OF NEW ZEALAND BRANCHES (with contacts)

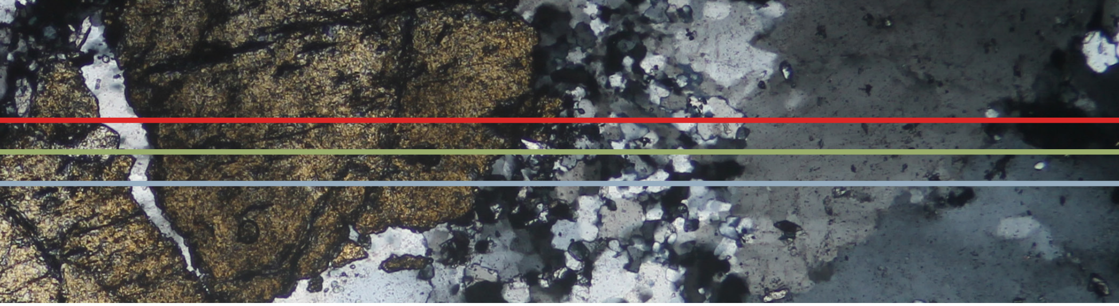
Auckland:	Jennifer Eccles	j.eccles@auckland.ac.nz
GeoClub:	Bruce Hayward	b.hayward@geomarine.org.nz
Geocene:	Jill Kenny (ed)	jill.kenny@xtra.co.nz
Waikato:	Andrew La Croix	andrew.lacroix@waikato.ac.nz
Taupo:	Paul White	p.white@gns.cri.nz
Taranaki:	Robert Park	park.rk.sm@sherwood-holdings.com
	Susan Burgess	susan@netmail.co.nz
Manawatu:	Julie Palmer	j.a.palmer@massey.ac.nz
Wellington:	Andrew Rees	andrew.rees@vuw.ac.nz
Canterbury:	Alex Nichols	alex.nichols@canterbury.ac.nz
Otago:	Nick Mortimer	n.mortimer@gns.cri.nz
Talks:	Sophie Briggs	sophie.briggs@otago.ac.nz

SUBCOMMITTEES AND SPECIAL INTEREST GROUPS (with convenors)

Awards:	Kat Holt	k.holt@massey.ac.nz
Fossil Record File:	Chris Clowes	c.clowes@gns.cri.nz
Geoheritage:	Bruce Hayward	b.hayward@geomarine.org.nz
Friends of the Pleistocene	Peter Almond	peter.almond@lincoln.ac.nz
Geoscience Education	Michael Petterson	michael.petterson@aut.ac.nz
Historical Studies	Simon Nathan	s.nathan@xtra.co.nz
Oil and Gas	Mac Beggs	mac@beggs.nz
Paleontology	Hamish Campbell	h.campbell@gns.cri.nz
Sedimentology	Mark Lawrence	M.Lawrence@gns.cri.nz
Geochemistry	Sebastian Naeher	s.naeher@gns.cri.nz
LAVA NZ	Adrian Pittari	apittari@waikato.ac.nz

Print version ISSN : 1179-7983 **Online version** ISSN : 1179-7991

Content



Presidents Letter

The goal of the GSNZ committee this year has been to raise the benefit of being a GSNZ member. I can already report a number of initiatives put in place. An obvious one is that we have a new website (live from ~ July 1st) that is easier to access, decluttered and presents a modern front to the Geoscience Society. What do you think? Our social media presence has been raised, with Twitter and Facebook now promoting the society. Strategies have been put in place to revitalize the Special Interest Groups, and I can report that Geoeducation, Hydrogeology and Oil and Gas Special Interest Groups (SIG) now have new leaders and new directions. Member access to the New Zealand Journal of Geology and Geophysics has been negotiated, and is accessible free via the membership portal on the new website.

Another change that should be obvious is this newsletter.
Do you like it?

This version here is a trial, and we're after feedback on whether it is an improvement and what else you'd like to see. Our photo competition (currently live) is intended to yield a suite of nice pictures that can be used to cover the Newsletter. Later in the year, there will be a member survey on whether to rename this newsletter, and what it should be.

Other goals this year are to raise the profile of the branches, and to formulate a strategic plan on how to best serve the NZ geoscience community over the coming years. (The planning has been done; the implementation is in progress). The Hochstetter Lecture tour featuring Phaedra Upton, and President's Tour featuring... me..., will run in the next three months. The GSNZ conference planning is in full swing, with the event to be run in-person (conditions permitting) in Christchurch in late November. Keep an eye out for updates in our regular Newsflashes (some people's computers appear to be over-zealously protective of their owners, and so if you aren't getting these Newsflashes then check your spam folder).

- James Scott, President

Editorial

This updated photo was taken in the Czech Republic at the medieval town of Český Krumlov, on December 29th, 2019 a month or two before the world locked itself down from the Covid-19 pandemic. It is a UNESCO world heritage site. The castle from where the photo was taken was built from about 1240 onwards in the Bohemia of the time. There is also a Baroque theatre in the town built in about 1680 and still used but only a few times a year.

Forgetting to pack a hat, I had to buy the beenie at the airport! Don't ask for what price. Anyway, 2020 will not be like any other since the influenza pandemic of 1918 and we still have a lot to learn about viruses, their evolution, how to manage them and how to teach about them.

This issue will be the penultimate compilation for me as editor and as allud-ed to by President James, you will notice some changes in the presentation. Finding a new 'editor'; is, not surprisingly, a bit of a challenge. So, if you are interested please make contact with the committee. The job means receiving articles and news, formatting into A5, fixing some layout, liasing with a print company, sticking on stamps and posting out. The first mail out I did in 2012 had over 900 so a bit of help was needed to put the stamps on. The boxes filled the car on that first run. Today, the mail out is down to about 260 (two boxes instead of nine) with fewer overseas postings. We also noticed a steady increase in postage as the digital universe took over and the posties bicycles became rusted up. Nonetheless, your Newsletter remains a highly valued benefit of membership of GSNZ but still dependent on your contributions. A point raised regularly by its editors since the Newsletter began. There are 181 Newsletters in a complete set since 1954 starting with typed foolscap and no logo then eventually moving to A5 and after several logo changes. Cyclostyling' and 'xeroxing' are words of the past and like 19th century newspapers, images were still some way off in 1960. For some, fitting A4 into the bookcase is a bit of a barrier! One looming task is the production of a third Index book. Many thanks to Ronja for putting together the redesigned and updated 31st issue of the GSNZ Newsletter. As James has said, we wel-come your feedback as we move forward to the next bed of GSNZ history.

Enjoy this issue.

- Glenn Vallender, Editor

ARTICLES

A new global citation metrics database: Outcome for New Zealand research institutions

Cam Nelson campbell.nelson@waikato.ac.nz

Researchers worldwide use citation metrics as one way of viewing the impact of their published research contributions in their particular discipline. Rightly or wrongly, citation metrics have become part of the personal profile record and CV of most researchers when it comes, for example, to applying for jobs, promotions, research funding, awards and honours, committee memberships, and the likes.

A recent article by Ioannidis et al. (2019) briefly mentioned the basis for a few of the various schemes employed for citation metrics, noting especially some of their shortcomings as a definitive measure of research excellence. They go on to (in their words) "offer a solution to overcome many of the technical problems and provide a comprehensive database of a sufficiently large number of most- cited scientists across science".

To do this they compile using Scopus citation data since 1996 a database for almost 7 million (= 6,880,389) researchers worldwide across all research fields, and then rank c. 100,000 (or c. 1.5% of total) of the most-cited authors across these fields using a composite indicator built from several citation metrics described previously by Ioannidis et al. (2016). These metrics include total citations, h-index, co-authorship adjusted hm-index, and citations to papers in different authorship positions. Moreover, because extreme self-citations and "citation farms" may affect the worth of citation metrics, the composite indicator is given with and without self-citations.

No.	Broad research field	Global no.	% of total	% rded [1]	100K no.	% of 100K	NZ no.	NZ % rded [1]
0	Unassigned	287,779	4.18	4.2	3	0	0	0
1	Agriculture, Fisheries & Forestry	232,801	3.38	3.4	1,462	1.46	35	7.6
2	Built Environment & Design	36,534	0.53	0.5	208	0.21	0	0
3	Enabling & Strategic Technologies	475,142	6.91	6.9	3,096	3.10	11	2.4
4	Engineering	436,723	6.35	6.4	3,164	3.16	11	2.4
5	Information & Communication Technologies	339,284	4.93	4.9	2,999	3.00	7	1.5
6	Communication & Textual Studies	20,292	0.30	0.3	91	0.09	2	0.4
7	Historical Studies	25,277	0.37	0.4	141	0.14	0	0
8	Philosophy & Theology	13,861	0.20	0.2	70	0.07	0	0
9	Visual & Performing Arts	3,717	0.05	0.1	0	0.00	0	0
10	Economics & Business	108,277	1.57	1.6	2,073	2.07	11	2.4
11	Social Sciences	119,260	1.73	1.7	1,321	1.32	10	2.2
12	General Science & Technology	69,789	1.01	1.0	108	0.11	0	0
13	General Arts, Humanities & Social Sciences	4,091	0.06	0.1	6	0.01	0	0
14	Biomedical Research	626,753	9.11	9.1	13,810	13.81	29	6.3
15	Clinical Medicine	2,113,734	30.72	30.7	40,461	40.46	165	35.8
16	Psychology & Cognitive Sciences	96,159	1.40	1.4	3,197	3.20	19	4.1
17	Public Health & Health Services	141,162	2.05	2.1	1,780	1.78	7	1.5
18	Biology	236,108	3.43	3.4	4,670	4.67	66	14.3
19	Chemistry	506,526	7.36	7.4	5,741	5.74	21	4.6
20	Earth & Environmental Sciences	223,246	3.25	3.3	4,371	4.37	43	9.4
21	Mathematics & Statistics	96,619	1.40	1.4	895	0.90	2	0.4
22	Physics & Astronomy	667,255	9.70	9.7	10,333	10.33	22	4.8
	TOTAL	6,880,389	99.99	100.2	100,000	100.00	461	100.1

[1] rded % = rounded percentage

Table 1 – Numbers and percentages of global researchers, most-cited 100,000 (100k) researchers and NZ researchers in the 100,000 group within 22 broad research fields based on data in appended Supplementary Tables S3 and S4- career-2018 in Ioannidis et al. (2019).

Ioannidis et al. (2019) present their comprehensive data in open access Excel supplementary tables in several different ways. These include: (i) Summary lists of the number of researchers in each of 22 broad research publication fields for both the c. 7 million global pool and the top-most cited 100,000 researchers (their Table S3); (ii/iii) Ranked and named lists of career-long (multi-year) data versus research fields and other statistics for each of the most-cited c. 100,000 scientists since 1996 through to (ii) 2017 (their Table S1), and again for the slightly longer time span through to (iii) 2018 (their Table S4). [Note that for papers published before 1996 the citations received during 1996-2017/18 are included in both these databases, but the citations received up to 1995 are not]; and (iv) A ranked list based on data for author citations in a single calendar year (2017) only (their Table S2).

From amongst this vast amount of data I was interested in gaining a general idea about the overall distribution and impact of the different research disciplines within the wider research community. In particular, I wanted to know: (1) What fields of research are our publishing global researchers principally involved in?

(2) What fields of research are the most-cited researchers in the database publishing in? (3) How do New Zealand research institutions fare amongst this most-cited cohort? A few data that offer some insight into these questions are summarised here in Tables 1 and 2 for the 22 major research fields of Ioannidis et al. (2019) (plus an ‘unassigned’ field), as well as in three simple bar graphs in Figures 1 to 3.

Figure 1 - Global (c. 7x106) researchers

The bar graph in Figure 1 strongly emphasises the worldwide dominance (30.7%) of researchers working in the Clinical Medicine field (designated research field 15). The addition of other primarily health-related fields of Biomedical Research (14; 9.1%), Psychology (16; 1.4%) and Public Health (17; 2.1%) increases the global health-research publication effort to over 43%, involving a workforce of about 3 million researchers. Among the more so-called "traditional" sciences, Physics & Astronomy (22; 9.7%) has the highest number of cited researchers (667,255), followed by Chemistry (19; 7.4%), Biology (18; 3.4%), Earth & Environmental Sciences (20; 3.3%) and Mathematics & Statistics (21; 1.4%). The total number of individuals in these fields in the database is about 1.75 million. Of this figure, Earth scientists probably account for about 0.25 million if some researchers from within closely related fields, such as agriculture (part of 1) and geo-engineering (part of 4), were included. Enabling & Strategic Technologies (3; 6.9%), Engineering (4; 6.4%), Information & Communication Technologies (5; 4.9%) and Agriculture, Fisheries & Forestry (1; 3.4%) account for the research fields of about 1.5 million (21.6%) of the cited scientists. Of the remaining research fields (nos. 2, 6, 7, 8, 9, 10, 11, 12 and 13), principally associated with business, humanities and social science disciplines, each involves less than 1 or 2% of the cited research publishers, with a combined total number of about 0.4 million researchers.

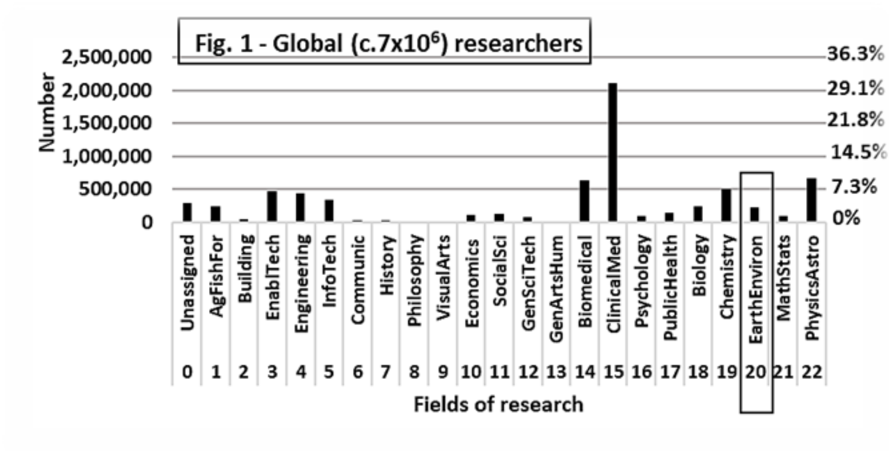


Fig. 1

Figure 2 – Top 100,000 ranked researchers

The overall distribution of researcher numbers in the different research fields for the top-most ranked c. 100,000 researchers in the 7 million pool (Figure 2) is broadly similar to that of the total population (Figure 1). However, the Clinical Medicine field (15) increases its numbers to over 40% (cf. 31% previously), as does the associated Biomedical Research field (14) from about 9% to 14%. Adding in the Psychology (16; 3.2%) and Public Health (17; 1.8%) categories has the primarily health-related researchers accounting for almost 60% of the top 100,000 ranked researchers according to the composite indicator data from Ioannidis et al. (2019). The relative standing amongst the "traditional" sciences remains similar to that in the total pool (Figure 1), but with small percentage increases in numbers in the case of Physics & Astronomy (22; 10.3% from 9.7%), Biology (18; 4.7% from 3.4%) and Earth & Environmental Sciences (20; 4.4% from 3.3%), and small decreases in the Chemistry (19; 7.4% to 5.7%) and Mathematics & Statistics (21; 1.4% to 0.9%) fields. Apart from a small percentage increase in the Economics & Business field (10; from 1.6% to 2.1%), all other research fields show reduced percentage values in the top 100,000 listing compared to the total pool.

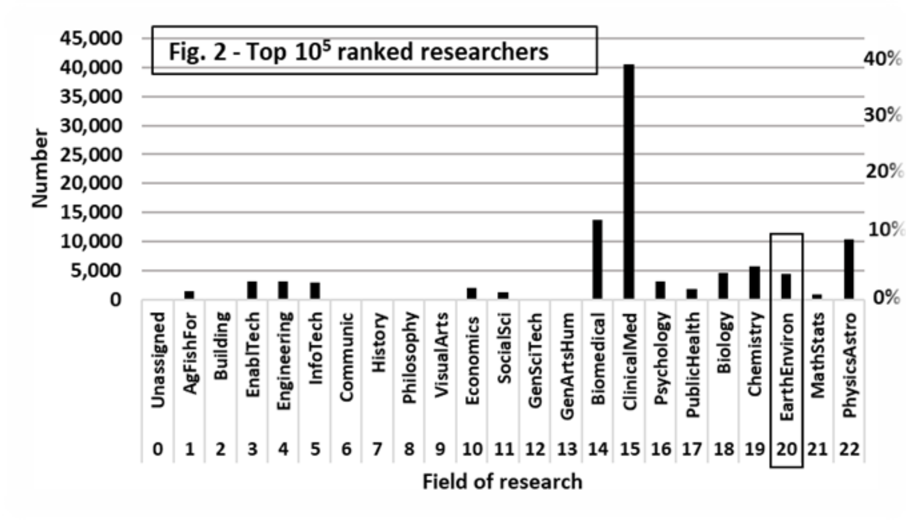


Fig. 2

Figure 3 – NZ researchers in top 100,000 ranking

A total of 461, or just under 0.5%, New Zealand researchers are included and named in the top-ranked c. 100,000 list in the career-long to 2018 database (Table S4) compiled by Ioannidis et al. (2019) (Table 2). With some notable exceptions, the distribution profile of fields in the bar graph for New Zealand researchers (Figure 3) is again broadly similar to the total and top-ranked global numbers (Figures 1 and 2). Numbers in the Clinical Medicine field (15) in New Zealand are by far the highest (165, or 36%). Adding in the much smaller numbers in the other associated primary health-related fields (14, 16 and 17) brings the total number of top-ranked health/medical researchers in New Zealand to 220 (47.7%). Of this latter group, only the Psychology & Cognitive Sciences field (16) shows a small percentage increase in number (4.1%) compared to that of the same field in the global 100,000 list (3.2%). The New Zealand institutions supporting the top-cited medical research are spread across our universities (180; 81.8%), hospitals and associated research establishments (34; 15.5%), CRIs (4; 1.8%) and consultancies (2; 0.9%). The universities of Auckland and Otago together account for 70% of this top-ranked medical-related research in New Zealand.

Among the more "traditional" science fields in New Zealand, Biology (18; 14.3%) and Earth & Environmental Sciences (20; 9.4%) take first and second place numbers (Figure 3), supplanting Physics & Astronomy (22; 4.8%) and Chemistry (19; 4.6%) from those positions held in both the total and top-ranked global data (Figures 1 and 2). These highly ranked fundamental science researchers are based mainly in our universities (118; 76.6%), CRIs (27; 17.5%) and consultancy groups (7; 4.5%) (Table 2). Across these same institutions there are also 35 researchers within the Agriculture, Fisheries & Forestry field (1), accounting for the fourth highest percentage group at 7.6% of New Zealanders in the top-ranked 100,000 list. This percentage is two to five times greater than that for the same research field in the total and top-ranked global numbers (Figures 1 and 2).

Six of the remaining research fields (3, 4, 5, 6, 10 and 11) each account for less than 2.5% of the top-ranked New Zealand researchers (combined total number of 52). However, of these, the Economics & Business (10; 2.4%) and Social Sciences (11; 2.2%) fields involve slightly higher percentages of top-ranked researchers than those for the same research fields in the total and top-ranked global numbers (Figures 1 and 2). Research fields 2, 7, 8, 9, 12 and 13 do not figure in the New Zealand-based data (Table 2, Figure 3).

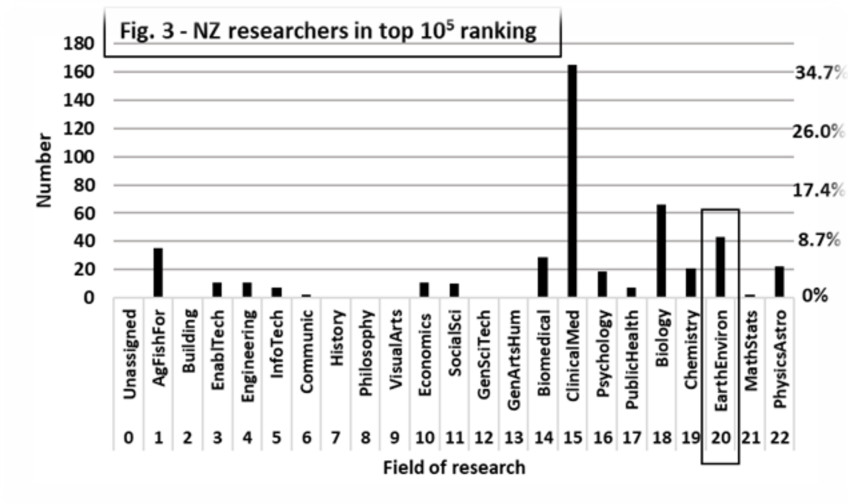


Fig. 3

Research fields ---->		1	3	4	5	6	10	11	14	15	16	17	18	19	20	21	22
Universities	**N**																
Auckland	160	6	3	9	3		5	5	6	75	7	2	13	8	8	1	9
Waikato	18	1	1		1		2	2	2	2			2	1	4		
Massey	34	11	2				1		3	3		3	6		2		3
Victoria	35		1		2	1	1	1		3	4	1	2	4	9	1	5
Canterbury	28	1	2	1	1	1	1	1		2	1		9	5	2		1
Lincoln	8	4							1				2	1			
Otago	85		1						11	45	7	1	9	2	7		2
Nel-Marl Inst Tech	1									1							
CRIs																	
AgResearch	6	2							3				1				
GNS Science	8														8		
Landcare	14	4							1				7		2		
NIWA	9			1									8				
Plant & Food	4	3											1				
Medical institutes																	
Hospitals	18								1	16							1
Springer	11									11							
Wolters[1]	6									6							
Consultancies[2]	14	3					1	1	1	1			5		1		1
No name[3]	2		1										1				
Total N	*461*	*35*	*11*	*11*	*7*	*2*	*11*	*10*	*29*	*165*	*19*	*7*	*66*	*21*	*43*	*2*	*22*
Total N as %	*100*	*7.6*	*2.4*	*2.4*	*1.5*	*0.4*	*2.4*	*2.2*	*6.3*	*35.8*	*4.1*	*1.5*	*14.3*	*4.6*	*9.4*	*0.4*	*4.8*
Research fields ---->		**1**	**3**	**4**	**5**	**6**	**10**	**11**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**

[1]Wolters Kluwer Health [2]Includes industry-based [3]No institutional name assigned

Table 2 – Number of New Zealand researchers and their institutions versus research fields (1-22) for the top-ranked c.100,000 researchers listed by Ioannidis et al. (2019) in their career-2018 Supplementary Table S4. Note that fields having no entries are omitted from the Table.

Geosciences comment :

In the bar graphs of Figures 1 to 3 the main research field capturing the geoscience discipline is the boxed Earth & Environmental Sciences (20) one. For this field alone, Table 1 shows that the number (and percentage) of publishing researchers is 223,246 (3.3%) in the total global pool, 4,371 (4.4%) in the top-most c. 100,000 lot, and 43 (9.4%) in this top-ranked cohort in New Zealand where the researchers are based in the universities (Victoria, Auckland, Otago, Waikato, Canterbury and Massey), CRIs (GNS Science and Landcare), and a single consultancy research organisation (Table 2). The data suggest that New Zealand Earth scientists are performing incredibly well on the world stage of geo-related research. Of course, the numbers (percentages) of researchers in the Earth &Enironmental Sciences groupings in Table 1 will in reality be higher than is shown because the scope of the discipline can spill over into several of the other named research fields, such as Agriculture, Fisheries & Forestry (1), Engineering (4), Biology (18), Chemistry (19) and Physics & Astronomy (22). No attempt is made here to directly address this matter. In addition, it is important to remember that a significant amount of really excellent research across all disciplines is published or otherwise made available without necessarily being subjected to some rigorous peer-review system, and so may not automatically end up in a citation metrics author database. This can apply, for example, to institutional research reports and records, to society newsletters and miscellaneous publications, to books, to conference presentations and abstracts, to maps, to research student theses, to film, TV, radio and online documentaries and articles, to newspaper and magazine articles, to music recordings, and so on. Despite this, citation metrics are probably here to stay, and for the time being the comprehensive composite indicator scheme of Ioannidis et al. (2016, 2019) deserves thoughtful consideration.

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Auckland Geology Club - GSNZ Auckland Branch Field Trips for 2019

Bruce W Hayward

In 2019 the Auckland Geology Club ran 12 field trips with an average attendance of 17 people, the same as last year. Most were one day or half day trips around the Auckland region to: Nikau Cave, Waikaretu (Feb, leader Wendy Goad); Matukutureia/McLaughlins volcano (Mar); Pakaurangi Pt to Puketi, Tinopai (Mar); circumnavigation of Mangere Mt western lava flow field (April); Kauri Pt Waitemata Sandstones, Birkenhead (May); Old Te Henga Rd quarry, andesite- sediment relations (June, Hugh Grenfell); Stanmore Bay - Waitemata Sandstones submarine slide (July); Otuataua lava flows and Maungataketake craters (Sept, Bruce Hayward and Christine Major); Quaternary geology of Southeast Manukau Harbour (Nov, Hugh Grenfell); Xmas BBQ at Pt Chev Waitemata Sandstones (Hugh Grenfell).

We also had two longer trips – the first was a 4 day visit to places in Northeast Northland not visited by previous trips (May, leader Bruce Hayward, 30 participants). Highlights were: visits to the Last Interglacial beach and sand dune sequence at One Tree Pt, Whangarei; the partly quarried Onoke scoria cone and the lava-flow-dammed Lake Ora. These latter two are near Kamo in the young Whangarei basalt field. Next day we visited the complex geology in the cliffs at the north end of Ocean Beach, made famous by the structural work of Bernhard Sporli on the emplacement of the Northland Allochthon and its subsequent deformation. Later that day we visited a recently recognised site on the edge of the Puhipuhi basalt plateau where particularly well-developed basalt karst has not yet been harvested as decorative blocks for people's landscaped gardens. On day 3 we headed to Doubtless Bay where the major stop was to examine the Early Cretaceous Tokerau Formation with its shallow sills, pillow lavas and thin turbidites intruded by early Miocene dikes. Another stop was to examine a recently discovered late Eocene fossil locality in in-situ Ruatangata Greensand at Kaeo. The last day was themed as "in the footsteps of Charles Darwin, 1835" as we visited Waitangi Falls over a basalt lava flow, Puketona scoria cones that Darwin walked among on his way inland to Waimate North Mission Station, where we had lunch. In the afternoon we visited Kawiti Caves, south of Kawakawa - the other place that Darwin visited and commented upon during his second inland foray (see GSNZ NL 22: 10-16).

The second longer trip was an 8 day visit to Northwest Nelson (Nov, leader Bruce Hayward, 28 participants). The Club's last visit to this area was in 2009 and on this trip, we had a mixture of some of the better sites seen ten years ago and some new goodies. We were based in Takaka and had wonderfully fine weather for our full day trips up the Cobb Valley, along Farewell Spit and around the limestone Tarakohe coast to the granite of Totaranui. New places for us to visit included: the old Kairuru marble quarry on a private farm on the top of Takaka Hill; the 1 million-year old Ngarua marble cave; Moutere Bluff Pliocene gravels; the amazing angled biokarst around the entrance to Rawhiti Cave; graptolites in black shales in Aorere Valley; the 1,500 year-old submerged fossil forest on the Rangihaeata coast, Takaka; Oligocene Thalassinoides trace fossil networks at Abel Head; and of course the dinosaur footprints around Whanganaui Inlet.

During the Auckland Heritage Festival (Sep-Oct) the Geoclub and GSNZ Auckland Branch hosted four free field trips for the public to: Karekare crater, Waitakere Volcano; Takapuna fossil forest in basalt lava flows; Pakuranga fossil forests and rhyolitic ash and ignimbrite; and a 6 hr walk around six central Auckland volcanoes (leader Bruce Hayward, average attendance 47). Many thanks to all those who contributed to another enjoyable and stimulating year of field trips, unfortunately there will be fewer to report on for 2020.

Opposite page:

Fig. 1. Large recumbent anticline of Waitemata Sandstone and Parnell Grit (darker) forms 15 m high cliffs at Stanmore Bay (July).

Fig. 2. Examining Last Interglacial beach and sand dune deposits at One Tree Pt, Whangarei Harbour (May).

Fig 1.

Fig 2.

Inspecting the crater of one of the Puketona scoria cones inland from Waitangi. The basalt stone heaps on the flat lava flow surface beyond are from pre-European Maori gardens (May).

Photographing the Devil's Boots Oligocene limestone pinnacles with overhangs in the Aorere Valley, Northwest Nelson (Nov).

The natural Tarakohe road arch, Northwest Nelson, was created during the 1938 Murchison Earthquake when one limestone pinnacle fell against the other (Nov).

The public field trip inside the eroded early Miocene Karekare Crater on the west coast of the Waitakere Ranges was part of the 2019 Auckland Heritage Festival (Sept).

Geoscience and Petroleum

Mac Beggs mac@beggs.nz

I have been encouraged to lead, in conjunction with Miko Fohrmann, a process to revitalise the Society's "Oil and Gas" Special Interest Group, which has lacked a convenor since 2017 and been relatively inactive apart from reasonably frequent newsletter contributions – ranging from scientific notes, to summaries of industry activity, and philosophical discussions - by Don Haw, Chris Uruski, Roger Brand and others.

Well over one hundred Society members have expressed an interest in this SIG, which suggests that there is strong appetite for us to develop a programme along the lines of other vibrant groups. The support of GSNZ leadership for this revitalisation is much appreciated.

The following is intended to stimulate some thinking about the symbiosis which exists between our profession (us) and the petroleum industry (including its customers – also us). Petroleum includes oil and gas in their natural state (crude oil, natural gas) and derivative products such as gasoline, diesel, aviation fuel, pipeline gas, and liquefied petroleum gas (LPG). Many geoscientists are interested in understanding the natural occurrences of petroleum, generally within the sub-surface of sedimentary basins.

Exploration, appraisal and development of oil and gas resources have provided professional livelihoods for several generations of geoscientists since the advent of commercial petroleum industries from the late 19th century. This important application of geoscience expertise in tandem with substantial capital investment in geophysical surveys, and in the drilling and evaluation of wells, has resulted in a very significant contribution to our state of understanding of the earth's crust, sedimentary basins in particular. Many diverse geoscience disciplines have been involved, and have benefited greatly from employment, from technology developments deployed in research, and from copious seismic and well data where it is made available in jurisdictions such as ours.

Petroleum resources are of course finite, and growth in their consumption has caused concern at their ultimate depletion, almost for as long as the industry has operated. In recent decades, these "peak oil" concerns have been largely over-ridden by concern at the consequences on global climate stability of greenhouse gas emissions arising from petroleum product consumption. It is now widely held that petroleum is a

"sunset industry" because these effects are intolerable.
Nevertheless, until the very recent COVID19 pandemic and associated curtailment of economic activity and hence demand for energy, global consumption of petroleum has seen inexorable growth. The following graphs are from BP's statistical review of world energy (2019). The sustained demand has required continuing investment in exploration and development and with technological innovation the development of lower-quality sources of petroleum such as oil sands and shale formations has eventuated.

New Zealand's endowment of petroleum is concentrated in the Taranaki Basin, with both onshore and offshore theatres. Exploration of unconventional resources such as shale formations along the East Coast, and coal seam gas in numerous regions, have not been fruitful. Several frontier basins continue to exhibit promise but have yet to yield a commercial discovery, these are closed to further exploration under policies enacted in 2018.

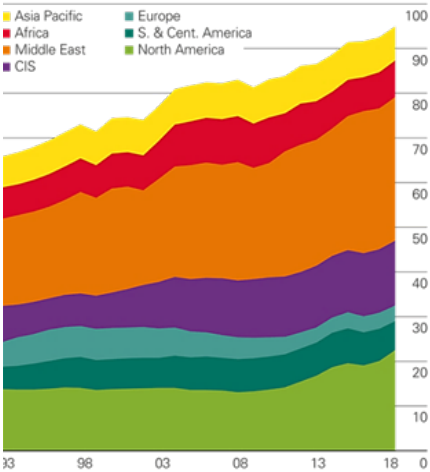
One class of potential resource that is clearly voluminous along the Hikurangi margin is gas hydrate. However, while subject to research and production technology development, commercial development of marine gas hydrate has yet to be pioneered anywhere in the world.

Historic discoveries and technological improvements have continuously extended the known stocks of oil and gas, in New Zealand and globally, forestalling the eventual sunset for the industry. Whether measures to mitigate effects on global climate, such as the Paris Agreement of 2017, result in an earlier and more complete contraction in the scale of consumption than the ultimately inevitable effects of depletion, remains to be seen. Very likely in my opinion, petroleum will continue to present rewarding professional opportunities for geoscientists for at least one further generation. The concept of a "sunset" may exaggerate the pace and totality of demise which many seem to take for granted. When I was recruited into the petroleum industry from a PhD study almost 40 years ago, I would have had little confidence that I would still be employed in the same field when I reached retirement age – because even without growth in demand, it seemed unlikely that enough resources could be added to the global inventory to sustain the scale of production for so long. Likewise, back in New Zealand with GNS in the 1990's, the longevity of then-developed gas fields was not widely foreseen and neither was the likelihood of new discoveries on the scale of the Pohokura field (discovered in 2000). While energy, including oil and gas, may appear plentiful at this time due to over- production and a temporary contraction in demand as a result of the pandemic mitigation measures, this will move towards balance and eventually, to shortage.

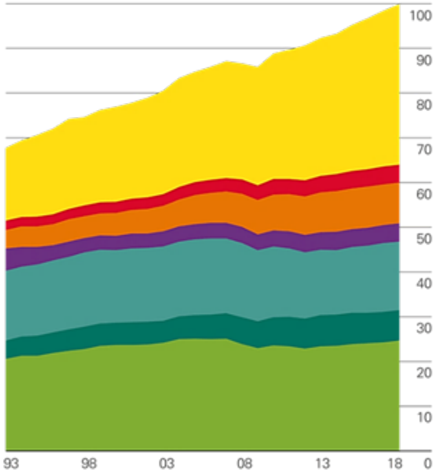
Oil production/consumption by region

Million barrels daily

Production by region



Consumption by region

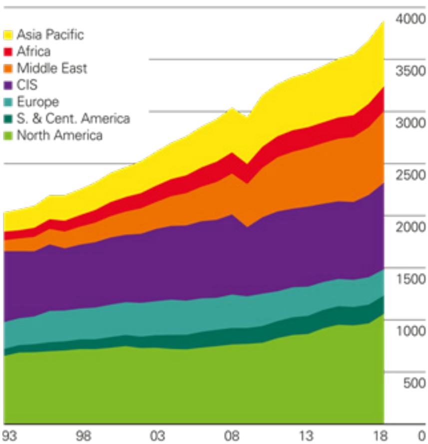


BP Statistical Review of World Energy 201
© BP p.l.c. 201

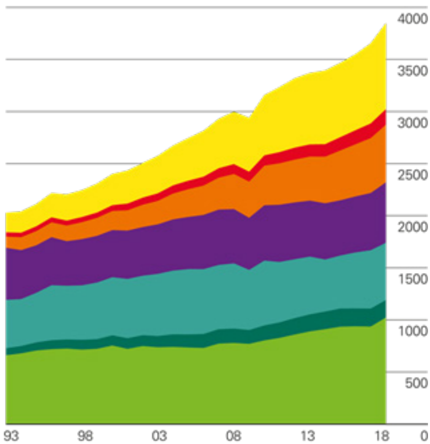
Gas production/consumption by region

Billion cubic metres

Production by region



Consumption by region



BP Statistical Review of World Energy 201
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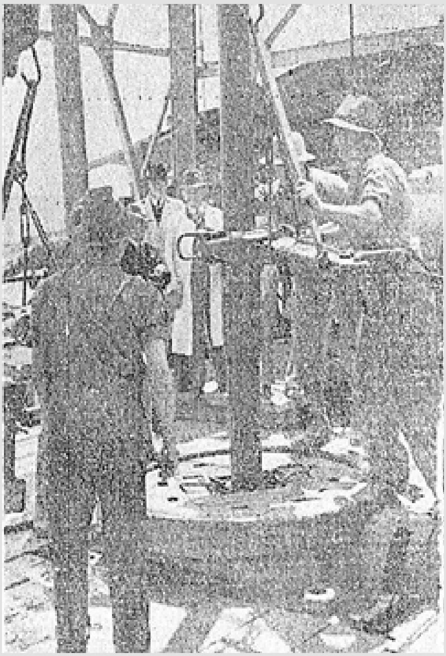
Existing developed resources will be progressively depleted; new discoveries and developments will be required by the children and grandchildren of today's workforce. With our ever-advancing knowledge of New Zealand's geology, and the vast legacy geophysical and well data available thanks to our world-class archive of the fruits of research, exploration and development investments over the past 70 years, our profession will be well positioned to lead a new stage of discovery, evaluation and responsible development.

I hope that the Special Interest Group will appeal to a good proportion of GSNZ members. Please consider participation, and feedback as to what you consider an appropriate agenda and programme. Members who have already indicated interest have been asked to complete a survey, others who wish to influence the direction can request this survey via the Administrator,
Nicki Sayers: admin@gsnz.org.nz.



Ed. note:
from Papers Past. The Gisborne Herald Vol LXXI (21583), December 9, 1944.

SEARCH FOR OIL. —After spending nearly£1,000,000 on boring for oil in the Dominion, the New Zealand Petroleum Company, Limited, is discontinuing further exploration. The illustration shows one of the 90ft. sections of the drill pipe at the Totangi Dome oil bore being unscrewed during the visit of the Minister of Works, the Hon. R. Semple, in November, 1938.

ARTICLES

"Geo-Homes" A Covid-19 lockdown online research project

Anette Ebbett Geraldine U3A (Geology Special Interest Group)

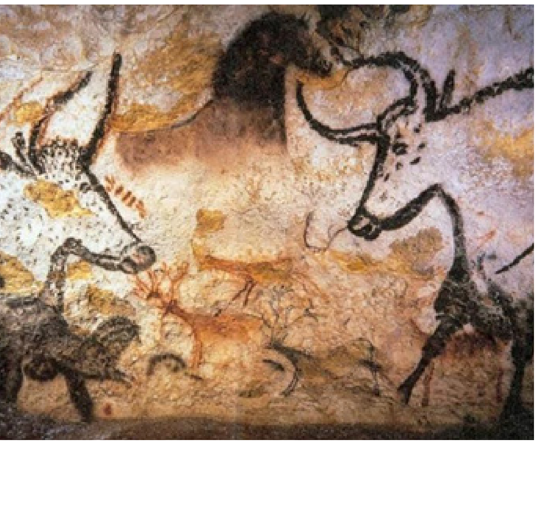
Ed. Note: There are many people throughout NZ invested and interested in all thing's geoscience through membership of geoclubs, mineral and lapidary clubs, natural history groups and U3A ('University' of the Third Age). All these groups contribute to an expression of local knowledge and interest and adds to the 'social capital' of a community. This is an article exemplifying this.

"Geo-homes" gradually formed in my mind after viewing photos of some simplistic rock dwellings in open settlement sites discovered in 1973/4. They are not what we would normally describe as a 'home', but considering the circumstances of the area, the size of the people, and the limited building material available they were adequate for a few hundred years. In fact, they appear to evolve in sophistication over those years. The older ones are simply small, robust, circular stone structures with walls about 1.2m high and clustered as small settlements in an area devoid of any bushes and trees which could have been used in their construction. They were constructed using slabs of late Precambrian schist and over the years, become more elaborate, better preserved, multicellular structures. Perhaps they had wild animal skins secured over them for shelter from the desert sun. "What wild animals?" you might ask. Some examples of the native fauna are, gemsbok and rare mountain zebra.

View of a settlement near the Zerrisene mountain range, Namib desert.

Prior to building simple rock dwellings, ancient peoples had lived in rock shelters and sometimes caves for thousands of years. A rock shelter is a shallow, cave-like opening at the base of a bluff or cliff. They formed natural shelters from the weather and pre-historic humans often used them as living spaces.

Caves are often solutional (karst) and can be many kilometres long. Only a small portion of humanity has ever dwelt in caves. Caves are rare across most of the world; most caves are dark, cold, and damp; and wild animals often made caves inhospitable for people. A famous cave in the French Riviera, was used by people approximately one million years ago. Although stone tools and the remains of eaten animals have been found in the cave, there is no indication that people dwelt in it. Usually shelters or 'tents' were built at the mouths of caves and the dark interiors were used for ceremonies.



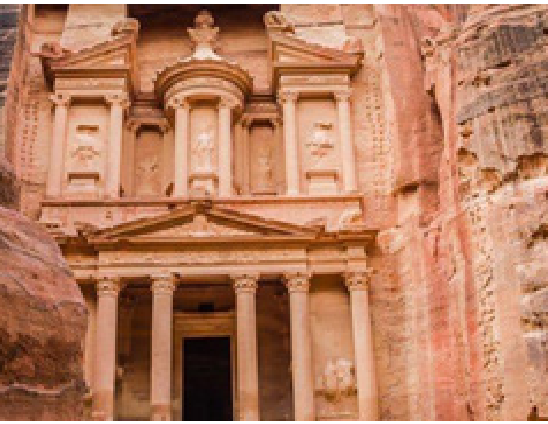
The Lascaux Caves are a well known cave complex in France adorned with famous and impressive paintings estimated to be over 20,000 years old. About 100,000 years ago, some Homo sapiens worked in Blombos Cave, South Africa. They made the earliest paint workshop now known, but apparently did not dwell in the caves.

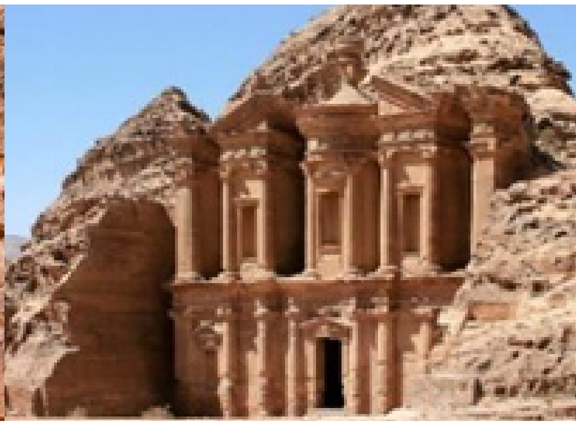
Cliff dwellings, Colorado, U.S.A. Anasazi Indians built homes in shallow caves and under rock overhangs along the canyon walls. These were virtually inaccessible to outsiders and were easily defensible.
The compact, masonry-walled communal habitations were called Pueblos.

An example of cave homes carved into cone-shaped, naturally formed, eroded, compressed volcanic ash formations at Kanovan, N.W Iran. Most of the cave houses are two to four storeys in height. In a typical four storey house, the ground floor is used as an animal shelter, the next two floors are used as living areas, the top floor is used for storage. The hardened material of the pillars is an efficient insulator and the cave dwellings remain cool in summer and warm in winter.

Cappadocia, Turkey where dwellings have also been carved into solidified volcanic ash. Earthquakes sometimes cause damage to the cones and pillars in these areas, but this is seen as a naturally occurring phenomenon.

Petra, Jordan, was an ancient city that was literally carved into red desert cliffs. Famous for its rock-cut architecture and water conduit system, Petra is also called the 'Rose City' because of the colour of the sandstone cliffs from which it is carved. Although the city was occupied in the Middle Ages, it was hit by a series of earthquakes and was eventually abandoned.
(Part of the film "Indiana Jones and the Last Crusade" was filmed in Petra.)“The Treasury”, Petra, Jordan and “The Monastery”, below.





From extreme complexity to quaint, unusual simplicity – an example of a **'cottage'** in England, that has been carved into a sandstone hill. Many of these original homes are warm and dry, while others can get extremely damp— particularly during the winter months.
Rather than carve homes out of ash or sandstone, some are made of rocks or stones. (The solid mineral material forming part of the surface of the earth, exposed on the surface or underlying the soil.)

Skara Brae is a Neolithic settlement located on an Orkney island Scotland. It consists of eight clustered stone houses, complete with stone 'furniture'! Occupied from roughly 3000 BC to about 2500 BC, it is Europe's most complete Neolithic village and is older than Stonehenge and the Great Pyramids.

In the winter of 1850, a severe storm hit Scotland. In the Bay of Skaill the storm stripped the earth from a large irregular knoll known as "Skerrabra". When the storm cleared local villagers found the outline of a village consisting of several small houses without roofs. The houses used earth sheltering, being sunk into the ground. This provided the houses with a stability and acted as insulation against Orkney's harsh winter climate, Skara Brae, is “extremely vulnerable” to climate change due to rising sea levels.

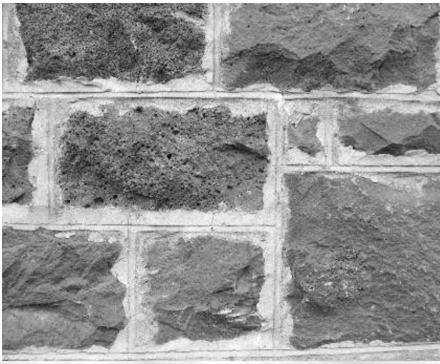
Old stone cottage, Bannockburn area, Otago and an example of a dry- stone wall, Cromwell, Otago.

Renovated Stone cottage, Cromwell

The most common rock used for building homes in Otago since the settles arrived was the local schist, a metamorphic rock created when layers of 250 million year old volcanic rock and sedimentary material was subjected to huge pressures and temperatures of up to 400°C.

Basalt is a dark- coloured, fine-grained, igneous rock formed from the rapid cooling of magnesium-rich and iron-rich lava that is exposed at or very near the surface of the earth. It most commonly forms as an extrusive rock, such as a lava flow. More than 90% of all volcanic rock on Earth is basalt. Basalt lava has a low viscosity, due to its low silica content, resulting in rapid lava flows that can spread over great areas before cooling and solidification.

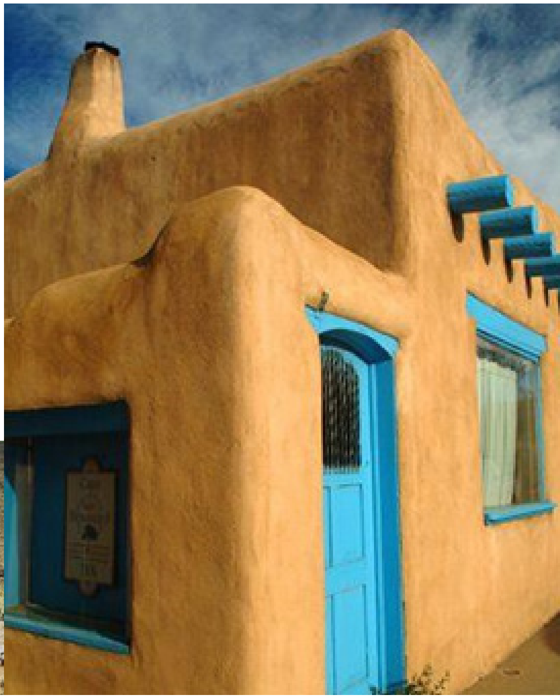
This building was constructed using a mix of basalt blocks with rather course limestone trim at the corners of the building, around the windows and the doors. Mt Horrible Basalt blocks with concrete Quarrymens' quarters, Halswell Quarry



Limestone Homes
Limestone is a carbonate sedimentary rock composed of the skeletal fragments of marine organisms such as coral, foraminifera, and molluscs. Its major materials are the minerals calcite and aragonite, which are different crystal forms of calcium carbonate.

Limestone block cottage, Ashburton Gorge – Then... , and now... .

Adobe homes are found worldwide. A Mexican one (right) and Nepalese adobe house, below. Adobe is a building material made from earth and organic materials. Adobe is Spanish for mudbrick, but in some English-speaking regions the term is used to refer to any kind of earthen construction. . Adobe is among the earliest building materials and is used throughout the world.

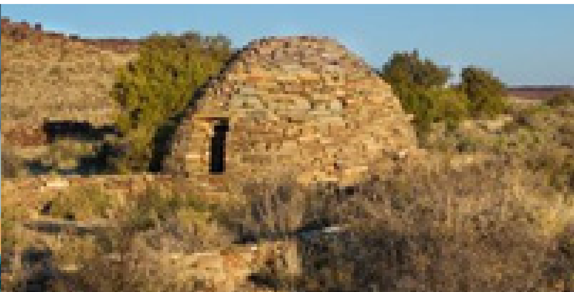


Corbelled houses

South African corbelled houses, looking like white-washed igloos, were built by early 19th century pioneer stock farmers in the Karoo semi- desert land-scape where there was little wood, but plenty of sandstone and dolerite.

This ancient method of construction, known as corbelling,
was implemented by placing successive courses of flat stone, each one ex-tending a little further inward than the layer beneath, until the walls almost met at the apex. The remaining hole over the roof could then be closed with a single slab or removed

Megalithic builders in Mediterranean countries used this building technique from as long ago as 4000 years, with examples of this style of architecture found in Spain, Portugal, Turkey, Greenland and Italy.

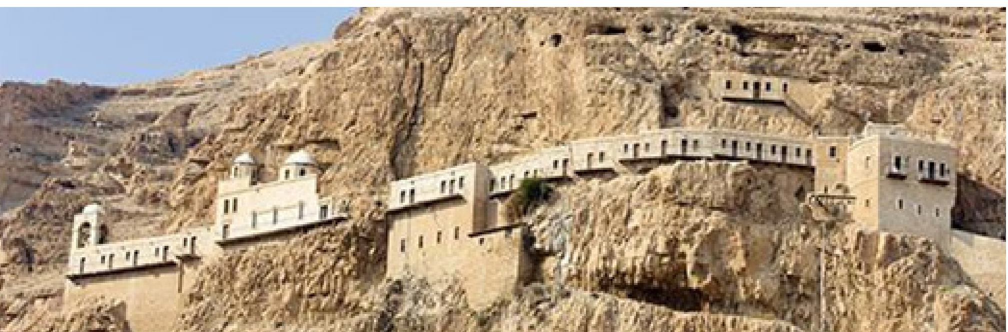


Corbelled houses inside view

Trulli houses, found in, Italy, are constructed in a similar fashion of limestone boulders and feature domed or conical rooves.

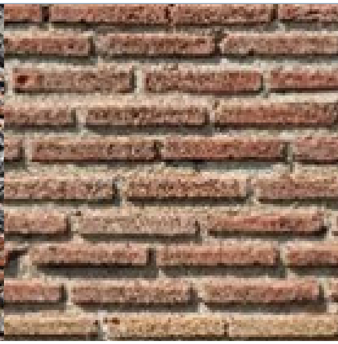
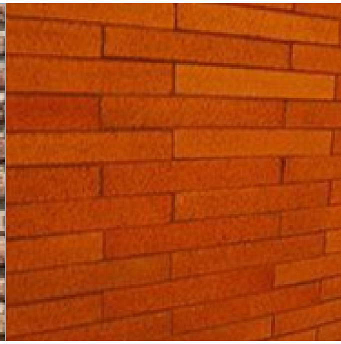
Brick homes. People have been using brick for building for thousands of years. Bricks date back to 7000 BC, which makes them one of the oldest known building materials. They were discovered in southern Turkey at the site of an ancient settlement around the city of Jericho

The first bricks, made in areas with warm climates, were mud bricks dried in the sun for hardening. Ancient Egyptian bricks were made of clay
mixed with straw.



The greatest breakthrough came with the invention of fired brick.

The earliest fired bricks appeared in Neolithic China around 4400 BC. These bricks were made of red clay, fired on all sides to above 600 °C, and used as flooring for houses.

In Victorian London, due to the heavy fog, bright red bricks were chosen which made buildings much more visible. Red remains the most desired colour for the bricks.

Starting in the 20th century, the use of brickwork declined in some areas due to concerns with earthquakes. During seismic events, the mortar cracks and crumbles, and the bricks are no longer held
together. Brick masonry needs steel reinforcement to help hold the masonry together during earthquakes.


ARTICLES

Cement and Concrete – these terms are often used interchangeably.
Cement is an ingredient of concrete. Concrete is a mixture of aggregates and paste.
The aggregates are sand and gravel or crushed stone;
the paste is water and Portland cement.

Cement is the binding element in both concrete and mortar. It is commonly made of limestone, clay, shells, and silica sand, with limestone being the most prevalent ingredient. The addition of water activates the cement, which is the element responsible for binding the mix together to form a solid.

Modern concrete degrades within decades, especially in harsh marine environments. Roman concrete used a mix of volcanic ash, lime and seawater, mixed to bind rock fragments. This mix prevents cracks from spreading. and makes the cement grow stronger—not weaker—over time. More than a thousand years after the western Roman Empire crumbled to dust, its concrete structures are still standing.

Steel/metal homes -
(Steel is an alloy of iron and carbon.) Steel homes and Metal Shipping Container Homes are gaining immense popularity lately. The containers are made from old metal shipping containers and can be multiple levels or have numerous containers attached to each other.

Bottle houses are rare and are made using glass bottles, mainly coloured ones.

The most familiar, and historically the oldest, types of manufactured glass are 'silicate glasses' based on the chemical compound silica (silicon dioxide, or quartz), the primary constituent of sand.

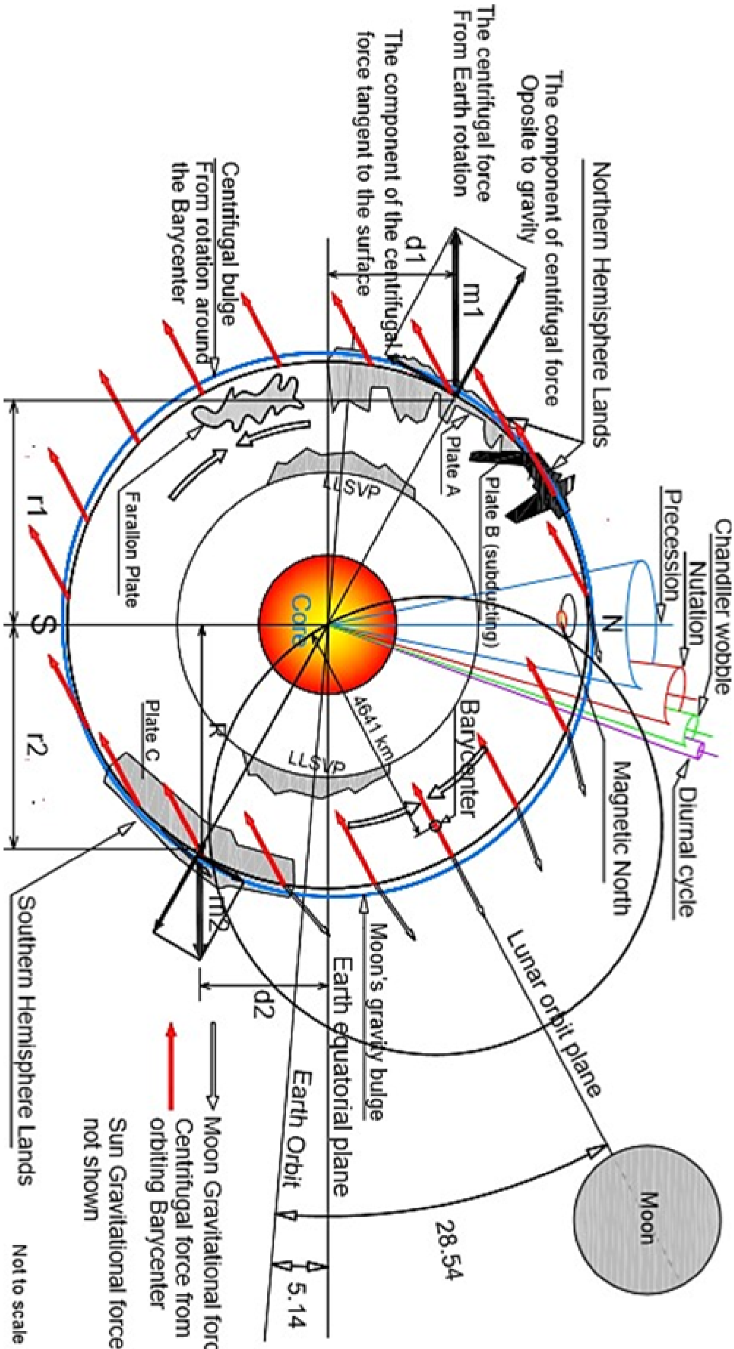
Although brittle, silicate glass is extremely durable. One way it can be coloured is by adding metal salts.

The use of empty vessels in construction dates back at least to ancient Rome, where many structures used empty amphorae embedded in concrete. This was not done for aesthetic reasons, but to lighten the load of upper levels of structures, and to reduce concrete usage.

Old Corrugated Iron backcountry huts that many of us are familiar with. A mixture of stone and corrugated iron is used.

Corrugated iron dwellings, N.W. Queensland

Art by Ronja Kemnitz


Northern Hemisphere Lands
The component of centrifugal force
Oposite to gravity
The centrifugal force
From Earth rotation
The component of the centrifugal
force tangent to the surface
Centrifugal bulge
From rotation around
the Barycenter
d1
m1
Plate A
Plate B (subducting)
LLSVP
Farallon Plate
Chandller wobble
Nutation
Precession
N
Core
S
r1
r2
R
4641 km
LLSVP
Plate C
Barycenter
Magnetic North
Diurnal cycle
Lunar orbit plane
Moon's gravity bulge
Earth equatorial plane
Earth Orbit
m2
d2
Moon
28.54
5.14
Southern Hemisphere Lands
Moon Gravitational force
Centrifugal force from
orbiting Barycenter
Sun Gravitational force
not shown
Not to scale

An open letter to researchers studying forces responsible for the movement of tectonic plates

Tomek Glowacki tomek@tegassociates.co.nz

I call for researchers to broaden up their inquiry regarding causes for the movement of tectonic plates.

Figure 1 - The complexity of the Earth's movement is causing various accelerations/deceleration. In scientists' current opinion, the movement of tectonic plates is still elusive. According to recent publications, one of the primary reasons causing the movement of plates is "thermal convection" occurring in the mantle. But the chaotic flow of magma and the low viscosity coupling between the Lithosphere and Asthenosphere cannot support this theory. I am a mechanical engineer, and these assumptions making me uneasy because they could lead to the wrong conclusions. "The push and pull of slabs", are only the results of movement and are not a cause. "Gravity, Earth's rotation, centrifugal forces, a moment of inertia, and tidal de-spinning..." are an implication only. However, I have not encountered anything in the literature, which considers the Earth's accelerations in this matter. Shifting a continent requires much energy. So, where does this energy come from, in what form, and how is it applied? What creates tangent forces to the Earth's surface, causing these movements? The fundamental laws of physics supported by the current discoveries from other disciplines provide the answer.

According to Newton's second law, a force is represented by the product of mass and acceleration F=ma. An acceleration occurs whenever an object's linear or angular velocity increases or decreases, or the object changes its direction. So, accelerations are created every time the Earth or its part move on a curve. Acceleration is a result of a force applied on a body mass. But a force is not visible. So, to identify a force, an acceleration related to this force needs to be recognised.
The energy necessary for the evolution of tectonic plates comes from:

a) The Earth's rotation around its axis (rotation and wobbling),
b) Circulating with the Moon around a common barycentre and, from
c) Moving through the universe.

These complex movements of the Earth create accelerations. By identifying an acceleration, we are exposing force associated with this acceleration. Acceleration can be identified by careful study of Earth's motions.

New Hypotheses

Various Earth's motions cause accelerations, and accelerations of mass expose forces moving tectonic plate. There are five primary sources of Earth accelerations/decelerations exposing tangent forces to the Earth's surface:

1. The rotation of the Earth around its Centre of Mass (CoM).
2. The wobbling of the Earth (Diurnal Cycles, Chandler wobble, Polar Motion, Nutation, and Precession) and is caused by the heterogeneity of the Earth. The paramount influence has Diurnal Cycle and Chandler Wobble due to a relatively small radius and short cycle. The daily movement of Magnetic North of up to 85 km per day, following the path of the distorted ellipse, is visible evidence of 'wobbling' motion of the Earth's daily cycle. More impor tantly, it shows how the Earth's wobbling can move material (molten iron) even inside the planet. This fact strongly suggests that wobbling of the Earth has a strong influence on shifting tectonic plates.
3. The rotation of the Earth around the Earth-Moon's Barycentre (gravitation and centrifugal forces).
4. A change of the Earth's spin and "slow vibration" caused by the movement of CoM against the axis of rotation caused by volcanos, earthquakes, landslides, tsunamis, hurricanes, glaciers, icebergs, and annual hydrological changes.
5. The change of the Earth's velocity when travelling near the perihelion (second Kepler's law)

Please note: accelerations sometimes overlap each other and either enhance or impair the acceleration.

- Low viscosity in the boundary between the Lithosphere and Asthenosphere allows for Lithosphere-Asthenosphere decoupling.
- Solid Land Tides (SLT) are caused by the Sun and Moon gravity and centrifugal forces induced by rotation around barycentre, creating land elasticity and helping to move tectonic plates.

In summary, energy comes from Earth's movements, various Earth's movements trigger forces tangent to the surface of the earth, these forces can be identified by identifying accelerations, which in turn can be recognized by studying the Earth's movements. Solid Earth Tide only makes the lithosphere more flexible. By accepting this hypothesis, we can logically explain many phenomena and episodes of the Earth. For example, how cycles of super continental amalgamation and dispersion have repeated, whether these processes have affected magnetic fields, climate change, life on Earth or plate movements. Also, how natural sources such as oil and gas have fallen under the bottom of the Arctic Ocean, perhaps it would be easier to interpret lost under water cities and find an explanation of how biblical floods occurred. All these phenomena could have been the result of a sudden lithosphere shift (ASL). The survival of today's science lies in an exceptional synergy of many scientific disciplines and its holistic approach. I hope this letter can engage a broader audience and encourage lively discussion.

Author Bio. **Tomasz (aka Tomek) M. Glowacki'**
Tomek Glowacki – has over 40 years' experience in various industries such as shipbuilding, smelting, construction, and tertiary education. Mechanical Engineer, Project Management Professional, Six Sigma Black Belt, ISO IBMS Lead Auditor, Ocean Going Yacht-Master.
Now semi-retired. Author of the book: "Successful, win-win strategies for a superyacht project - what makes or breaks the construction of a superyacht". His latest passion is the movement of tectonic plates. In his research, he considers himself a curious and analytical researcher with a holistic approach to discovering.

New Zealand Geology: an illustrated guide

By Peter Ballance, with illustrations by Louise Cotterall

Edited, updated and prepared for final publication
by Bruce Hayward and Jill Kenny.
397pp, available as a free pdf download at
http://www.gsnz.org.nz/information/nz-geology-i-26.html

Reviewed by Julian Thomson

This book attempts to unravel the daunting complexity of New Zealand's dynamic geology in such a way that it can be grasped by a non-specialist reader. With a lifetime of acquired knowledge to draw on, Peter Ballance took on this project over the last 11 years of his life. The draft was not quite finalised by 2009, when Peter passed away. Eventually in 2016 Jill Kenny and Bruce Hayward took on the task of formatting it, adding numerous photos and updating some details of the text. Whilst it is not available as a published hard copy, it is free to download in pdf format, courtesy of the GSNZ.

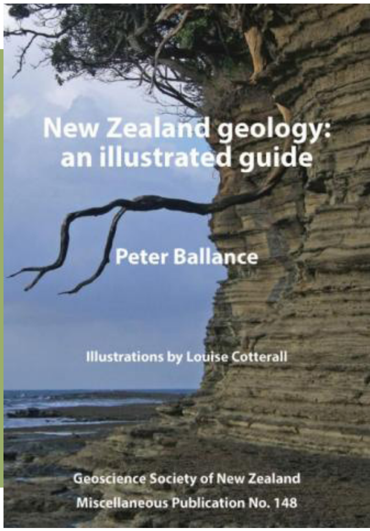
11 years of effort is a huge dedication of time and focus, and when you take a look at the outcome, it is easy to see why that amount of time was taken. It offers rich and eye opening coverage of how New Zealand has been shaped, slowly building up a comprehensive tectonic framework whilst leading the reader into a huge variety of detail. The unifying element that anchors all the information, all the distributed outcrops and the diverse biological, physical and chemical processes that are included, is the portrayal of our complex and evolving plate boundary.

The book is in three parts: an introductory section (a mere 46 pages!) where Peter leads us step by step from the dating of rocks, plate tectonic processes and unique details of the New Zealand plate boundary, to an overview of the evolution of Zealandia from 500 million years ago to present. In parts 2 and 3, he then dives in to the detailed geology of the country by dividing it into 17 geological regions, which are treated according to their individual character. Numerous diagrams and text boxes that explain geological processes (with very clear and well-designed graphics by Louise Cotterall) are introduced as we progress from region to region, and these can be referred back to where they apply again later down the track. One improvement that could be done with these stand-alone boxes would be to list them in the contents page to allow them to be found more easily. This would offer a 'topic based' entry point into the content.

In the preface, Peter suggests that the book will be useful for senior secondary and first year tertiary students. It is indeed written with very clear explanations, using non-technical language and supplemented with many excellent diagrams, maps, and photos, making the content accessible to interested non-specialists. At the same time, with nearly 400 pages of densely packed information, this is not a light read, but something to invest considerable time and effort in. Anyone who does so will be richly rewarded with fascinating insights into a myriad of processes and events that have created our multifaceted landscape.

Educators and communicators will surely be pleased that they have permission from the Ballance family and GSNZ to freely share any of the text or illustrations.

For me personally, reading through this book has been a deeply enlightening experience of how all the jigsaw pieces of our geology fit. Peter had a fantastic ability to link phenomena on different scales and express the information very clearly. I would heartily recommend this book to anyone who is keen on geology and has the time on hand to work through the text. I hope that the existence of this fantastic legacy of Peter Ballance will be widely promoted by the geoscience community.



"Mary Kathleen Reflections"

by Andrew Cuthbertson

Published by Amazon, May 2020, 95pp,
in e-book and hard copy format

Review by Cam Nelson (campbell.nelson@waikato.ac.nz)

What a delight it was to recently receive an email from Andrew Cuthbertson, one of my postgraduate students of 40 years ago, who has just published a new book having full title "Mary Kathleen Reflections:
A loss of innocence working at a uranium mine in the Australian outback".
Andrew completed an MSc(Hons) degree in Earth Sciences at the University of Waikato in 1981 with a thesis titled "The Hinuera Formation in the southern Hauraki Lowland, central North Island". Subsequently, his study formed a part of the Kaimai 1:50,000 geological map sheet T14 (Houghton BF & Cuthbertson AS 1989. Kaimai: Sheet T14 BD. 1 map and notes 35 p. Geological map of New Zealand 1:50,000).
Straight after completing his MSc, Andrew departed New Zealand for the mining industry in Australia to work during 1981 and 1982 as a mine geologist at the remote Mary Kathleen uranium mine in North West Queensland. His book describes in a factual and often humorous way the personal experiences of a young geo-graduate entering the mining workforce for the first time, and what life in a small, outback mining town with its tight-knit community was like before final closure of mining operations in late 1982.
Following a Preface, in which the history of uranium mining in Australia is documented, including a reminder that Australia is reported to hold the largest reserves of uranium in the world, the text is arranged into seven, well-illustrated chapters:

Chapter 1 – The Mary Kathleen mine: Describes the discovery (in 1954), geology, and history of commercial development and exploitation of the mine.

Chapter 2 – The journey begins: Highlights the trials and tribulations of geo-job hunting in New Zealand and Australia, the eventual offer from CRA Group (Conzinc Riotinto of Australia) to become a mine
geologist at Mary Kathleen, and the initial apprehension of a young man moving from New Zealand to begin employment in a very remote, hot, and variably dry to humid location in outback Queensland.

Chapter 3 – Life as a mine geologist: Together with a number of aside tales and an amusing poem from an anonymous mine worker, Andrew outlines the operations associated with mine site exploration, quarrying, processing and worker safety, and his own main responsibilities for monitoring pit geology, structural mapping and production grade control.

Chapter 4 – The last phase of exploration: After more than 20 years of successful operation, the final pit-engineering plan for Mary Kathleen was, by 1982, drawing to an end. With uncertain futures, stress on the townsfolk was mounting, and so a new exploration phase in the vicinity of the mine and elsewhere, involving geophysical and ground surveys and drilling, was mounted in an attempt to extend the life of the mine. Overseeing and management of this exploration proved to be a bit of a nightmare, and in the end the attempt failed.

Chapter 5 – Mary Kathleen and the wider world: Andrew provides some fascinating and often amusing insights into the retail, sporting and other facilities supporting the mining township of about 820 people, and the often-tense interactions between the mine management staff and the mine workers. He records that at times strikes, security and corruption issues, and clandestine operations were a part of mine life
.

Chapter 6 – Social environment: Despite Mary Kathleen offering several sporting and cultural opportunities outside work hours, issues existed due to a “social gap” between management staff and the general workforce, and between some married and single employees. Only small numbers of single females were in town. For many, nearby Mt Isa became the venue of choice for social occasions. Again, Andrew has some amusing tales to tell, and concludes the chapter with another humorous poem about social life from an anonymous mine worker.

Chapter 7 – Preparing for the end: This “winding down” chapter reports the procedures adopted by CRA for the gradual shut down of the mine and township during 1982. Consideration was given to the welfare measures and future jobs for company personnel.
Environmental rehabilitation of the mine site was undertaken, and equipment and buildings sold. The Mary Kathleen township officially closed on 23 October 1982. This 95-page book is both a factual and captivating read for anyone, layperson or professional, interested in exploration geology and what life can be like in a remote small mining town. It should be of particular interest to those new geo-graduate students thinking about a career in geological exploration. It will be essential reading for those intent on visiting and

exploring the Mary Kathleen "ghost town". Andrew's book is self-published and available through www.Amazon.com in electronic and hard copy format. Hard copies will also be available via the author from early August at ascuthbertson1957@gmail.com.

Following his Mary Kathleen geo-experiences Andrew went on to have a 35-year professional career in the international mining industry. During this time, he contributed to the discovery and development of copper-gold mines in Papua New Guinea, Indonesia, the Philippines, Mongolia, and Columbia, and he supervised high-level geo-political and stakeholder engagement in many countries across four continents. As well as writing extensively about the mining industry in Southeast Asia, South America, and Eastern Europe, he has published two previous books, available through www.Amazon.com: "Neither the Time nor the Tide: A Personal Perspective of the Second World War and a Life Thereafter" in 2004; and "Posting to Mongolia: A Personal Perspective" in 2019. Andrew is married and currently lives in retirement in Perth, Australia.

View north over the Mary Kathleen mine site.
Photo source Andrew Cuthbertson.

Roger Cooper

12th March, 1939 – 2nd March, 2020

By James Crampton, Alan Beu, John Simes, Richard Fortey

Dr Roger Cooper, FRSNZ, passed away on 2nd March, 2020, following a battle with cancer. Roger was one of New Zealand's pre-eminent paleontologists. His contributions to our understanding of Zealandia's rich geological and paleontological histories are enormous and he leaves an important corpus of local and international research. His life was rich: accounts of his career read like something from a child's adventure story and open a window on explorative, frontier-style field research that is now almost a thing of the past. He was an insightful, gentle, generous and kind colleague and mentor, and a person of great integrity.

He was, quite simply, one of the best.

Fig.1 Roger in the office of the Chief Paleontologist, New Zealand Geological Survey, 1988.

Roger grew up in Eastbourne, the seaside village suburb of Lower Hutt, located on the eastern shore of Port Nicholson (Wellington Harbour). The son of Lawrence and Roslyn Cooper (nee Sherman), he was the second eldest of five children. His parents met in 1933 on a ship to the UK, when Lawrie was starting his OE and Ros was leaving Burma, where she had grown up. Eastbourne in the 1940s afforded ready access to waters of the harbour and the steep, bush- clad hills fringing the village, and adventure for the children was never far away. The Pencarrow coast track to the south was one of Roger's favourites, and site of a secret valley where he and his father boiled billies and, later, where Roger camped with his own family. Other adventures for Roger lay in the garden shed and presaged use of a rock hammer – once, his father found Roger hammering a live .303 cartridge in the vice to see what would happen, and at other times the young paleontologist hammered holes in the lids of his father's home brew in order to test the contents.

As a child and young man, Roger was a passionate Meccano fan and woodworker – some of his furniture creations are still used by his brother Nigel. He was also a committed Wolf Cub, head prefect at Muritai School, tramper and cricketer. On the subject of cricket, Roger recalled that the small lawn of his childhood home was squeezed between beach and home, and he attributed his life-long weakness of cricket leg-side strokes to the fact that these resulted in broken windows and were strongly discouraged; despite this, he was an opening batsman for Hutt Valley High School's 1st XI.

Fig.2
Roger leads a pack horse through the Clarence valley during field work with Gerald Lensen, January-March 1960.

As a geology student at Victoria University of Wellington, one of Roger's first paid tasks was in January 1960, as field assistant to Gerald Lensen of the Geological Survey, who was making the original 1:250,000 geological map of Marlborough. The trip lasted almost three months and was an incredible learning experience for the second-year student. Along with Mike Hall and Tom Haskell, also student assistants, three pack horses, military radios, and rifles, they wound their way into the Clarence valley after stints in the Awatere valley and on the coast. A dislocated shoulder, acquired using a rock hammer as an "ice axe" on steep scree, meant that Gerald had to go out for treatment, and for much of the time in the Clarence, the three students were on their own. The area is remote and other humans encountered were mainly deer cullers more used to the company of themselves and their dogs. The beautiful and well- provisioned cob cottage at Quail Flat was a welcome oasis, complete with outdoor, wood-fired bread oven and a radio that worked (their military radios having proven useless). Roger recalled that, in a lovely juxtaposition, the BBC news on the night that they arrived announced both the birth of Prince Andrew and the invention of the contraceptive pill. A scheduled air drop of provisions was only partially successful – the provisions did indeed drop, but the contents of the carefully packed and straw-padded sugar sacks were distributed over a large area of river flats, and pervaded by honey, having been despatched from a great height, at great speed, by the pilot. The horses were a mixed blessing, but this did not stop the party from wrangling and semi-taming a half-wild stallion.

Things came to a head when one of the cantankerous mares bolted, with cameras, film and completed field maps on her back; a split-second decision by the geologist holding the rifle resulted in a £40 bill from the farmer to the Geological Survey for one "very valuable" horse.

The following summer, Roger swapped the heat of inland Marlborough for ice, as a student member of the Victoria University Antarctic Expedition (VUWAE 5). This took him to the western margin of the Koettlitz Glacier and the flanks of the South Victoria Range. For two months his job was to make a geological map of the region as the party tramped between base camps and food dumps that had been deposited by helicopter. One of the food dumps almost resulted in catastrophe, as the aging helicopter hit the snow in a saddle but, remarkably, bounced and continued flying.

Fig.3
Roger, on right, during the Victoria University Antarctic Expedition (VUWAE 5) to the Koettlitz Glacier and the flanks of the South Victoria Range.

Other dramas followed. Roger recalled the angst and profound isolation of crossing a large glacier in total whiteout – unable to see even one's own feet – the five party members navigating by compass, linked by rope and ready to plunge their ice axes into the snow should the rope suddenly run, indicating that one of them had fallen into a crevasse. On Christmas Day, working as usual, two members of the party found flowing water, the result of a breached ice dam at the snout of a glacier. Boxing Day was spent by the entire party building a “scientific” dam and then swimming; Roger always supposed that this was the first swim in a flowing river in the Ross Dependency. In typical New Zealand style, the expedition had begged and borrowed much of their equipment, and lived in woollen clothing, carrying everything in old Mountain Mule packs. Camera film, rolling tobacco and liqueur were donated by Wellington companies. Most of the time, meals comprised “white powder, grey powder, yellow powder” (milk, potato, egg) that were mixed with water and cooked. In later years Roger returned to the Antarctic twice, leading expeditions in 1974-5 and 1981-2. During these expeditions, the parties produced geological maps and made important fossil collections that have clarified the geological history of Antarctica and its relationships to the other continental fragments of the great southern supercontinent Gondwana.

During 1961, Roger completed his BSc Honours at Victoria University. Unbeknownst (perhaps) to university authorities, he lived for two months in the old green sheds that used to house the Geology Department, with a sleeping bag under a work bench and his primus above. Later, he was to share a famous student flat with a number of notable geologists – James Kennett, Tom Haskell and Jim Eade. The following summer, Roger accompanied several other students (including one of us: AGB) and the Wellman family for a geological tour of north-western Nelson, and it was during this trip that Roger’s MSc topic – the Ordovician and Silurian in the region of the Pikikiruna Range – was identified. Upon completing his MSc, he spent a year mapping area of commercially useful limestone in Otago and Southland for the New Zealand Geological Survey. His MSc research set the course for much of his subsequent career, but before starting his PhD, he embarked on a rather different enterprise.

Starting in March 1963, Roger undertook an eighteen-month United Nations contract in Sabah, Borneo. The Labuk Valley Project was designed to investigate resources needed to support local industry in the lowlands and thereby encourage the hill tribes to resettle, so that they would have access to modern medicine, education, etc. The project involved geochemical sampling traverses in remote areas, lasting a week to ten days at a time, with transport by canoe and then by foot through the jungle.
Assistance in the jungle camps and on the traverses was provided by Iban people; they travelled without shoes, carried large weights on their backs in sheet-iron boxes, were highly skilled in jungle lore, expert navigators, and careful to protect Roger from harm.

The young geologist shared the "tent" – a fly sheet draped over a pole – with the Ibans, conversed with them in Bazaar Malay, and greatly enjoyed these traverses.

Throughout his later field work in New Zealand, Roger used the parang – the jungle knife forged by hand from the leaf spring of a car – that was gifted to him by his jungle minders (the blowpipe, on the other hand, was used only for entertainment in New Zealand).

Roger's early plans to live off tinned meat whilst in the jungle resulted in vitamin deficiency and saw him eat thereafter with the Iban: on the jungle traverses, they lived largely off the land, eating land turtle, fish, mouse deer, snake, monkeys, fungus, berries, and bark, all accompanied by rice. Wildlife was a constant source of interest and irritation, in equal measure – fire ants, enormous spiders and leeches, gibbons whooping and swinging through the trees, hornbills, geckos, giant pythons up to seven metres long, and other snakes such as a green whip snake that became Roger's ill-tempered pet for a short time. Again, there was near disaster involving a small aircraft, when they became trapped above thick cloud that was surrounding unseen mountains; eventually the pilot flew the plane down in a tremendously steep spiral through a small hole in the clouds, levelling out just above glimpses of ground.

Fig.4
Roger and a bogged motorbike, during one of his recreational motorbike rides in Borneo, 1963.

As if such adventures weren't enough, Roger teamed up with another expatriate for explorations using borrowed scrambler motorbikes; the highlight of these trips was along an abandoned and, to all intents impassable, former wartime track across the Crocker Range to the foot of Mt Kinabalu. Bouncing the bikes over fallen trees, walking them through bogs, and at one point carrying them over a large slip with the help of bemused locals, eventually the benighted travellers had an unplanned stay with a local hill tribesman in his shanty. Late in 1963, Roger was joined in Borneo by his then wife Dot – they had married just ten days before he had first departed for the contract, and she then worked at the Geological Survey in the town of Jesselton (now Kota Kinabalu) whilst Roger was away on his jungle traverses. Together they continued to explore the west coast of Borneo, and climbed Mt Kinabalu (4095 m). Recently, in 2018, Roger returned to Borneo with his second wife, Robyn, and managed to reconnect with some of the families he had known there in 1963-4. Later, Roger's recreational adventures continued with Robyn: they climbed Mt Vesuvius during one of several archaeological trips to Turkey and the Middle East, experienced hot-air ballooning in white-out over Cappadocia, tramped around Lord Howe island, and explored his mother's old haunts in Burma, being guided in her hometown of Maymyo by the family who bought the property from Roger's grandmother in 1933 and still live there.

Fig.5
Roger talks to locals during one of his recreational motorbike trips in Borneo, 1963.

During his MSc research, Roger had become interested in evolution of a particular fossil graptolite species, Isograptus caduceus; graptolites are an ancient group of animals, now extinct, that floated in the oceans and dominated marine ecosystems about 400-500 million years ago. Upon return from Borneo, he embarked on a PhD at Victoria University to study these fossils, supervised by Harold Wellman and Paul Vella. The senior geology students had their offices in an old house at 11 Clermont Terrace, about a kilometre from the main university Kelburn campus. Harold and Paul usually joined the students for lunch, and Harold – famously argumentative – typically would have dreamed up a topic for "discussion", often not geological, and so the problems of the world were solved, one by one,

as toast burnt on the ancient gas stove.
One of us who shared that house (AGB) remembers this as a wonderfully enjoyable time of life. Roger's thesis was examined in 1969 by the famous Woodwardian Professor Oliver Bulman, at Cambridge University, who described it as "a very sound piece of work" – praise that was almost unknown from the hypercritical old professor. With the award of his PhD, Roger secured a position as Paleozoic paleontologist at the New Zealand Geological Survey in Lower Hutt.

Following his employment at the Geological Survey, Roger continued working on the paleontology of the northwest Nelson area. In 1969 he recruited one of us (JES) as a field assistant and, over 20 subsequent years, unravelled the complex, fascinating geology and paleontology of New Zealand's oldest rocks. Roger had refined outdoor skills that had been honed by tramping trips as a youth and coaching from the Iban in Borneo. He could make a distinctive rising, Tarzan-like call that would travel great distances in dense bush and, it turns out, proved invaluable for relocating a lost field assistant. He would carefully construct parsimonious fires at lunchtime – just enough to boil the billy and toast the mould from the bread – paying close attention to the choice of firewood, billy pole and toasting fork. In all of this, he used the parang given to him by the Iban in Borneo. On many of the longer field seasons, Roger was accompanied by his now-growing family, who would set up base camp for the summer in the Cobb valley. After long days of geology in the hills and valleys, he would return and help settle children – Alan and Julie – and share stories, play games, and do homework. During one of these field seasons, Roger won a crate of beer in a wager with the Director of the Geological Survey: in the first outcrop he sampled, Roger discovered what are still the only known fossils in a large tract of rocks known as the Greenland Group, a unit that the Director and many other geologists had declared unfossiliferous. As he had done elsewhere in his travels, Roger always did his best to befriend the locals. One such person was Jim Sweeny, a hermit gold miner who lived in a tiny bush hut near Mangarakau. Jim, a self-taught chemist, cultured yeast for his bread from the air and had been jailed as a conscientious objector and pacifist during World War I. His pacifism extended to rodents, which he would live-catch and release on the other side of the creek. On occasion the geologists would stay with Jim for a night or two, careful not to outlast the hermit's welcome, and Roger would always bring him whisky, cigarettes, and other provisions. All this fieldwork culminated in the publication, in 1979, of a large monograph (amongst many other publications), "Ordovician geology and graptolite faunas of the Aorangi Mine area, north west Nelson, New Zealand" (New Zealand Geological Survey Paleontological Bulletin 47). Forty years later, this publication remains the only comprehensive treatment of the Ordovician and Silurian stratigraphy and paleontology of New Zealand; as things stand, there is no prospect of the work being updated or superseded. His research on these rocks and associated formations also gave Roger key insights into unravelling the complex structure and history of the ancient terranes

– building blocks of the crust that have been brought together by continental drift
– that make up the oldest parts of the continent Zealandia, and he co-authored the current version of the geological map of the Nelson region.

In 1989, Roger became Chief Paleontologist at the Geological Survey, a role that he held for eight years. Over this period, he successfully managed and mentored about 20 staff through major and sometimes painful structural and funding changes that were occurring in the New Zealand science system, and the transition from the Geological Survey to the Institute of Geological and Nuclear Sciences (now GNS Science).
It is sobering and, in these times, somewhat depressing to note that Roger devoted just Friday afternoons to the completion of all administrative duties associated with the role of Chief Paleontologist. Over the same period, for 11 years Roger led one of the large public-good science programmes within the Institute, which undertook a wide range of paleontological research related to geological mapping, resource exploration, climate and environmental change, and geological time scale development. That GNS Science has maintained a strong team of paleontologists doing relevant and cutting-edge research can be attributed, very much, to Roger's careful stewardship of the group, and this represents a major service contribution to New Zealand science that will have impact well into the future. For those of us who often ate lunch with Roger in the office of the Chief Paleontologist, we remember with fondness his lunchtime tea that he preferred to drink so weak that, some days, he was forced to ask us whether or not he had added tea leaves to the pot. Roger retired from GNS Science in 2002, but maintained an office there and went on to publish another 70 peer-reviewed book chapters and scientific papers, many in highly ranked international journals.

Roger's scientific legacy spans many areas, and it simply isn't possible here to give any more than a passing sense of his research contributions. In 1993 he was selected to chair the Cambrian-Ordovician Boundary Working Group of the International Subcommission on Ordovician Stratigraphy, the committee tasked with defining the boundary of this key division of the international geological time scale. The successful prosecution of this contentious and geopolitically charged task – this was no gentle discussion over tea and scones – is testament to Roger's patience, diplomacy, knowledge, standing, and impartiality. At the same time, he was instrumental in using new quantitative approaches in innovative ways to refine the geological time scale itself, and he is first of two authors on the currently accepted international geological time scale for the Ordovician Period. He brought the same skills to bear on New Zealand's very own geological time scale – the scale that is used to calibrate the timing of geological events and rates of geological processes that have affected Zealandia. In 2004, under his leadership, a comprehensive and ambitious revision of the New Zealand geological timescale was published (GNS Monograph 22). This is still regarded internationally as the benchmark for regional geological time scales.

Throughout his career, Roger has tackled large questions in evolutionary and paleobiological research, and he has always brought novel insight and clarity of thinking to scientific problems. His early work on graptolites provided a standard for description of these ancient organisms, with collaborators he used them to test models of continental drift, and he was also the first to attempt to use (then) very new, objective techniques to classify the group. With his son, molecular biologist Alan Cooper, he examined the implications of putative mid-Cenozoic (about 25 million years ago) drowning of Zealandia on the development of New Zealand's unique terrestrial biota; this research subsequently inspired several high-profile research programmes. He then recognised the potential of New Zealand's remarkable online "Fossil Record File" to investigate questions relating to the controls of marine biodiversity, and he conceived two successful and prestigious Marsden Fund projects on this topic, although he generously encouraged others to take the lead on these. More recently, with Professor Pete Sadler in California, he used the unparalleled fossil history of the graptolites that they developed, together with entirely novel analytical approaches, to generate important new insights into planetary-scale relationships between climate change, geochemical cycles, and evolution and extinction in the marine realm.

Roger received many awards and accolades over his career. To name just a few, he received the McKay hammer of the Geological Society in 1980 for the "most meritorious published work on NZ geology", he was elected a Fellow of the Royal Society of New Zealand in 1988, he was awarded a DSc from Victoria University in 1993, and he received the NZ Science and Technology Silver Medal in 2003 and the Hutton Medal in 2017, both from the Royal Society of New Zealand, for "research of outstanding merit". He received many funding awards to support travel and research overseas, from institutions in New Zealand, Australia, China, the United Kingdom, Sweden, and Germany. Foremost amongst these was a prestigious Nuffield Travelling Fellowship, awarded in

1979, that enabled him to spend 15 months at the Natural History Museum, London, and Cambridge University, to pursue his graptolite studies.

Roger is survived by his first wife, Dorothy (Dot) Cooper, his children Alan and Julie, his second wife Robyn Cooper (m. 1991), her children Katrina and Aaron, and grandchildren Meghan, Lauren, Bianca, Torin, Erica, Pierce, Chloe and James.

During one field season in northwest Nelson, whilst hiring motorbikes in the town of Motueka, Roger spied a Penny Farthing leaning against a wall. In no time he had dusted it off and was doing figure-of-eights in the courtyard, before he cycled off down the main street.

He brought such levity and humour to all things –his colleagues never saw him angry or upset. His humour shines through the notes that he prepared for his own funeral:

"To my family and my friends. If you are listening to this message, it is because I am no longer with you. Sorry about that – I had another appointment that I could not put off … I have never felt that I retired from my work as a research scientist – it has been an abiding interest for me. But now I am retired, properly … in the literal sense. It has been a great life and I have enjoyed it immensely".

With those words, Roger Cooper has now ridden the Penny Farthing off into the sunset.

Ian Devereux MSc., PhD., FNZIC., AMAusIMM.

(1940-2020)

Geoscientist and founder of Rocklabs

Adrian Pittari, David Lowe, Chris Hendy, Cam Nelson and Vince Neall

Ian Devereux (born 11 February, 1940) passed away on 25 April, 2020 at the age of 80. Ian is well known as the founder of Rocklabs in 1969, which became a world leader in scientific rock-testing instruments. He has been described as “one of the export ‘Vikings’ of the 1970s, 80s and 2000s who led New Zealand's expansion as an export nation” (Rob Stock, 18 June, 2017, Stuff). His story and the rise of Rocklabs has been told in his biography Ian Devereux: To Cut a Long Story Short, by New Zealand biography writer for Life Stories, Karen Jarvis (self- published, 2017), who particularly recalls this as one of her most interesting biographies (Danielle Clent, 22 March, 2018, Stuff). She notes his fascinating stories as a forensic scientist on the Arthur Allan Thomas case and his “scary and hilarious” travel tales while visiting over 55 countries on company business. Business journalist Rod Oram of the Sunday Star Times, who coined the term “export Vikings”, noted Rocklabs as “a new type of business model on the rise: specialised, world-class, hard-working and little known” (Rob Stock, 18 June, 2017, Stuff). Ian is particularly remembered for his business generosity having shared the company profits equally with all staff, and when it was eventually sold to Scott Technology in 2008 the large sum of payment was shared with family, friends and Rocklabs employees. During tougher times, Ian took a large pay- cut himself to reduce company debts without cutting employees’ wages.

Less well known to the New Zealand business community is Ian’s early research career in the 1960s. Yet, his early work on oxygen isotopes has influenced geoscientists from several geoscience subdisciplines, in particular on his palaeotemperature measurements through the Cenozoic (Devereux, 1967a,1967b; 1968a,1968b; Devereux et al., 1970) and work on the Otago metamorphic belt (Devereux, 1968c; Devereux et al., 1968). A Science paper on palaeotemperatures from fish otoliths is also worthy of note.
Fundamentally a geochemist, Ian was raised in Otago and completed an MSc in geochemistry at the University of Otago (Devereux, 1961).
He then worked briefly as an industrial chemist running a small paint factory before going on to complete a PhD on Application of oxygen isotope studies to some New Zealand geological problems at Victoria University of Wellington with DSIR.

Chris Hendy worked closely with Ian at Victoria University and remembers him during his PhD days.

"Ian and I shared an office (and chair actually) as we were both given DSIR PhD scholarships on condition we ran the Nuclides Mass Spectrometer donated to NZ under the atoms for peace program. As Ian had a family (wife Felicity), he ran it in the daytime and I ran it at night. Ian started a little earlier than me and finished sooner, so I had to pick up some of his unfinished projects after he left (Mangaopari Stream section). Ian's thesis was very broad. He wanted to analyse the Otago metamorphic belt and determine the palaeotemperatures using oxygen isotopes of co-existing silicates. However, there was no-one in the Geology Department at Vic who was prepared to supervise it, and so a compromise was worked out. Half of the thesis could be on the Otago schists and the other with Paul Vella's pet project to determine a palaeotemperature curve for the Tertiary in New Zealand. To do this, Ian collected two samples from each marine stage. I was working on the last 100,000 years where there was clearly a pronounced cycle of climate change and so argued with Ian and Paul that there were likely similar shorter-term variations in climate throughout the Tertiary. Paul was also wondering about the evidence of cyclic sea level change (he described them as cyclothems) he could see in the south Wairarapa. Hence Mangaopari Stream. Peter Blattner was persuaded by Ian to pick up the bromine pentafluoride extraction of oxygen isotopes from silicates when Ian left the Institute of Nuclear Sciences. After he finished Ian took up a job with analytical chemist Jim Sprott (of Arthur Allan Thomas fame) to set up a mineral's analytical facility as interest in gold mining was beginning to develop.
From this he saw a need to manufacture such equipment as the orbital grinders."Cam Nelson notes his particular impact on the New Zealand palaeoclimate record.

"Ian was just a few years ahead of my own geology years (1962-65) at Victoria University and so I did not know him personally then. In my subsequent PhD study of the Oligocene Te Kuiti Group limestones in the wider Waikato region I argued that, unlike convention in the global literature of the day, these carbonates were cool-water ones and did not develop in warm tropical seas. When Ian published in 1967 (Devereux 1967b) a NZ palaeoclimate/palaeotemperature record for the NZ Cenozoic based on oxygen isotope analyses of fossils and carbonate rocks, I was delighted to see the absolute marine temperatures in the NZ region in the Oligocene were recorded as being mainly in a cool to warm temperate realm. The paper showed some considerable changes in absolute marine temperatures through the Cenozoic and became a milestone one in NZ palaeoclimatology.

Significantly, the general trends in his climate record have stood the test of time, despite refinements across specific time intervals.

I then had the pleasure of meeting Ian personally when I joined the Earth Sciences staff at Waikato University in 1971. In those formative days we were setting up new geo-laboratories and required rock cutting, crushing, powdering and related machinery. Ian had founded Rocklabs (in Auckland) which promoted and sold such equipment. We ended up purchasing several Rocklab products from him in those early days. Ian was a very amiable person, he would deliver items himself, demonstrate their use, ensure we were happy with the purchase, and give great aftersales service. All in all, a top salesman. I gather over the years that Ian's products found their way into the laboratories of several other geoscience organisations around the country."
Vince Neall also remembers Ian at Victoria University.

"Perhaps, for its time it was wonderful to see a geochemist extracting such useful information from microfossils. Ian was intellectually alive. He loved extending his own knowledge into micropaleontology and oceanography and was always prepared for a good scientific argument if things didn't seem logical, even if it wasn't his field of expertise!" Through his business model of Rocklabs he has been described as being 'ahead of his time'.
As a geoscientist in the 1960s, his work mirrors our modern aspirations towards multidisciplinary research.

Known geoscience publications from Ian Devereux:

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PhD Thesis from Auckland University.

Siliceous Sinters as Dipsticks for Epithermal Mineralisation

By Ayrton Hamilton,
University of Auckland

Supervisors: Kathleen A. Campbell, Julie V. Rowlanda, Shaun Barkerb, Diego M. Guidoc

School of Environment, The University of Auckland, Private Bag 92019,Auckland, New Zealand. Email: ayrton.hamilton@auckland.ac.nz

ARC Centre of Excellence in Ore Deposits (CODES), School of Natural Sciences, University of Tasmania Private Bag 79, Hobart, Australia
cCONICET-UNLP, Instituto de Recursos Minerales, Calle 64 Esquina 120, La Plata 1900, Argentina

Siliceous sinters, or silica-rich hot spring deposits, are primarily composed of hydrothermally derived silica precipitates occurring in bedded, erosion-resistant mounds and sheet deposits, metres to tens of metres thick, that contain a variety of sedimentary textures and other features of environmental significance (i.e. lithofacies). Sinters form as surface manifestations of geothermal systems, where thermal fluids of varied compositions are discharged at the intersection of the water table and the Earth’s surface. They potentially may be spatially associated with Au-Ag ore producing adularia sericite epithermal deposits at depth, particularly those derived from fluids of near-neutral pH alkali chloride composition.

This thesis by publication utilises lithofacies associations, especially textural identification, together with trace elemental analysis within a paragenetic framework to demonstrate how siliceous sinter deposits in the geologic record can be used as a tool in exploration for epithermal ore deposits, via three main themes of identification, characterisation and mineralisation, outlined further below. This thesis is mainly focused on case studies from the Hauraki Goldfield, Coromandel Volcanic Zone, New Zealand, a Miocene age, 200 × 40 km region of 50 gold-silver bearing, adularia-sericite type epithermal deposits and several porphyry copper prospects. Moreover, this study also examines other sinters and superficially similar deposits of various ages (presently forming to Pliocene) throughout North Island, New Zealand, as well as global examples within known epithermal regions, including the Jurassic Deseado Massif, Argentina, and the Miocene deposits of the Great Basin, California and Nevada, USA, in order to compare features to improve identification, characterisation and mineralisation understanding of siliceous sinters.

Identification of siliceous sinters in the geologic record is primarily achieved through textural differentiation of the varied hot spring related lithofacies as compared to other silicified sedimentary and volcanic deposits often associated with sinters, the latter of which may appear similar with respect to geomorphology and/or outcrop features and/or be interbedded with or cross cut sinters. These similar surface features are known as pseudosinters, many of which will have no known direct association with epithermal deposits at depth. Herein, the lithofacies of siliceous sinters and pseudosinters, from numerous examples ranging in age from Jurassic to modern, are described and their formation environments inferred, thereby systematically distinguishing the former from the latter. Furthermore, trace elemental analysis is utilised in conjunction with textural analysis of silicified features – including sinters as well as silicified travertines, fluvial and lacustrine sediments, volcanics, chalcedonic veins and inferred mud pool deposits – for various Miocene age sites in the Coromandel Volcanic Zone, to distinguish between different formation environments of sinters and pseudosinters.

Characterisation of preserved (i.e. ancient) siliceous sinters through comparison of lithofacies to relevant modern analogues allows reconstruction of the paleoenvironmental formation conditions. Sinter lithofacies transitions from vent and proximal slope, through middle and distal apron areas, to the commonly widespread, geothermally influenced marshes along a thermal continuum (~100°C – ambient), may be used to infer thermal fluid type, direction and relative fluid volume discharged. Paleoenvironmental reconstructions of 18 Miocene sinter deposits of the Coromandel Volcanic Zone Identified in this thesis, through the analysis of lithofacies and geological associations, aid in delineating and vectoring towards potential zones of epithermal fluid upflow. Additionally, such reconstructions in a paragenetic framework can characterise various changes – fluid composition (e.g. acidic overprinting with a drop in water table), hydrological, seasonal and post depositional – within a given hydrothermal system over time.

The mineralisation potential of several occurrences of sinters, ranging in age from modern to Miocene, revealed that the concentrations of 47 elements in 30 siliceous sinter deposits from three calk-alkaline volcanic arcs of North Island, New Zealand, were found to be highly variable in pathfinder elements, alkali metals and immobile elements. The evaluation of this variability suggests an association with several factors including geothermal reservoir conditions, protolithic material type, as well as weathering and diagenetic history. Moreover, gold was observed to be primarily affiliated with the arsenic that is hosted within sulphides contained within some sinter deposits. The sulphides are inferred to have formed at depth and were transported to the surface and incorporated into siliceous sinters during or post sinter deposition, providing important information on reservoir conditions and allowing assessment of possible epithermal ore deposit associations.

Recent PhD Theses from VUW

Andrew Rees

The thermo-tectonic evolution of the Suckling-Dayman metamorphic core complex, southeastern Papua New Guinea

By Jeurgen Oesterle

Southeastern Papua New Guinea is one of only a few regions on Earth where the relationship between active continental breakup and metamorphic core complex (MCC) formation can be observed. In the western Woodlark Rift, extension is focussed on a single structure—the Mai'iu Fault—an active low-angle normal fault (LANF). LANFs, normal faults that slip at dips of <30°, are controversial structures as their orientations of slip are at odds with standard rock mechanical theory; yet they are common in the rock record. Most well-studied LANFs are, however, inactive, partly eroded and/or have been modified by deformation events that post-date their origin. Studying the best-exposed and fastest slipping active continental LANF on Earth, the Mai'iu Fault, avoids some of these complications. The Mai'iu Fault has exhumed in its footwall a remarkable structural dome – the Suckling-Dayman metamorphic core complex (SDMCC). The spectacularly smooth topography of the SDMCC is clearly expressive of geologically recent uplift.

Despite previous studies, the precise timing and rates of exhumation of this continental MCC are poorly constrained on a million-year timescale. This thesis provides the first comprehensive set of U–Pb, fission-track and (U-Th)/He ages from the SDMCC. The data provide constraints that are relevant both to models of LANF formation as well as the Cretaceous–Recent history of this MCC, the Papuan Peninsula and the southwest Pacific region.

U–Pb ages from metasedimentary and metaigneous rocks in the footwall of the Mai'iu Fault suggest that the protolith of the metamorphic core of the SDMCC formed between ~103 and ~72 Ma and was subsequently intruded by gabbros- tonalites in the Paleocene (~60-57 Ma), and much later—syn-extensionally—by granitoids in the Plio-Pleistocene (~3.8-2.0 Ma). Together with the Plio- Pleistocene depositional age of syn-tectonic conglomerates and extension- related cooling of the Mai'iu Fault footwall from ~3 Ma (recorded by fission-track and (U-Th)/He thermochronometry), the Plio-Pleistocene granitoid ages suggest that extension on the Mai'iu Fault had begun by ~4 Ma. Slip on the Mai'iu Fault occurred on cm-per-year rates as evidenced by data from low- temperature thermochronometry (calculated from the inverse slope of zircon (U- Th)/He ages against slip-parallel distance from the fault trace) and the slip rate required to restore the intrusion depths (up to ~8 km, based on Al-in-amphibole thermobarometry) of the Plio-Pleistocene granitoids, now exposed 20-25 km south of the Mai'iu Fault trace at elevations up to 3.4 km. Combining paleo- temperature estimates from fission-track and (U-Th)/He thermochronometry and Raman spectroscopy of carbonaceous material, a minimum paleo- temperature gradient of ~10°C/km has been estimated for the exhumed Mai'iu Fault plane. Based on this, and assuming that the modern regional geothermal gradient in the Woodlark Rift (~20°C/km) is a maximum estimate of that which existed prior to extensional exhumation of the SDMCC, an average initial dip of the Mai'iu Fault of ~44° was estimated. Presently dipping ~21° at the surface, this suggests that the Mai'iu Fault has been back-rotated since the onset of extension, consistent with a rolling hinge-style evolution of this continental MCC.

Quantifying modern changes in New Zealand glaciers and investigating their climatic drivers

By Lauren Vargo

Glaciers across the Southern Alps of New Zealand have been photographed annually since 1977, creating a rare record of Southern Hemisphere glacier change. Here, we revisit these historic photographs and use structure from motion photogrammetry to quantitatively measure glacier change from the images.

To establish this new method, it is initially applied to Brewster Glacier (1670 – 2400 m a.s.l.), one of the 50 monitored glaciers. We derive annual equilibrium line altitude (ELA) and length records from 1981 – 2017, and quantify the uncertainties associated with the method. Our length reconstruction shows largely continuous terminus retreat of 365 ± 12 m for Brewster Glacier since 1981. The ELA record, which compares well with glaciological mass-balance data measured between 2005 and 2015, shows pronounced interannual variability. Mean ELAs range from 1707 ± 6 m a.s.l. to 2303 ± 5 m a.s.l. The newly developed ELA chronology from Brewster shows several years since 1981 with especially high mass loss, all of which occurred in the past decade. Investigation using reanalysis data shows that these extreme mass-loss years occur when surface air temperatures, sea surface temperatures, and mean sea level pressure are anomalously high. In particular, the three highest mass-loss years on record, 2011, 2016, and 2018, each had a 2-month mean surface air temperature anomaly of at least +1.7°C between November and March, which is exclusive to these three years over the time investigated (April 1980 – March 2018). Using event attribution — a methodology using climate model simulations with and without human-induced forcings to calculate the anthropogenic influence on extreme events — we calculate the anthropogenic influence on these surface air temperature anomalies. The positive temperature anomalies during extreme mass-loss years have probabilities of 0 – <1% of occurring in a natural world, but probabilities of 1 – 10% of occurring with anthropogenic forcing, showing a clear human influence on the drivers of extreme glacier mass loss. Finally, we use event attribution methods, with the added step of simulating glacier mass balance, to calculate the anthropogenic influence on the two highest glacier mass-loss years: 2011 and 2018. We show that mass loss was at least 10 times (>90% confidence) more likely to occur with anthropogenic forcing than without. This increased likelihood is driven by present-day temperatures ~1.0°C above the pre-industrial average, confirming a connection between rising anthropogenic greenhouse gases, warming temperatures, and high annual ice loss.

Microgravity surveying in the Wellington CBD

By Alistair Stronach stronaalis@myvuw.ac.nz

I am an MSc student in geophysics at Victoria University of Wellington and was delighted to be awarded an S. J. Hastie Research Award by the GSNZ to support my research this year. The working title of my thesis is "High Resolution Gravity Mapping of Basin Depth in the Wellington CBD for 3D Ground Motion Simulations". This research aims to improve the current knowledge regarding the 3D geometry of the Wellington sedimentary basin. This will be done by the collection of a large number of high accuracy gravity measurements throughout the CBD, particularly focussing on areas which are deepest, most lacking in borehole data and/or fault adjacent. Using this data, as well as subsurface borehole constraints, a three-dimensional basin model can be constructed improving our knowledge of the Wellington subsurface geology. The results will also help define the onshore location and geometry of the recently discovered Aotea fault. Model results will be invaluable for the simulation of earthquakes in 3D and thus identify areas of the city likely to be impacted by 2D and 3D basin amplification effects, such as constructive interference at basin edges, generation of surface waves and focussing. These effects are currently not captured by the New Zealand Building Code, leading to a risk of design limits being exceeded, for example in Thorndon and Pipitea during the 2016 Kaikōura earthquake. My work will lead to greater earthquake resilience for Wellington city. Two lines of gravity data were collected prior to the COVID-19 lockdown, totalling 64 measurements (Figure 1). These lines transect the poorly understood onshore extent of the Aotea fault that has no surface expression and bounds the western side of Mount Victoria, and aim to characterize the fault location, dip and vertical offset. Supplementary data has been collected and integrated into a GIS project, including current geological interpretations, density tests, borehole records and high– resolution LiDAR–derived elevation data. The latter used to correct measurements for the effect of terrain, as well as buildings, given this urban environment.

Data from the first lines have been processed and interpreted into preliminary geological models (Figure 2) and indicate that the Aotea fault is closely located to the interpretation, parallel to Kent Terrace. The fault dips steeply west and the adjacent Pleistocene sediment is ~140 m thick agreeing well with models by Kaiser et al. (2019) but this study suggests thicker sediment westward into the basin. Measurements will continue to be made over the Aotea Fault and Te Aro basin. Gravity measurements will also be made in the Thorndon basin, a thick sediment accumulation highly susceptible to earthquake amplification and poorly constrained by drilling.

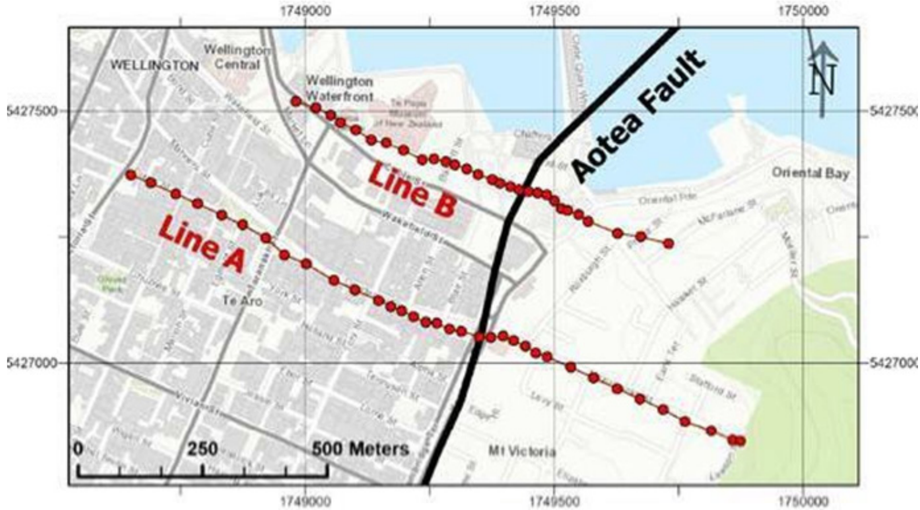


Figure 1: Map of Te Aro showing the current Aotea Fault interpretation (black, Barnes et al., 2018; Kaiser et al., 2019) and two lines of gravity measurements collected across it (red).

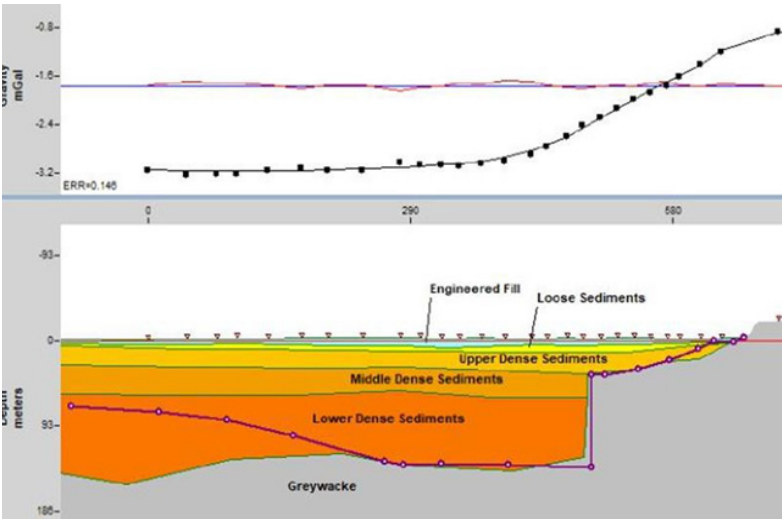


Figure 2: Preliminary modelling of gravity data collected along line B, looking NE. Top: modelled gravity response plotted against observations (black line and black squares), along with misfit (red line). Bottom: Geological model generating the gravitational response using five sediment blocks with densities that increase with depth in the basin. Basement surface from 3D geological modelling of Kaiser et al. (2019) shown by purple line for comparison.

Scientific drilling at the Okataina Volcanic Centre: exploring the complex interactions between an active caldera, active faults, fluid circulation and microbiota.

Cécile Massiot C.Massiot@gns.cri.nz

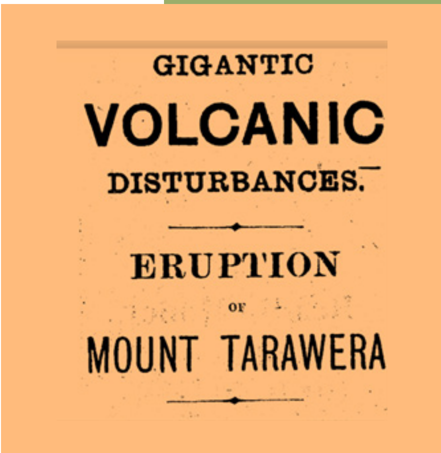
On behalf of the steering team we are announcing here our intention to submit an Inter Continental Drilling Programme (ICDP) proposal for scientific drilling in the Okataina Volcanic Centre (OVC). The OVC is a focal point of interacting geothermal, hydrological, tectonic, volcanic and microbiological processes. Scientific drilling and long-term monitoring will provide the first direct observations to unravel the inner workings of a large silicic centre in an actively rifting arc. In turn, it will improve sustainable management of ground-water and geothermal taonga and resources; and improve understanding of volcanic and tectonic hazards towards increased resilience, in New Zealand and similar geological settings overseas.

Underpinning scientific questions to be answered by drilling, monitoring and associated investigations include (but are not restricted to):

1. What are the feedbacks between magmatism and tectonism?
2. What controls the timing and rates of deformation, volcanic eruptions and earthquakes?
3. Large-scale hydrology and magma systems: how are fluids and heat conducted through a continental rifted arc?
4. Does the geological and geochemical context of the TVZ support a deep biosphere microbiological community?

We are building relationships with Māori groups to develop a strong programme of indigenous cultural relevance alongside the scientific work. Similarly, we aim to build the scientific drilling program to complement and build on ongoing research in the region.
If you are interested in being involved in the design of the project and contribute to the ICDP pre-proposal (to be submitted on 15th January 2021), or would like to contribute to the discussion, please register your interest by filling out a brief questionnaire here:

(https://www.surveymonkey.com/r/J7QNRTH).



GIGANTIC

VOLCANIC

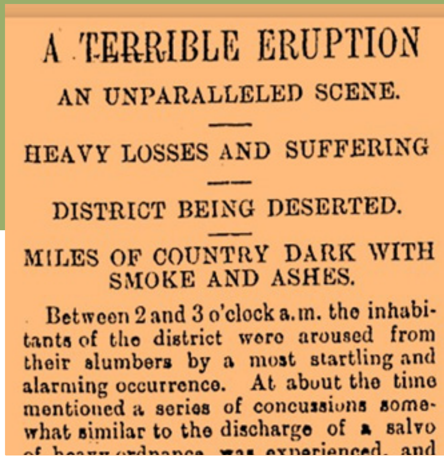
DISTURBANCES.

ERUPTION

OF

MOUNT TARAWERA

Thames Star Vol XVII (5420)
June 10, 1886



A TERRIBLE ERUPTION

AN UNPARALLELED SCENE.

HEAVY LOSSES AND SUFFERING

DISTRICT BEING DESERTED.

MILES OF COUNTRY DARK WITH SMOKE AND ASHES.

Between 2 and 3 o'clock a.m. the inhabitants of the district were aroused from their slumbers by a most startling and alarming occurrence. At about the time mentioned a series of concussions somewhat similar to the discharge of a salvo of heavy ordnance was experienced, and

Poverty Bay Herald Vol XIII
(4605) June 10, 1886

Looking north east across the Waimangu Valley and Rotorua lakes
towards Mt Tarawera and Mt Edgecumbe beyond.
Credit: Dougal Townsend

YOUR COMMITTEE 2020

Back row: Jenni Hopkins, Richard Wysoscanski, James Scott, Sam McColl, Alan Orpin. Front row: Andrew Rees, Eleanor Mestal, Glenn Vallender, Mathew Sagar, Angela Griffin, Jennifer Eccles. Absent: Phaedra Upton

Reminiscence of David Skinner (centre left),' at work' at a committee meeting.

NAME AND POSITION ON COMMITTEE

Matt Sagar, Publications Convenor

BIRTH PLACE : Christchurch, New Zealand

WHAT SECONDARY SCHOOL DID YOU GO TO?
Riccarton High School, Christchurch

HOW DID YOU GET INVOLVED IN GEOSCIENCE?
An interest in the physical world and enjoyment of the outdoors led me to study geology at the University of Otago upon completing high school. Although, prior to commencing my studies I was still undecided on what my major subject would be.

WHO OR WHAT INSPIRED YOU TO HAVE A CAREER IN GEOSCIENCE?
In my second year at university I took "Igneous Petrology and Mineralisation", which was taught by J. Mike Palin. The subject matter, Mike's teaching, and a project on the petrogenesis of plutonic rocks from the Karamea Batholith inspired me to pursue a career in geoscience research.

WHAT HAS BEEN A HIGHLIGHT OF YOUR WORK?
(1) Having the opportunity to teach and impart my enthusiasm for geoscience to Otago undergraduate students, first as a teaching assistant and then a Teaching Fellow;

(2) having the privilege to work under or alongside geoscientists for whom I had a deep admiration—Daphne Lee, Diane Seward, Andy Tulloch, Nick Mortimer, James Scott, Dave Prior, Greg Browne;

(3) remote fieldwork with good friends.

WHY IS GSNZ IMPORTANT?
Many reasons, one being the dissemination of geoscientific knowledge to the general public through our publications.

NAME AND POSITION ON COMMITTEE:

Andrew Rees
I am a co-opted member of the National Committee who represents the Wellington Branch.

BIRTH PLACE

I am originally from Fredericton, New Brunswick, which was bulldozed by the Laurentide Ice Sheet during the Last Glacial Maximum.

HOW DID YOU GET INVOLVED IN GEOSCIENCE?

The subdued topography of my hometown might explain my interest in lakes and rivers.

WHO OR WHAT INSPIRED YOU TO HAVE A CAREER IN GEOSCIENCE?

During my undergraduate degree, my favourite course was about reconstructing Quaternary environments and was taught by Dr. Les Cwynar, a palynologist. I think the genuine multidisciplinary nature of paleoecology inspired me to pursue a career in the geosciences.

WHAT HAS BEEN A HIGHLIGHT OF YOUR WORK

The highlight of my work so far certainly is the opportunity to core 380 lakes across New Zealand as a member of the Lakes380 team.
The objective of the project is to reconstruct water quality across the country over the last millennium.

WHY IS GSNZ IMPORTANT?

Outside of research, I also feel privileged to represent the geoscience community of New Zealand. GSNZ is one of the largest and most active science groups of which I have been a part, and I look forward to participating on the Committee!

NEW STAFF MEMBER

by Jennifer Eccles

Dr James Muirhead has recently joined the School of Environment at the University Auckland after a post doc at Syracuse University (New York, USA). James is a returning Kiwi who grew up in Invercargill and Auckland. He attained his BSc and MSc in Geology from the University of Auckland, and as NZ Fulbright grantee conducted his PhD studies at University of Idaho, USA. To learn a little more about this new addition to our community he has agreed to answer a few questions:

WHAT INSPIRED YOU TO BECOME A GEOSCIENTIST?

From a young age, the sight of volcanic islands looming over Auckland's Waitemata harbour served as a constant reminder to me of our society's vulnerability to active volcanic and tectonic processes. This awareness, as well as an eagerness for working outdoors, is what inspired me to study Earth Sciences.

WHAT DOES YOUR CURRENT RESEARCH FOCUS ON?

Broadly, my research focuses on magmatic-tectonic processes in mafic volcanic fields, continental rifts, and large igneous provinces. I investigate the nature of shallow magma transport, the impact of magmatism on fault behaviour, and the extensional tectonic-magmatic processes driving deep carbon transport. These studies not only have implications for understanding volcanic and earthquake hazards, but have provided new insights into the role of large-scale, volcano- tectonic systems in controlling climate-modulating atmosphere CO2 levels in Earth's geological past.

WHAT HAS BEEN YOUR PROUDEST OR MOST SATISFYING PROFESSIONAL MOMENT TO DATE?

Through international collaborative research my team has had the opportunity to help facilitate student research in countries currently developing local expertise in active volcanic processes. We have provided training and field support for postgraduate students studying volcanic-tectonic processes in Tanzania, who would otherwise not have the technical or academic support to pursue their interests.

NOW YOU ARE BACK IN NEW ZEALAND DO YOU HAVE ANY NEW PLANS OR ASPIRATIONS?

My plan is to involve myself in earthquake and volcanic research across the country. I have started working with New Zealand's ECLIPSE team, to better understand the tectonic triggers and warning signs of volcanic unrest at our largest volcanoes in the Taupo Volcanic Zone. I am also interested in earthquake hazards in Auckland and Northland.
Although they may seem tectonically inactive compared to other parts of the country, some of these regions are still deforming at rates similar to those observed at some continental rift settings,
like the East African Rift.

EVENT CLASH

It is with some disappointment and frustration I find in planning my diary of forthcoming geological events that the Annual General Meeting of the GSNZ and the annual Geothermal Workshop once again coincide in dates if not in location. This lack of coordination is unfortunate at a time when geothermal energy deserves greater recognition and should become a significant part of our 'renewable' energy resource. In the opening session of the GSNZ conference last year Gary Wilson's presentation 'Earth Sciences for Our Future' detailed a major shift in GNS Science towards Energy highlighting geothermal and hydrogen. It would be interesting to learn how this effort is proceeding. Now I am wondering whether a few days at the local Waitangi Copthorne (22- 24 Nov) might be preferable to the overseas trip
to Christchurch (22-25Nov)

Roger Brand Hokianga

Reply

Dear Roger
It is far from ideal to have two conferences covering related topics at the same time. This year is too late for any timetable change, but the GSNZ committee will, in conjunction with the Branch that is next hosting the event (Massey), examine the timing of the 2021 GSNZ conference with the NZGW in mind. Thanks for writing; this is just the sort of information that is needed to better link geoscience communities across New Zealand.

Best wishes James Scott

CALL FOR NOMINATIONS AND APPLICATIONS FOR THE 2020 GSNZ AWARDS

PREMIER GEOSCIENCE-WIDE AWARDS:

Hochstetter Lecturer
For a geoscientist with excellent public speaking skills to present new research to all branches of GSNZ

McKay Hammer
For the author(s) of the most meritorious geoscience paper(s) from the last 3 years (2017-2019)

GSNZ Honorary Member
Nominations are called for to recognise outstanding lifetime contributions

NEW for 2020! Hayward Communication Award
Awarded to a NZ-based geoscientist or geoscientists for the most meritorious contribution to geocommunication
in the previous 3 calendar years (2017-2019).

YOUNG RESEARCHER/STUDENT AWARDS:

Jim Ansell Geophysics Scholarship
Post-graduate scholarship for NZ's top up-and-coming geophysicist
John Beavan Geodetic Fieldwork Grant
Support for students involved with geodetic research to undertake or participate in associated fieldwork
Wellman Research Award
A contribution of up to $4000 towards research in New Zealand. Contribution can cover field, travel, analytical expenses, etc
(more details on website)
Werner F. Giggenbach Prize for Geochemistry
For the most outstanding geochemistry publication in 2019 by a NZ-based young researcher

SPECIAL AWARDS:

New Zealand Geophysics Prize
For the most meritorious publication in NZ geophysics in the current and last 2 years (2018-2020)

Harold Wellman Prize
Awarded for a recent discovery of important fossil material within New Zealand

Kingma Award
Awarded to the most outstanding Earth science technician in New Zealand

Pullar-Vucetich Award
For the author(s) of the most meritorious paper(s) in tephrochronological research from the last 3 years (2017-2019)

Alan Mason Historical Studies Fund
Up to $500 awarded to assist research on the history of Earth science in New Zealand

Please email your nominations or applications to the Awards Subcommittee Convenor, Kat Holt, at k.holt@massey.ac.nz by the 18th of September 2020.

For more details on the awards and to download nomination templates please visit http://gsnz.org.nz/awards.

Geoscience Society of New Zealand Annual Conference 2020

Tēnā tātou katoa,

We invite you to the Geoscience Society of New Zealand annual conference in **Christchurch, 22-25 November 2020.**
We are committed to running the conference as normally as possible within any remaining restrictions.
The conference will be held on campus at the University of Canterbury and will include oral and poster sessions, an evening public lecture or panel discussion, and field trips.

Online presentations will be possible for presenters overseas, and in case of heightened restrictions at the time of the conference, we will be able to switch to a virtual format.

We will also be organising the usual conference dinner, icebreaker, and numerous lunchtime breakout sessions, meetings, and workshops. This will be an opportunity to meet with people, network, and will be a welcome chance to interact face to face.

We are looking forward to seeing you in Christchurch. Welcome all.

Kari Bassett, Conference Convenor
James Scott, President, Geoscience Society of New Zealand

CALL FOR SUBMISSIONS
The GSNZ Organising Committee are calling for Session and Field Trip proposals for consideration. Visit the relevant page on the conference website for submission guidelines, or click on the links below.

Session Submissions Deadline: **6 July 2020**
Field Trip Submissions Deadline: **15 July 202**

Interested in partnering with the GSNZ Annual Conference 2020?
Please get in touch via gsnz@confer.co.nz, to discuss exhibition and partnership opportunities

https://confer.eventsair.com/gsnz2020/

GEOSCIENCE QUIZ 31

by Aenigmatite

1. New Zealand's two largest islands by area are the North and South islands (Te Ika-a-Maui and Te Waipounamu). How many of the next five largest islands can you name?

2. What is the difference between mineralogy and minerality?

3. Kryptonite has what special property?

4. What do 1I/'Oumuamua and 2I/Borisov have in common that makes them special?

5. There's a back story behind pneumonoultramicroscopicsilicovolcanoconiosis. What is it?

Answers:

1. In order of decreasing area Stewart (Rakiura) > Chatham (Rekohu/Wharekauri)> Auckland (Motu Maha) > Great Barrier (Aotea) > Resolution (Fiordland, 209km2. The next largest is D'Urville at 150km2.

2. Mineralogy=study of minerals. Minerality=a claimed non-fruit, non-herb, non-spice taste or aroma of wine e.g. salty, flinty, chalky or stony.

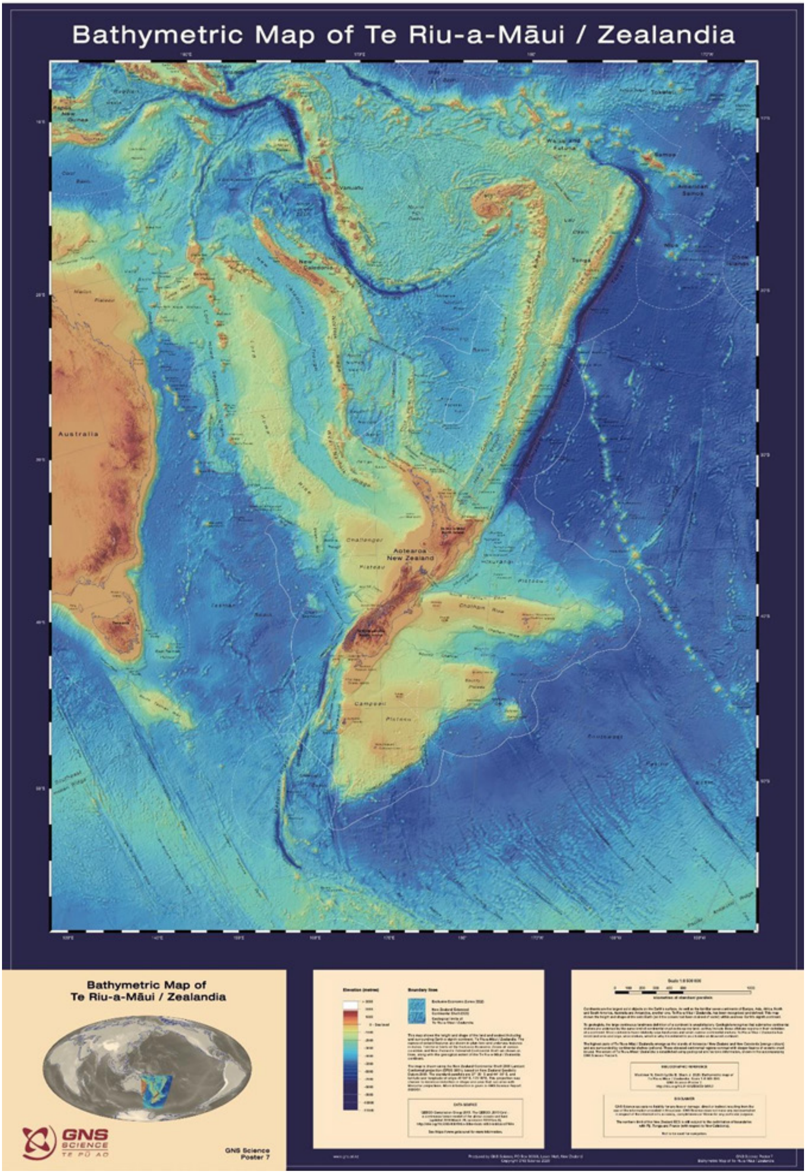
3. This fictitious extra-terrestrial mineral deprives Superman of his powers.

4. They are the first, and so far only, interstellar objects known to have passed through our solar system (discovered in 2017 and 2019 respectively)

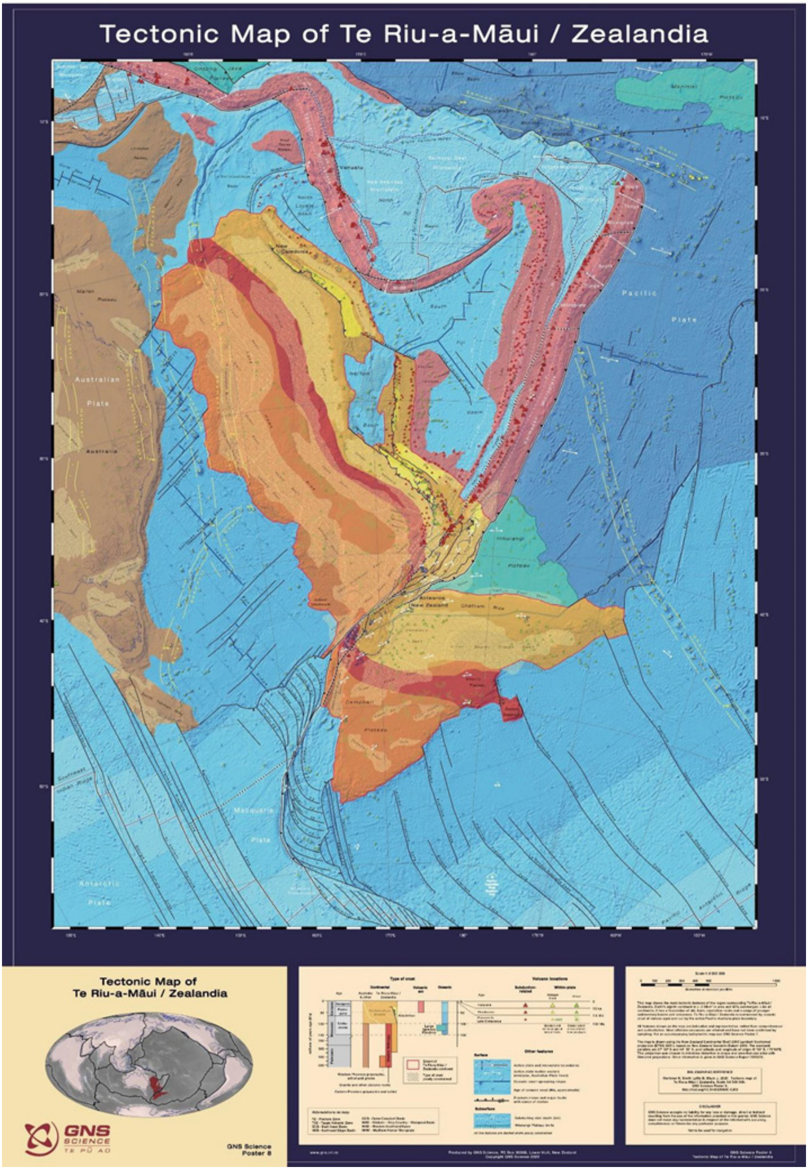
5. It's a made-up disease of the lungs, contrived in 1935, with the intent of making it the longest word in the Oxford English Dictionary (45 characters).

GNSScience OFFICIAL LAUNCH of the LATEST ZEALANDIA POSTERS JUNE 22, 2020

Note: they will also be launched as web maps.



Bathymetric map (higher resolution will be available)



Tectonic map (higher resolution will be available)


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

IT IS TIME TO HAND THE REINS OVER!

WANTED

?

One enthusiastic Newsletter editor/compiler

Glenn has decided that it is time to move on at the end of this year to other geoscience things.

For details please contact Glenn Vallender on ge.vallender@xtra.co.nz or a current committee member.

If you haven't already

Find out more:
www.gsnz.org.nz

Be part of an awesome community !
Enjoy fieldtrips, annual conferences, social functions and become eligible for a number of discounts

Geoscience Society of New Zealand

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

DONATIONS
Donations enable those 'extra' things to be achieved. They are always gratefully received and can be sent upon membership renewals online on www.gsnz.org.nz. Donations of more than NZ$5 can qualify for a 33% tax credit from Inland Revenue (you will need to keep the receipt you get from us and fill in an IRD tax credit claim form at the end of the tax year).
See the IRD website for more details.

BEQUESTS
Suggested wording for a bequest (We recommend you consult a solicitor to match the existing wording in your will)

I give to the Geoscience Society of New Zealand (Incorporated) the sum of $ * for general purposes**, for which a receipt from the Secretary, Treasurer or Administrator of the Geoscience Society of New Zealand (Incorporated) shall be a full and sufficient discharge to my trustees.

* or "% share of the residue of my Estate absolutely"
** or nominate a particular fund or award

Note: The Geoscience Society of New Zealand
- is registered as Incorporated Society no. 219911
- is approved as Registered Charity no. CC41125
- has most of its award funds protected in a trust:
  the Geoscience Society of New Zealand Awards Trust (Incorporated), Registered Charity no. CC35670

NEWSLETTER
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GEOSCIENCE SOCIETY OF NEW ZEALAND NEWSLETTER

EDITOR: Glenn Vallender
16 Woodham Drive, Allenton, Ashburton 7700
ge.vallender@xtra.co.nz

DEADLINES:	March Issue	February 15
	July Issue	June 15
	November Issue	October 1

This is your newsletter and the editor seeks correspondence, news items, interim or preliminary reports of current research, reviews of books and of recent geological publications and other topical articles. Reviews of New Zealand geology, geochemistry and geophysics published overseas are particularly welcome.

We suggest a limit of 1000 words or one to four pages in the current format for most contributions with minimal but key referencing. Depending on space, longer articles suitable as feature articles with illustrations are often published.

Email copy in any text format is acceptable. The newsletter is formatted for A5 in Arial 13 with 2.0cm side margins and full justification. Coloured graphics often lose their impact and readability when in greyscale.

Note that names are normally of the format “John Smith” or “Jane Smith”. We prefer not to use titles such as Mr, Dr or Professor, nor to worry about whether we should use Miss, Mrs, or Ms.

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NEWS LETTER

ISSUE 31

June 2020