Geocene

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Editor: Jill Kenny

As a celebration of the 30th anniversary of the Auckland Geoclub, I have brightened up the Geoclub's Geocene Magazine, using a geological gold colour. Obvious on this page are the logo and the gold shadow effect for the Geocene label above. There is a gold footer for every page, containing page number, Geocene issue number and author surname. There are gold headers for title pages and gold backgrounds for figure and table captions to better differentiate captions from article text.

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Geocene is a periodic publication of Auckland Geology Club, a section of the Geoscience Society of New Zealand's Auckland Branch.

Contributions about the geology of New Zealand (particularly northern New Zealand) from members are welcome. Articles are lightly edited but not refereed.

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LAVA AND ICE IN TONGARIRO NATIONAL PARK

Christine Major

I have been tramping in Tongariro National Park for 30 years, marvelling at the landforms. With a lifelong interest in glaciation, owing to my mother's family having lived within sight of Franz Josef Glacier since the 1870s, I was particularly impressed by the two striking glacial valleys that I describe in this article, which I encountered on well known tramping tracks. Using the wonderful account in Townsend *et al.* (2017), I was able to learn more about the formation of these glacial valleys and how they differ from glacier derived valleys in the Southern Alps. Here I share some of my photographs with you, the reader, along with the explanations I have extracted from 'Geology of the Tongariro National Park area' (Townsend *et al.* 2017) – a GNS publication that can be purchased online at https://shop.gns.cri.nz/gnsgm4/.

With earliest volcanic activity assessed as occurring roughly 300,000 years ago for Ruapehu and 275,000 years ago for Tongariro, both mountains have been subjected to a succession of glacial and interglacial periods, as shown in Table 1.

Table 1. Glacial and interglacial periods in New Zealand in the last 500,000 years (from Te Ara: The Encyclopedia of New Zealand).

Years before present day	Interglacial period	Glacial period
0		
	Aranui	
14,500		
		Ōtira
75,000		
	Kaihinu	
125,000		
		Waimea
180,000		
	Karoro	
220,000		
		Waimaunga
280,000		
320,000		
		Nemona
370,000		
450,000		
		Kawhaka
500,000		

Cool period (blue) Warm period (orange)

Interactions between lava and ice have therefore shaped these two volcanic edifices. For Ruapehu in particular, the bulk of the volcanic rocks at the surface erupted under and next to ice prior to or during the last glaciation (Townsend *et al*. 2017).

During glacial periods, with glaciers occupying valleys, valley walls are heightened, as expected, by lateral moraine formation, but additionally when eruption occurs, much lava will be directed by the presence of glaciers to flow down these moraine ridges, raising their height further. Glacial action will erode the valley floor, which will receive no contribution from lava flowing onto the ice (other than remnants present in terminal moraines).

Lavas may be grossly over-thickened where lava flowing down the top of the moraine ridge has burrowed down beside glacier ice, forming knuckles of massive lava. Commonly a "web" of lava will result as the lava flow on the top of the ridge develops multiple branches down to knuckles, which then often merge with each other. Thus, high stacks of lava and glacial till will build up beside valley glaciers (Townsend *et al*. 2017).

Lava that has flowed along a glacial margin will cool very quickly and so will often show fine-scale fractures and glassy margins; the jointing may be horizontal instead of vertical as the ice to the side of the lava flow will be cooling the lava faster than the air above (Townsend *et al*. 2017).

Volcanic cones cannot form in established glaciation. For example, the distorted shape of Girdlestone Peak is understood to be the result of the extrusion of lava confined and buttressed by thick ice in the last glaciation (Townsend *et al*. 2017).

These are some of the glacial valleys on the slopes of Ruapehu and Tongariro other than the two described below in more detail:

- Mangatepopo Valley at the start of the Tongariro Crossing Track;
- Mangaturuturu Valley on Ruapehu visited by Geoclub in 2012;
- Whakapapaiti Valley accessed from the Bruce Road on Ruapehu;
- Whangaehu Valley that constitutes the path of major lahars originating from Ruapehu's Crater Lake.

Wahianoa Valley

The huge Wahianoa Valley on Ruapehu's southeastern flank is visible from the Desert Road. It is crossed by the Ruapehu Round the Mountain Track. A geology map and photos can be found on the following page (Figs 1 & 2).

The valley's history begins with the first Wahianoa Formation flows (155ka) occurring below an ice cap in the penultimate

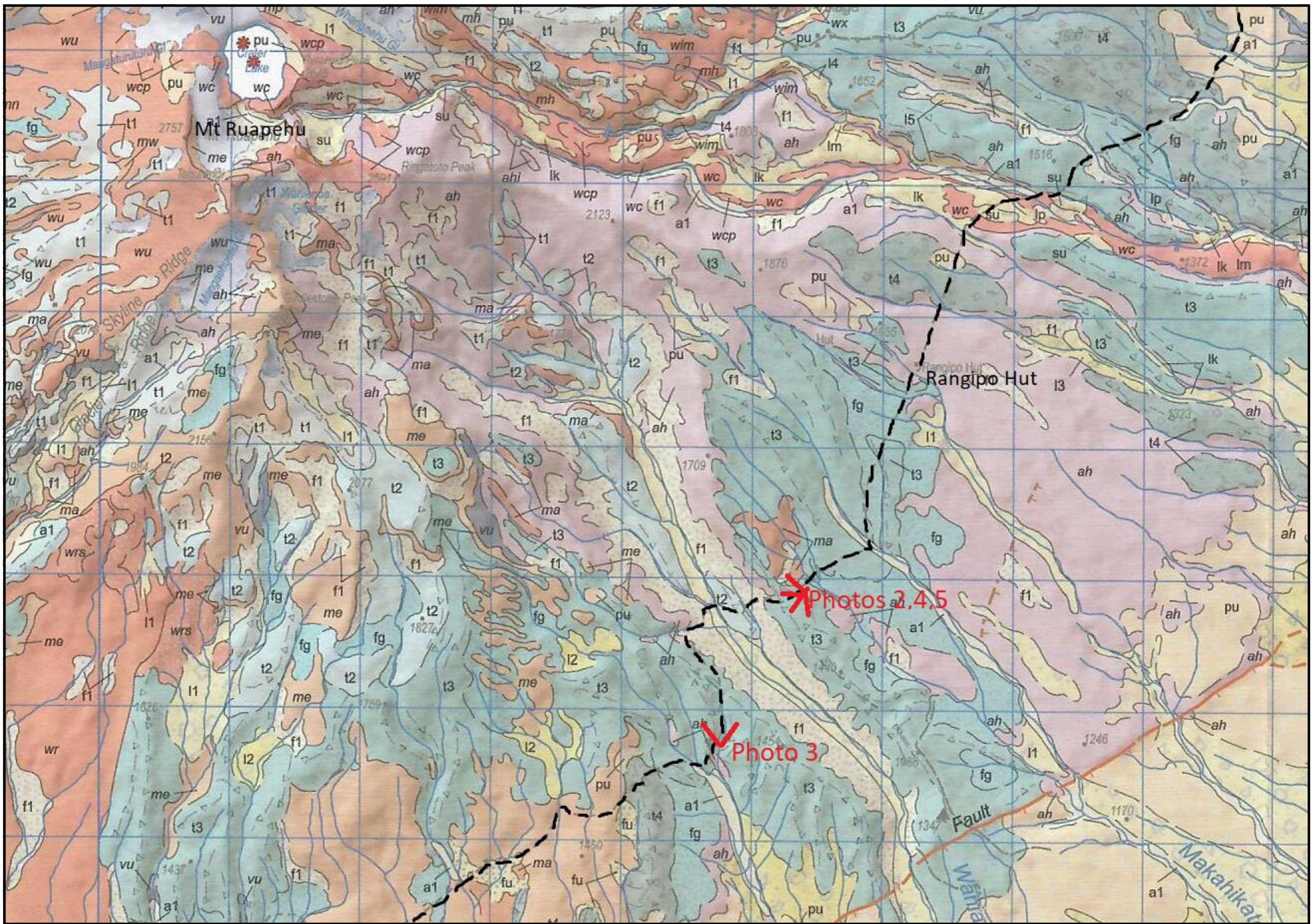


Fig. 1 (above). Geology map of the Wahianoa area on the southeastern flank of Ruapehu (modified from Townsend *et al*. 2017) (ah mauve = Wahianoa Formation lava flows, 155ka; ma red = Makotuku Member lava flows, 18ka; t3 blue = bouldery glacial till), and **Fig. 2** (below). Photos of the Wahianoa Valley (positions shown in red on map above) from the Round the Mountain Track (dashed line).

Standing close to Makotuku Formation lava on the true left valley wall, looking up the Wahianoa Valley.

Looking up Wahianoa Valley from the true right wall. Wahianoa Formation lava flows visible in upper true left valley wall.

Aerial photo of "Wahianoa Glacial Valley" (Townsend, *undated*, Geotrips).

Lower Wahianoa Valley lateral moraine sheathed walls.

Looking directly across the deep Wahianoa Valley.

(Waimean) glaciation. In the subsequent interglacial there were some valley lava flows, but these were covered and eroded by the larger glacier that filled the valley in the following (Otiran) glaciation. Later Wahianoa Formation flows diverted to glacial margins, building the high ridges visible today. A few 18ka flows (ma red, Fig. 1) occurred at the head of valley, but otherwise lava was excluded because of thick ice. More recent flows have been unable to get into the valley because the vent (under Crater Lake) is now on the other side of a high ridge. The lower valley walls largely comprise boulder-sized volcanic clasts in a sandy muddy matrix (t3 blue). A much-reduced Wahianoa Glacier remains today.

Waihohonu Valley

The spectacular Waihohonu Valley is crossed by the Tongariro Northern Circuit Great Walk (Figs 3 & 4).

Tama Trig Formation lava (~200ka) in the walls of the upper valley (Fig. 3) are all that remain of the early geology of the Waihohonu Valley, as the head of the valley is buried underneath the classic volcanic cone of Ngauruhoe, which developed over the last 7000 years, unencumbered by ice. The large Waihohonu Valley was carved out in the last two ice ages when Tongariro was encased in a large ice cap from which the Waihohonu glaciers flowed. Today glacial till of volcanic clasts lines the valley walls (Townsend *et al*. 2017).

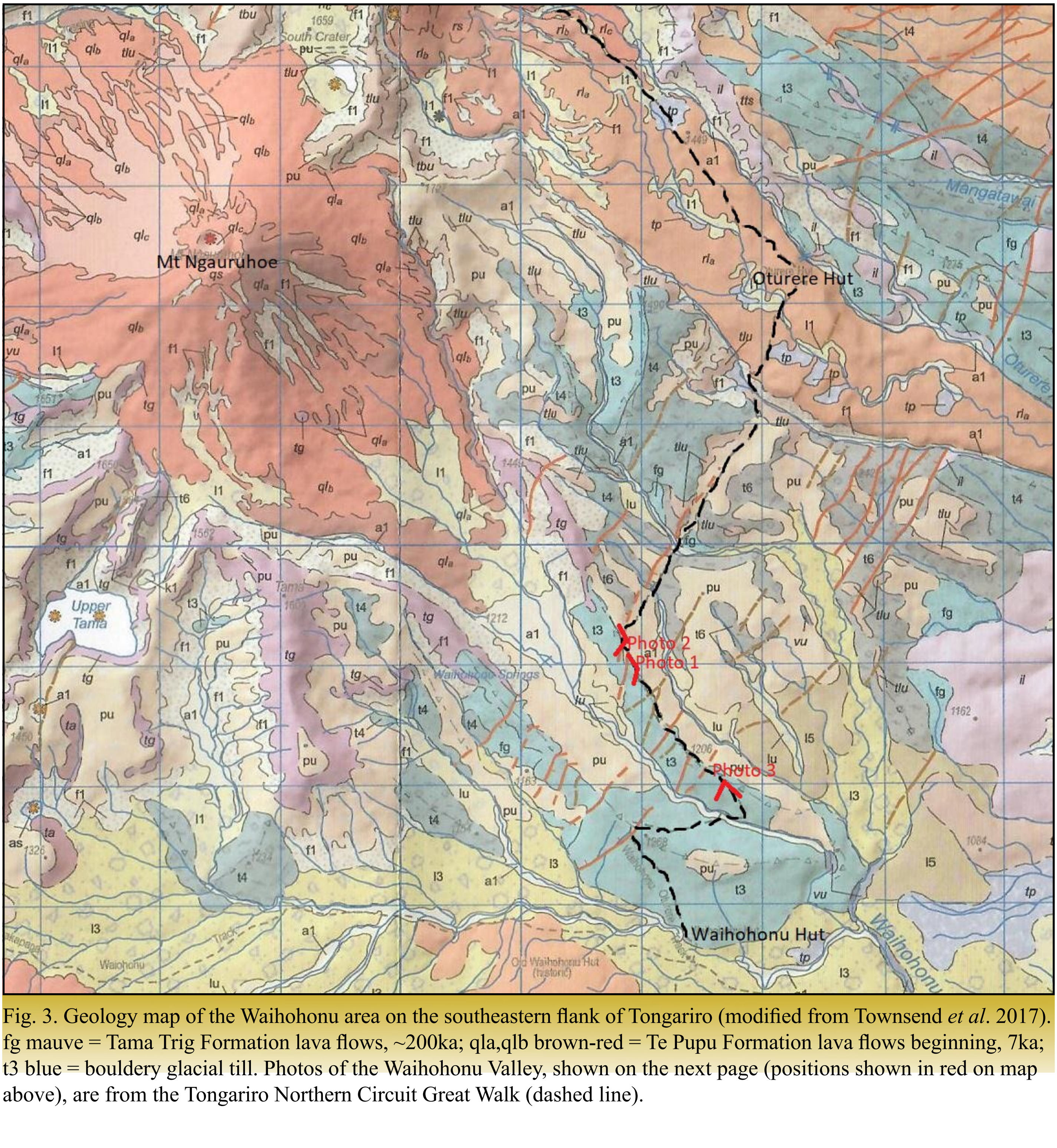
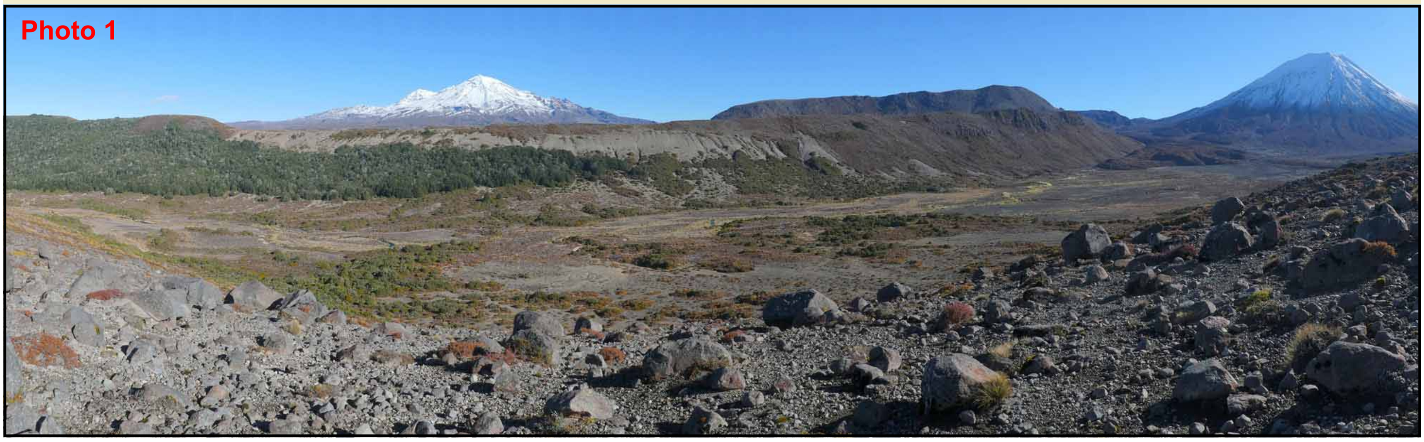


Fig. 3. Geology map of the Waihohonu area on the southeastern flank of Tongariro (modified from Townsend *et al*. 2017). fg mauve = Tama Trig Formation lava flows, ~200ka; qla,qlb brown-red = Te Pupu Formation lava flows beginning, 7ka; t3 blue = bouldery glacial till. Photos of the Waihohonu Valley, shown on the next page (positions shown in red on map above), are from the Tongariro Northern Circuit Great Walk (dashed line).

Fig. 4. Photos of the Waihohonu Valley from the Tongariro Northern Circuit Great Walk (dashed line in Fig. 3).



Waihohonu Valley panorama from true left valley wall.

Dark tongue of qla Te Pupu Formation lava at foot of Mt Ngauruhoe at head of Waihohonu Valley. Tama Trig Formation lava is visible in the true right valley wall above this flow.

Lateral/terminal moraine till of bouldery volcanic clasts.

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Te Ara: The Encyclopedia of New Zealand - Glacial periods in New Zealand diagram.

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ROLE OF COASTAL POHUTUKAWA TREES IN SHAPING BEACH TOPOGRAPHY

Bruce W. Hayward

My wife Glenys and I walk along Auckland's Tamaki Drive several times a week and we notice some of the more rapid geological processes at work in an urban setting. I have previously written short notes on some of these – rapidly eroding sandstone at high water level (Hayward & Kenny 2013); compaction-induced subsidence of Tamaki Drive along the routes of infilled tidal channels (Hayward 2020a); rapid formation of false beach rock (Hayward 2020b); and sand-dune growth in grassed parks behind sand supplemented beaches (Hayward 2016). In the last three decades, the three most popular beaches along Tamaki Drive each had vast quantities of sand added to them to protect their sea walls from erosion and to enhance their recreational value – Mission Bay in 1995, Kohimarama in 2004 and St Heliers in 2006 (Fig. 1).

Fig. 1. Map showing the three most popular beaches at the eastern end of Tamaki Drive, Auckland.

Fig. 2. The rolling, semi-regular sand highs and lows that have developed at the back of Kohimarama Beach, Auckland, August 2022. Note that the lows coincide with each pōhutukawa tree and the highs coincide with the gaps between the trees.

Since then, we have observed the continuing growth of small sand dunes on the kikuyu-grass-covered seaward edge of the flat beach reserves behind Mission Bay and St Heliers beaches (e.g., Hayward 2016). Sand was being blown up and over the seawall during strong northerlies and being trapped and stabilised by kikuyu grass. More recently I have noticed that above spring high tide mark, all three beaches have been developing a pattern of rolling highs and lows at semi-regular spacing of about 20–50 m apart (Fig. 2). I wondered what could be causing this. I soon recognised that the low areas at the back of the beach seemed to coincide with each of the large pōhutukawa trees that grow along the beach reserves, set 3–8 m back from sea walls, with many having grown outwards to overhang the top of the beach (and provide welcome shade in summer). The rounded mounds (0.5–1 m higher than the lows) coincided with the gaps between the trees.

The most obvious observation was that highs were composed of loose, usually dry and easily blown sand and the lows were usually damper (being more shaded by the trees) and more stable, often with accumulations of leaves and other debris (Fig. 3) and sometimes with sparse weeds growing. Initially I thought the lows were not building up because the damper sand in the shade was more stable, but I wondered why dry sand from beyond the overhanging trees was not being blown in and captured. I thought that, theoretically, the damper areas should be building up with trapped sand, just as

Fig. 3. Closer view of several of the sand waves at the back of Kohimarama Beach, showing the shaded, damper hollows beneath the overhanging branches with leaves and sticks accumulated in most hollows. The most probable explanation for the sand highs is the pōhutukawa trees acting as obstacles for strong northerly winds with the strengthened breeze deviating through the gaps and carrying along sand grains that have built up against and sometimes over the seawall.

the dunes are growing where the kikuyu grass traps the wind-blown sand.

In some places one or two of the pōhutukawa trees are smaller or further back from the beach and the sand in front of them is not damp, but there is still a low in the beach profile at the back of the beach. This provided the clue that it is not the shade but the local strength of the strong northerly winds that is responsible for the rolling topography of the sand beach. Where there is a pōhutukawa tree, much of the wind is clearly deviating around either side of its bushy obstacle and becoming stronger as it sweeps through the gaps between the trees. The trees clearly influence the strength of the wind many metres seaward of their actual location, with the strengthened gusts being able to move the dry sand above high-water mark in a landward direction, progressively building up the sand highs against the seawall. In some places these highs have reached the top of the seawall and the sand is now blowing further inland during northerly gales.

References

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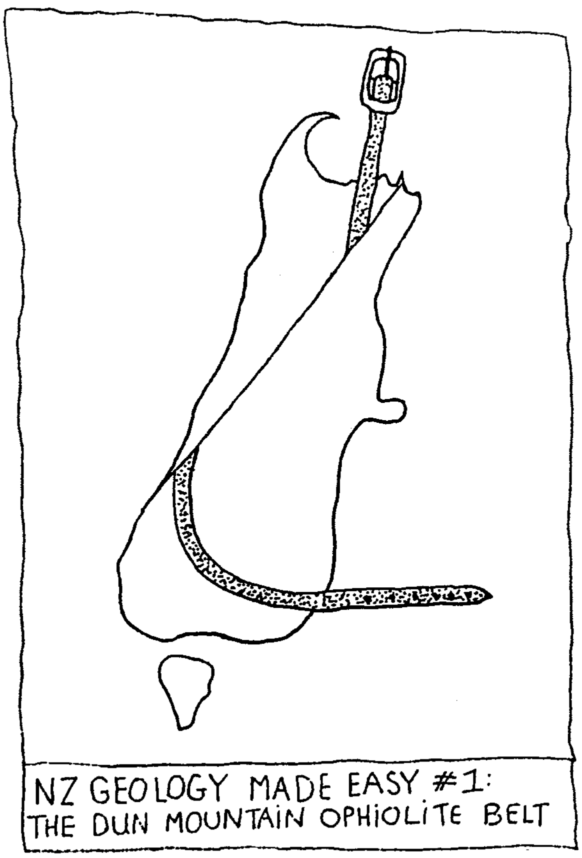

METEORITES IN THE MANUKAU HARBOUR?

Lori Dale

Inspired after reading the exploits of Geoclub members (Hayward 2021), the Wattle Downs coastal area was explored during 2022 by the author – an amateur in geology terms. In February 2022, a spherical-shaped, 2.5 kg, 20-cm-long, 3.4 gm/cc density, very magnetic, black rock was found lying on the mudflats near the Wattle Downs South Path, Carnoustie Road, Wattle Downs, Auckland, New Zealand (Fig. 1).

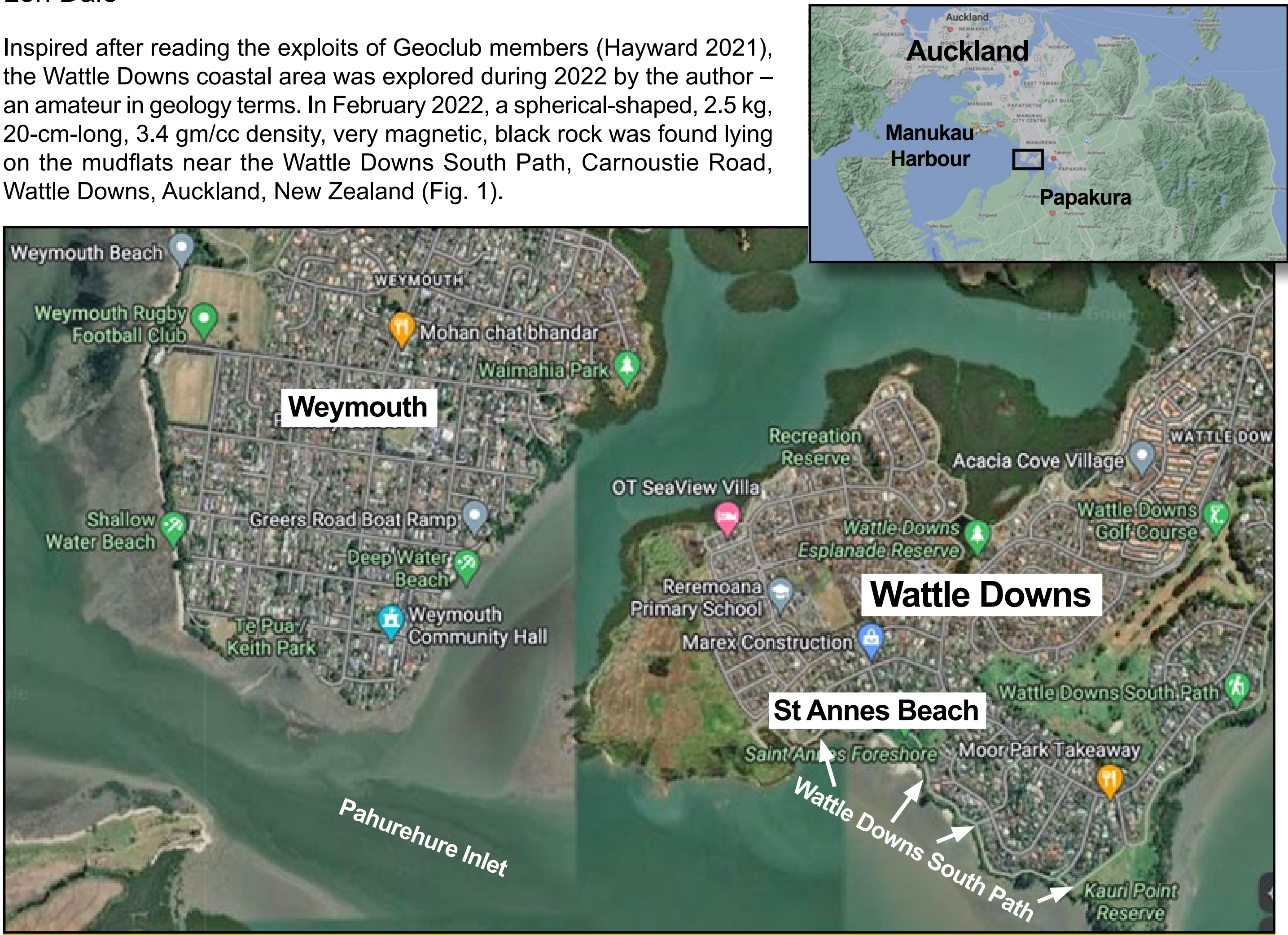

Fig. 1. Map of Manukau Harbour Coastline (Google Maps) in the vicinity of Wattle Downs and its location in Auckland (black box in inset map).

The week before, on 18 February 2022, a spectacular meteor had been witnessed by people from Taheke to Tauranga (Fig. 2). The meteor was described as an 'orange-yellow-white-fiery-red' ball 'with a long tail'. It was seen to 'split' into 3 parts as it flew west to east over the Manukau Harbour and out to sea past the tip of the Coromandel Peninsula (Weather-Watch 2022). Could this be a dream come true? The discovery of a meteorite, literally, and very conveniently, at my feet?

The discovery of this heavy magnetic rock - my gateway 'meteorite' - led to a journey through time out-of-mind… and time of-the-usual-sort. Many hours have been spent since the 'find' poring over photos of meteorites, reading up on the geology and history of the Manukau Harbour, and seeking advice from very kind meteorite experts: an appreciative thank you to Dr Randy Korotev and to Dr Joel Schiff.

In short, the 'meteorite' pictured here (Fig. 3) is likely not a rare lunar meteorite, but a chunk of ilmenite-bearing rock eroded out of a nearby bank. The 'meteorite', dubbed

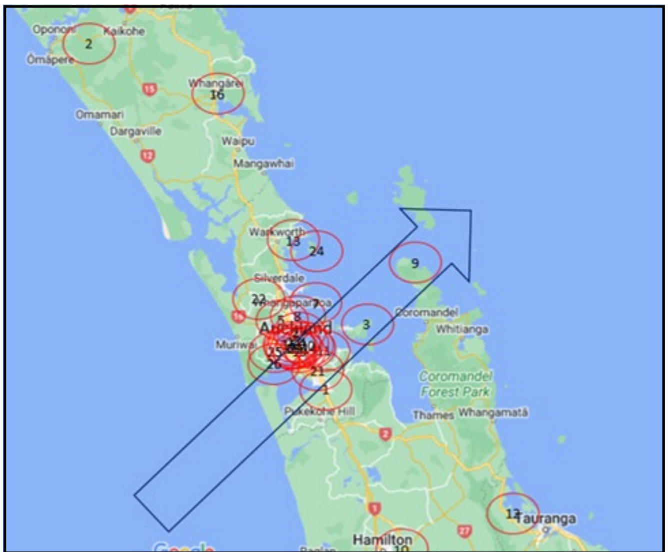

Fig. 2. An unscientific plot of sightings of the 18/02/2022 meteor over Manukau Harbour (Weather-Watch 2022). Taheke is number 2 in the northwestern corner of the map; Tauranga is number 12 in the southeastern corner.

‘Woolly Downs’, is now a hilly home for a piece of sheep-shaped Manukau Harbour common opal.

Fig. 3. Woolly Downs – home to opal sheep shape.

The jury has returned its verdict, but the dream continues. Might it be possible to find a meteorite - a small one would be awesome - while wandering the Manukau Harbour mudflats? In short: not likely.

The odds

The odds are against it. Only nine meteorites have ever been found in New Zealand. Most have been found on farms where there are no other rocks, so they stand out. One in Ellerslie crashed through someone’s roof - that was a bit of a giveaway (NBC News 2004, Jun 14). Another in Mokoia hit a tree and broke it - too easy (Price 2011) (Fig. 4). Worldwide, only two meteorites have ever been found on a beach (Korotev 2022a-c).

Fig. 4. The Auckland Meteorite (left photo) that crashed through a roof (NBC News 2004), and the Mokoia Meteorite, Whanganui (photo above) that hit a tree (Dickison & Beautrais, 2014).

The terrain

The best places to find meteorites are vast open rock-free spaces. Think, Antarctica, where meteorites gather in moraines, and fresh black meteorite crusts stand out against the white snow (Korotev 2022a-c). Or Morocco, and other northwest African deserts, where shiny iron/nickel blebs wink up out of the sand (Wolchover 2012). Farms are okay too. Odd newcomer rocks can be spotted against a grassy paddock backdrop. The meteorites below were found on New Zealand farms.

Fig. 5. New Zealand meteorite examples (modified after Nathan 2006).

Freezing, or dry, is good. New Zealand forests, bush and humidity are bad. Meteorites break down just like terrestrial rocks (Wolchover 2012). Some carbonaceous chondrite meteorites can be crumbled in one hand (Collins Dictionary of Astronomy 2006). If they are not found quickly in New Zealand, meteorites may disappear into the ground, becoming but a black smudge on a boot sole.

What about the plain grey mudflats of Manurewa? Comparable with the white snow of Antarctica or the pale-yellow sand of northwestern Africa? Is it easy to spot a black meteorite against the grey? Possibly. A rock was found at St Annes Beach, Manukau Harbour foreshore at Wattle Downs, sitting far from other rocks out on the mudflats, so it warranted a closer look. It has a smudgy carbon spot and shimmers of metal, but it is not magnetic.

Note: If a rock has metal but is not magnetic it is unlikely to be a meteorite (Korotev 2022a-c).

Fig. 6. Carbon ‘spot’, St Annes Beach, Wattle Downs.

Any heavy meteorite – an iron, or stony-iron – would likely be swallowed up by the hungry mudflats. Less heavy meteorites might make it to shore, but identifying features are likely to have been rolled away on the journey, making them hard to spot (Korotev 2022a-c). Regmaglypts (thumb-print-like hollows - Glossary of Meteoritics 2022), crusts, contraction cracks, flow lines, metal blebs – all have been smoothed away.

The competition – rocks and fossils

Meteorites must also compete for attention amongst the many very lovely rocks and fossils along the 520 km Manukau Harbour coastline (Figs 7 & 8 – local rocks). The Weymouth area of the Manukau Harbour, in particular, is renowned for its abundant Miocene (23–14 mya), Pliocene (4–3 mya) and Quaternary (2.6 mya – 50 kya) fossil wood (Figs 9 & 10), and fruits, seeds and shells in sedimentary rock (Fig. 11), arguably just as amazing as meteorites (Hayward 2022, Hayward & Geary 2017, Moore & McKelvey 1971). Examples of rocks and fossils found while hunting for meteorites include the following (all pers.obsv.) (Figs 7–11).

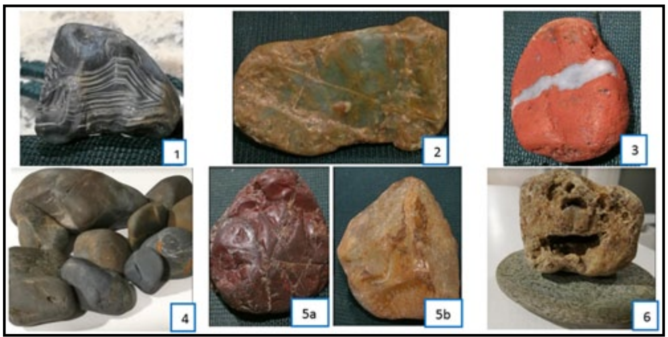

Fig. 7. Fossicked rocks, all found on the Manukau Harbour coastline:
1) chalcedony – banded agate;
2) chalcedony – very bright blue (abundant in many colours);
3) chalcedony – red jasper (also abundant in many colours);
4) pakohe (argillite) and basalt;
5a&5b) both test for diamond! … likely spinel, carnelian and faulty tester;
6) happy zeolites in rock (mounted on schist).

Fig. 8. Opaque rock with a sandpaper-texture surface - it looks like a bird-emerging-from-an-egg fossil, but is actually a burrowing critter creation found in a Parnell Grit layer within Waitemata Group sediments.

Fig. 9. Petrified wood.

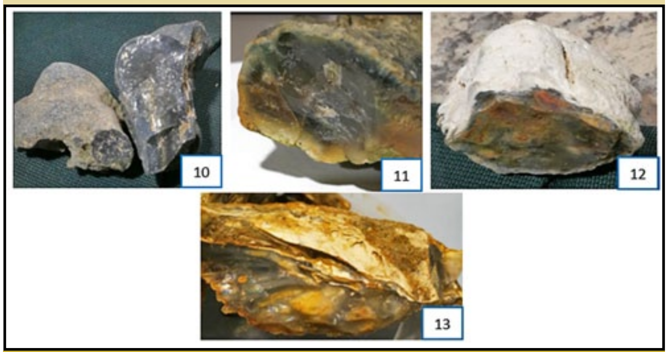

Fig. 10. Silicified / opalised wood:
10) Blue opal limb casts;
11+12) Silicified wood with inclusions;
13) Silicified oyster *Crassostrea ingens* - found in clay - likely montmorillonite similar to that near opalised logs and seeds at Weymouth Beach. The very fragile internal oyster layers have been silicified with some play of colour on both sides of the break shown (likely girasol opal, if any).

Fig. 11. Miscellaneous:
14) Seed out of rock;
15) Seed in rock;
16) Hand-sized shell in loose clay clump;
17) Starfish cast.

Other competition

Also competing for attention in the Manukau Harbour (and potentially raising the odds a meteorite will be found!) is the ship ballast often dumped overboard in the past at harbour ports, though it is unlikely any inadvertently-included international-origin meteorites made it into the mix.

Terrane

Complicating identification in the Manukau Harbour is the terrane within the terrain. Many meteorites are olivine-rich. So is the Dun Mt-Caples-Maitai ophiolite basement terrane that underlies the hinterland of the Manukau Harbour (Ballance 2017). But rocks on the foreshore are unlikely to have come from the far-below basement rock. Local faults are thought to have been inactive for hundreds of thousands of years (Kenny 2013), so are not likely to be grinding away at the ophiolite terrane, sending olivine-containing rocks to the surface and onto local shorelines.

Local basalt volcanoes might have contributed to foreshore material (Spörli *et al*. 2015), as with the peridotite (Fig. 12, left), likely originating from nearby Puhinui, Wiri, Ash Hill or Karaka volcanoes (Hayward 2018, Ballance 2017).

Manukau Harbour is also one of the few areas in New Zealand where an REE predictive data report (Morgenstern *et al.* 2018) asserts rare earth minerals, including magnetic minerals, might be found, but these are unlikely to be confused with magnetic meteorites (Morgenstern *et al.* 2018). Magnetism is also found in the adjacent Junction Magnetic Anamoly (JMA) (Hatherton & Simpson 1970), but it is not believed the JMA is linked to any ancient meteorite strewn field!

Depending on the meteorite, it can be hard to distinguish a local olivine-rich terrestrial rock from an olivine-rich meteorite. For example, this large lump of local dunite (Fig. 12, left) is not a martian nakhlite meteorite (right).

Fig. 12. Dunite (pers.obsv.) versus NWA7325 martian nakhlite meteorite (Ralew, 2013).

And this Weymouth Beach-sourced peridotite (Fig. 13, left) is not a piece of martian shergottite meteorite (Fig. 13, right) trapped in local basalt.

Fig. 13. Peridotite in basalt (pers.obsv.) versus NWA2373 martian shergottite meteorite (St John, 2011).

On the other hand, local basalt can look like lunar basalt or martian basalt, though the chemical composition will be different. For some meteorite look-a-likes, only the presence of other indicators (magnetism, crust, regmaglypts, etc.) and a definitive scientific analysis, will confirm identification (Fig. 14).

Fig. 14. The difficulty telling terrestrial rocks apart from meteorites:
A+E) martian augite basalt (Fine Art Auctions 2019, NWA8159);
B) local Manukau Harbour terrestrial volcanic black-crusted spinel-bearing basalt (pers. obsv.);
C) lunar feldspathic breccia meteorite possibly originating from the Sinus Aestuum spinel-rich basalt region on the moon - the man-in-the-moon's nose (Tisserlitine 001, 2022);
D) a ureilite achondrite (.296 Grams NWA4852, 2002).

Magnetism

A key indicator for most meteorites (not all) is they attract a magnet. I have attached a magnet to the end of a stick in a high-tech bid to find meteorites (Fig. 15).
Tip - make sure the stick is long enough to avoid walking doubled half-over, which prompts many passers-by to ask if you're okay.

With my magnet-on-a-stick, I have picked up a lot of old nails - some reminiscent of an *Archesabella bartrumi* at first glance (must get to SpecSavers). Also old iron fence rebar, old padlocks, old chains, old tools . . .

Fig. 15. Highly magnetic *Archesabella bartrumi* nail (apologies to Hayward & Geary 2017).

I have also picked up, near a shell midden south of St Annes Beach, three very magnetic, but no doubt terrestrial, rocks (Fig. 16). All streaked black when tested on porcelain, so likely contain magnetite. Or titanomagnetite in the case of the last rock pictured - found on Kariotahi Beach… the only rock on the entire wave-pounded beach. (Hopes up, hopes down)

Fig. 16. Magnetic rocks.
A–C) St Annes Beach magnetic;
D) Kariotahi Beach magnetic.

Alluvial deposits

Any meteorites in the Manukau Harbour most likely fell directly from space, but some might have been transported there by old river courses. There are three main sources for any alluvial meteorite deposits. One is the Waikato River. The Waikato flowed north from the Taupo Volcanic Zone and into the Tamaki Sea much closer to the present-day Manukau Harbour mouth, near Awhitu Peninsula (Briggs *et al*. 2005). A second alluvial meteorite source is the 3.5 mya Clevedon River. The Clevedon ran from the gold-bearing Coromandel area through the Clevedon depression and past Weymouth (Hayward *et al*. 2007, Ballance 2017). The third source is the three major present-day inlets at Waiuku, Pahurehure and Māngere.

Meteorite survivors

Over the past 50 mya the Manukau Harbour has been an inland area, a delta, a shallow water basin, a deep-sea basin, and part-sea/part-land (Hayward, 2022). At present, it is a relatively shallow-water harbour. Realistically, the present-day shoreline has been under water for much of its geologic history. A line might be drawn after the last glaciation (20 kya) when sea levels were up to 130 m lower and the harbour was then a plain - lots of land for a non-fragile meteorite to fall on, if it could resist weathering, tides, and terrestrialisation to the present day - which is not very likely (Ballance, 2017).

Camera capture

If a meteorite fell more recently, it might trigger an alert and potentially be captured on the new network of cameras that meteorite hunters are setting up with the help of residents across New Zealand (Fireballs Aotearoa 2022) - a great way to locate New Zealand's next meteorite fall.

Ownership

If you do become the finder of New Zealand meteorite #10, or #11 onwards, on a Manukau Harbour beach, notoriety will be yours, but not so much a wad of cash. Meteorites remain the property of the landowner where found. That is likely the New Zealand Government, in partnership with local iwi, if found on beaches.

Homeowners are luckier - the 4.6 bya Auckland Meteorite that fell in Ellerslie was sold by the property owners to the Auckland Museum for $40k (NBC News, 2004). No matter where found, you will need the permission of the New Zealand government if you want to sell or export a New Zealand meteorite overseas.

Finding that meteorite

This takes us back to the odds. Geologists have calculated that, globally, 1 meteorite falls, for every 1 sq km, every 10,000 years (Choi 2022). If 20 kya is, generously, allowed as a time frame for a meteorite to land within the Manukau plain/shallow harbour environs, and if we factor in that the Manukau Harbour is 340 sq km, by my calculations there should be at least 680 meteorites rolling around the harbour (1 x 340 x 2 = 680). That is not even counting those potentially carried there by ancient river courses! (It is possibly clutching at - even more - straws to add any meteorites transported as ship ballast. But surely one or two meteorites made it to the beach in the past 20 kya?) My example from St Annes Beach is so near, yet so far (Fig. 17). The hunt continues.

Fig. 17. Pecora Escarpment 02007. On the right is a lunar feldspathic breccia meteorite (Korotev, 2013). The rock on the left, from St Annes Beach, looks similar but would need to be sliced to view the interior, and have 20 grams forwarded for scientific identification and classification by the Meteoritical Society. (It shows metal blebs but is not magnetic so is unlikely to be a meteorite, pers. obsv.).

It is a lot of fun attempting to find rocks that might be meteorites. It would be even more fun if one of them actually *was* a meteorite! If anybody reading this goes to a Manukau Harbour beach and finds a meteorite, I will be … very happy for you. Base tests and close comparisons with other meteorites found will generally help to show whether rocks could be, or are most likely not, meteorites. Cutting a slice from any potential meteorite to provide a 'window' inside the rock, is usually necessary to find out if it's worth progressing to the formal testing and identification stage.

If you suspect it's an *oriented* meteorite - one that has special inflight-created surface features (Collins Dictionary of Astronomy 2006) - DO NOT CUT IT!

Acknowledgements

For assistance with meteorite information, special thanks to Dr Joel Schiff, founder of Meteorite Magazine, who viewed most of these rocks and offered good advice and educational opportunities, including listening in to a 6 am local-time talk on meteorites to the University of New Mexico. *Muchas gracias!* Also, to retired Dr Randy Korotev, who responded in depth to an initial query. Recommended is his meteor-wrong information posted on the Washington University in St Louis website. Huge thanks also to the International Knowledge Bolide crew and Topherspin Meteorites for their to-infinity-and-above-and-beyond awesome Youtube weekly podcasts about everything meteoritic. An incredible gift of your time and knowledge. And final thanks to the New Zealand geology community who inspire getting out there and looking - especially the South Auckland Rock and Mineral Club; the Auckland Geoclub and Dr Bruce Hayward, who produces so much helpful information (I don't know how he does it); Jill Kenny, who helped immensely with the edit and planning of this article; and Lynn Hellyar, who inspired me with my first fossil shell book (I am turning the pages correctly). The world is a richer place with you in it.

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OLD BEACH DEPOSITS RECORD HIGHER SEA LEVEL AND STABLE LAND ELEVATION AT KAWERUA, NORTHLAND

Bruce W. Hayward

I recently revisited the site of the former Auckland University Field Club Scientific Hut at Kawerua, on Northland's west coast on the fringe of the Waipoua Forest (Fig. 1). Fifty years ago, I wrote a description of the surrounding geology (Hayward, 1972). For up to 2 km north of Kawerua there are 2–5 m high sea cliffs at the back of a narrow strip of cobble and sandy beach. Seaward of the beach there are sections of relatively flat, mid-low tidal shore platform made of early Miocene Waipoua Basalt (Fig. 2).

The lower 0.5–3 m of the low sea cliff is composed of weathered Waipoua Basalt, which is overlain by relatively fresh Pleistocene sediments, mostly sand. The contact between the basalt and overlying sediment is a relatively flat unconformity remarkably similar to the modern shore platform except that the underlying basalt in the cliff appears to be somewhat more weathered and altered (Fig. 3). In some places, core stone weathering is underway with fresh basalt cores surrounded by exfoliating layers of weathered basalt (Fig. 4).

In some places the unconformity is directly overlain by near flat-layered sand, but in other places a layer, up to

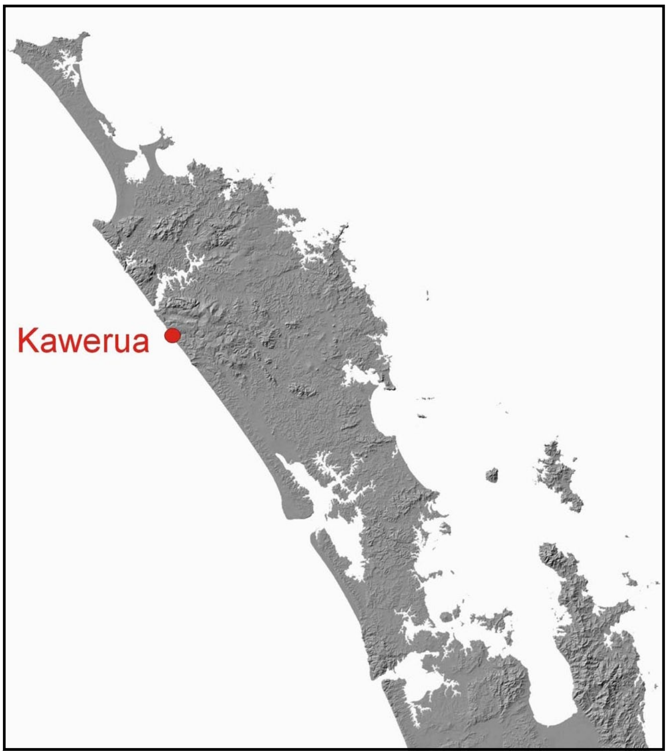

Fig. 1. Map showing the location of Kawerua on the west coast of Northland.

Fig. 2. View over southern portion of the low cliffed coast north of Kawerua. Oblique aerial photograph by Bruce Hayward, 2016.

Fig. 3. Cobble beach deposit overlying a thin lens of pebble gravel siting in a slight depression in the underlying unconformity.

1 m thick, of rounded basalt cobbles and pebbles lies directly on the unconformity (Fig. 4). In one place a layer of cobbles is separated from the unconformity by up to 1 m of sand (Fig. 5). In 1972, a group of us students spent one morning excavating 1 m square quadrats through the cobble beach and the cobble layer in the cliff behind. In each quadrat, the size, orientation, sphericity and roundness of each cobble was recorded and then the two deposits compared. The deposits were so similar that it was concluded that the cliff deposit was also of beach origin (Hayward, 1974). The overlying sand is flat-lying or gently dipping towards the sea, and laminated to at least the top of the low cliff sections (Fig. 6). These features are those of beach sand and not of wind-blown dunes.

Thus, the unconformity and all the visible overlying sediments in the cliffs were eroded and deposited intertidally. The unconformity was most likely eroded at low-mid tide level, whereas the cobble beach deposits would be mid to high tide deposits. The beach sands could have been deposited at any level, but the upper parts were probably at about high-water spring level. When combined and compared with present sea level, these deposits suggest sea level was 2– >4 m higher than present, when the cliff sediments were deposited. These elevations suggest that the beach deposits in the cliffs were probably deposited during the Last Interglacial Period (130,000–120,000 yrs ago) when sea level around New Zealand reportedly reached up to 5–6 m above present (e.g., Hayward, 2017, fig. 11.1).

Around the coast of much of New Zealand there have been considerable vertical land movements of >2 m up or down over the last 100,000 years (Beavan & Litchfield 2012). Northern New Zealand is inferred to be the tectonically most stable part of the country and this tectonic stability seems to be confirmed here at Kawerua.

Fig. 4. Core-stone weathering underway in jointed basalt lava beneath the unconformity.

Fig. 5. A layer of beach cobbles within beach sand overlying the unconformity in the low sea cliffs.

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Fig. 6. Flat-lying laminated sand overlying the unconformity eroded across the dark-coloured, weathered basalt surface.

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HEAPHY'S 1857 COROMANDEL AREA MAP ANNOTATED BY HOCHSTETTER

Hugh R. Grenfell

Charles Heaphy's map of the geology and geography of part of the Coromandel Peninsula and Great Mercury Island is very interesting (Heaphy 1857). An intriguing, perhaps unique, copy held in Berlin with handwritten annotations in German, is discussed.

Heaphy (1820–1881) was a surveyor and landscape artist who is well known, perhaps in particular to students of Auckland geology and historical geology. The Hochstetter - Heaphy controversy in the early 1860s has been extensively documented (e.g. Mason 2002 & 2003, Hayward *et al*. 2011, Schoeman 2012, Grenfell 2013 & *in press*). An extensive biography of Heaphy has been written by Iain Sharp (Sharp 2008).

Two young Germans arrived in New Zealand in 1858 within a day of each other. They were Dr Christian Gottlieb Ferdinand Hochstetter (who was later knighted and became Dr Ferdinand Ritter von Hochstetter, 1829–1884) and Johann Franz Julius Haast (later Sir Julius von Haast, 1822–1887). Both would go on to make tremendous contributions to our knowledge of New Zealand geology and palaeontology (e.g. among many works regarding Hochstetter see Kermode 1992). While in Auckland working for the Provincial Government, they accompanied Heaphy to the Coromandel from the 8th–12th of June, 1859 (Johnston & Nolden 2011).

The original geological map itself is somewhat preliminary and basic when compared with contemporary European maps, but it does also contain a lot of historical information, in particular relating to early gold exploration sites, pa sites, place names, landholders etc. (see next page for examples). The coastline, topography and soundings etc. are undoubtedly based on the work of British naval surveyors such as Stokes and Drury. It is unknown how many copies of the map were originally produced, but no physical copy appears to exist in New Zealand. However, an intriguing digital copy of this map (Fig. 1), heavily annotated with handwritten notes in German, can be

Fig. 1: Inch-to-the-mile map of part of the Coromandel Peninsula and Great Mercury Island (Heaphy, 1857).

viewed through the Alexander Turnbull Library website (see Heaphy 1857 and a link). The original is held (and has been for a very long time) by the Humboldt University, in Berlin (Fig. 2). The map (together with another of the Wellington region) was given to Hochstetter and taken to Vienna in 1859. Later they were taken to Humboldt University in Berlin by Albrecht Penckin in 1906 (Fig. 2). For details see Alexander Turnbull Library website.

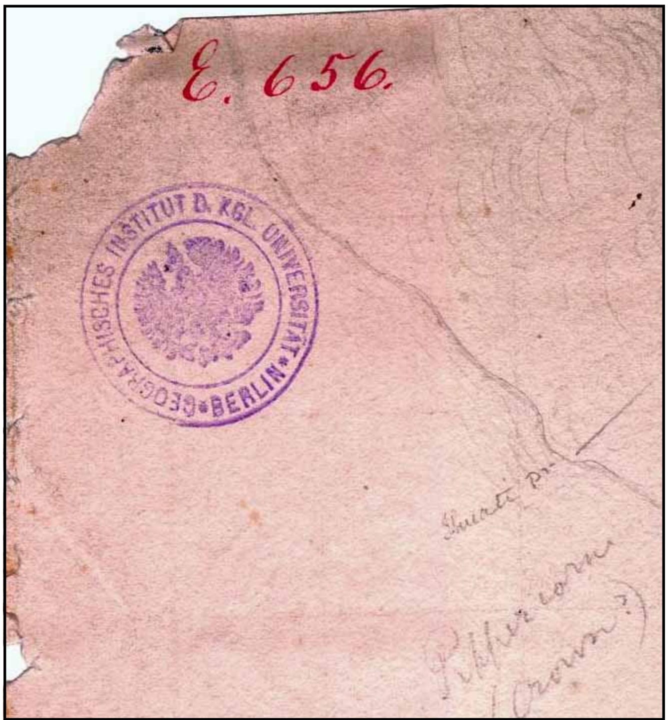

Fig. 2: Stamp of the "Geographisches Institut Der Königlichen Universitat Berlin". Now Humboldt University, Berlin.

Previous work referring to Heaphy 1857

Clearly the handwritten annotations on Heaphy's map are the first commentary on it. Dave Skinner discussed the first record of basalt in the Coromandel Volcanic Zone (Skinner, 2013). He makes only a brief mention of the existence of Heaphy's 1857 map (Skinner, 2013, p.33 - the same Berlin copy). But Skinner does discuss Hochstetter (1864 and the translation by Fleming 1959) where Hochstetter (p.89) uses the terms *"trachydoleritischen oder basaltischen"* (trachydolerite or basaltic rock) at Cathedral Rock, Great Mercury Island. This is the first published record of basaltic rocks in the Coromandel. Skinner goes on to explain the term trachyte was universally used in New Zealand for almost all volcanic rocks. Hochstetter (1864) discusses the carpetbag term trachtye used for six different types of volcanic rock. In a table on p.83 (or between pp.112–113 of Fleming, 1959) Hochstetter details his thoughts on the classification of plutonic and volcanic rocks. However in 1859, not seeing some of the Coromandel rocks himself, and in the absence of hand specimens available to him, Hochstetter was mostly probably obliged to use the existing terminology. Clearly his thoughts had changed by 1864, perhaps based on other data.

The annotated text

In addition to the original handwritten text on the map (i.e. for the legend, place names etc.), there are two other sets of annotated handwriting. One in pencil (usually names of landholders or Maori chiefs), and another in ink - German handwriting describing the geology (e.g. Figs 3 & 4). New Zealand's acknowledged Hochstetter expert, Dr Sascha Nolden, was consulted about the handwritten German annotations and he considers them to be Hochstetter's (S. Nolden pers. comm.). For some examples of these inked annotations, see below (page 20). The pencilled annotations might also be Hochstetter, but there is only a hint of German (see the southern end of Great Mercury Island) and most are the names of various Maori chiefs or Europeans (e.g. Preece's Farm just east of what is now Preece Point, south of Coromandel township).

In the magnificent Hochstetter Collection, Basel volumes by Nolden & Nolden (Parts 1–3, 2011–2013), a different map has similar eastern Coromandel area annotations by Hochstetter (Nolden & Nolden, Part 1, 2011, p.23). For

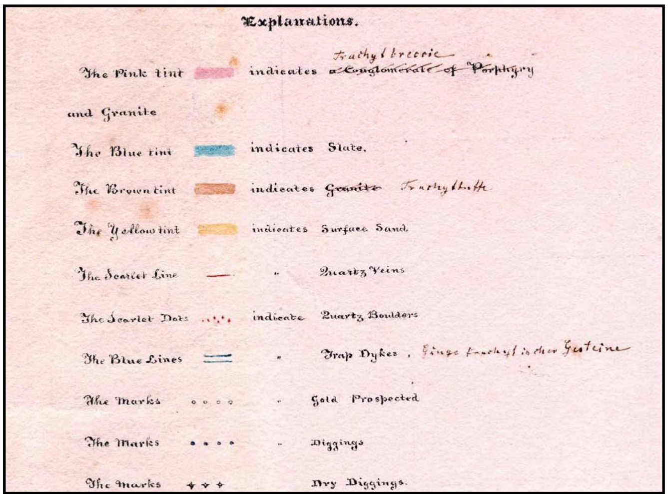

Fig. 3: Corrections to the map legend by Hochstetter. E.g. Conglomerate of "Porphyry" (Trachyt breccie = Trachyte breccia), Granite (Trachyt tuffe= Trachtye tuff), Trap dykes (Gänge trachyt in ober Gesteine = Vein trachyte in upper rocks).

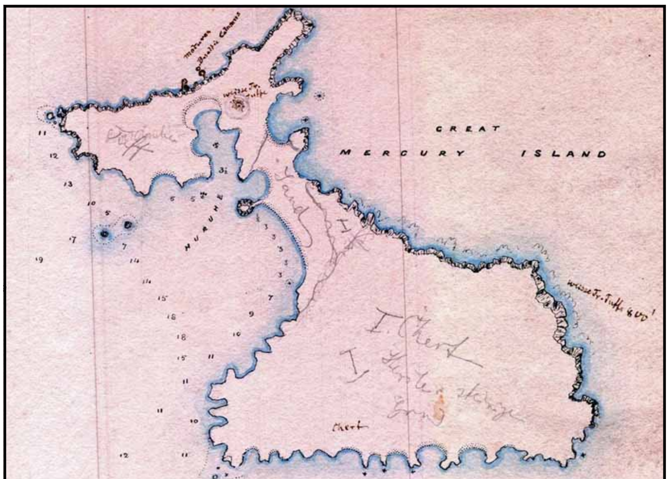

Fig. 4: Great Mercury Island with pencilled and ink annotations.

example *"Säulen bas."* = columnar basalt, *"Trachytuffe"* = trachyte tuff.

Hochstetter does not describe going to Great Mercury Island himself in his journals and publications. But having seen the geology of the island myself, the accurate comments in German about the geology and topography of the Great Mercury Island are intriguing. They may simply be Hochstetter perceptively interpreting the observations of others.

He noted (Hochstetter 1864, p.XX) that Heaphy had published two notes in 1854 and 1855 in the Quarterly Journal of the Geological Society of London about the Coromandel District and on the gold prospecting there. Hochstetter commented - *"However, the trachytic rocks of the area there were confused with granite."*

Another link to the Coromandel is a chromolithograph in Hochstetter 1864 (opposite p.81) of the columnar basalt cliffs at Cathedral Rock (Moturoa), Great Mercury Island. This is derived from a sketch by Heaphy and acknowledged as such by Hochstetter (see Fig. 5). Marshall (1932, p.200) identified the rock as a hypersthene basalt and clarified the correct location of Heaphy's sketch as being at the northern end of Great Mercury Island, Cathedral Rock, and not Moturoa Island (Tower Rock) at the entrance to Mercury Bay.

In Hochstetter (1864) there are a few pages discussing the Coromandel Goldfield (pp. 24–27) and the origins of the alluvial gold, and also on pages 88–89. The brief mention of Great Mercury by Hochstetter (1864, p.89) was translated by Fleming as follows (translation of Hochstetter, 1864 by Fleming 1959, p.119).

"Similar conditions seem to be repeated on the east coast of Cape Colville Peninsula. From the Mercury Islands, Mr Smalfield brought me hand specimens of yellow trachyte tuff with baked scraps of trachyte, pumice, obsidian, and clay marl, and a small island of the group is said to consist of regular columns of a trachydolerite or basaltic rock. I am grateful to Mr Ch. Heaphy for a fine sketch of this columnar formation, which has been reproduced in colour by Mr Grefe".

This was Conrad Grefe (1823–1907). The hand specimens are most likely an ignimbrite.

The "Mr Smalfield" referred to by Hochstetter is probably not Octavius Smallfield, as thought by Fleming (see Fleming 1959, footnote p.119), but George Smallfield who, among other prominent Aucklanders, contributed monetarily to a "testimonial" for Hochstetter (New Zealander 1859), which was held at the Mechanics Institute in Chancery Lane in 1859, just prior to his departure to Nelson. He lived in Princes Street (Hochstetter's address also) and was listed on Jury Lists of the day as "Editor".

The excellent foreword to Fleming's Hochstetter centenary translation (Fleming 1959) by then Director of the GSNZ, RW (Dick) Willett, also mentions Hochstetter's association with George Smallfield and notes he was editor of the New Zealander newspaper (Fleming 1959, p.x).

Also in Hochstetter (1864, pp. 88–89) are two figures of Coromandel Harbour (acknowledged as sourced from and given to Hochstetter by Heaphy). They are *"Patapata Point am Coromandel-Hafen, Trachytbreccie (nach einer Skizze von Ch. Heaphy)"* and *"Ansicht des Coromandel-Hafens mit dem Castle Hill (nach einer Skizze von Ch. Heaphy).* See also Nolden & Nolden (2011, Part 1, Figs 1.4.8–13) for high quality versions of these and other Heaphy Coromandel sketches (some colour) from the Hochstetter Collection, Basel.

Coromandel geology is also discussed and mapped in Hochstetter & Petermann (1863 & 1864 - pp.14–16, 51 of the Fischer translation).

Fig. 5: Left: Heaphy sketch of columnar basalts at Cathedral Rock (Moturoa), Great Mercury given to Hochstetter in 1859. Right: Published with acknowledgement as a chromolithograph by Grefe in Hochstetter (1864, p.89).

Examples of original historical geographical data by Heaphy:

- Site of Charles Ring's discovery of alluvial gold in 1852 at Kapanga / Driving Creek (said on the map to be October, 1852). Also a second location marked of Ring finding gold in the stream draining into Te Kouma Harbour. Ring (and his brother) are often cited as the "first" discoverers of gold in New Zealand. They were certainly the first to claim a reward (apparently £500) for discovery in 1852. It is not clear if the reward was actually paid.
- A site on "Arataunga" / Hatatauanga Stream with alluvial gold found by Heaphy (claimed on the map to also be October, 1852, which is odd).
- A site at Kuaotunu with alluvial gold found by M. Gaston. As at Coromandel, underground mining was subsequently important here.
- "Wangarahi" Pa just south of present day Coromandel.
- Maori diggings north of Kikowhakarere Bay.
- Scarlet dots indicating quartz boulders and different marks for "Gold prospected", "Diggings" and "Dry diggings".

Examples of Hochstetter ink annotations:

- Legend corrections: *Conglomerate of porphyry / trachyt breccie* = trachyte breccia. *Granite / Trachyt tuffe* = Trachyte tuff (ignimbrite). *Trap dykes / Gänge trachyt in ober Gesteine* = Vein trachyte in upper rocks.
- The columnar Mercury Basalt at Motuto Point, north of Whangapoua: *Phonolith säulen* = phonolite columns.
- South of Castle Rock in two places. Text: *hoh. (=hohen) rücken trachyt or trachyt br.* = high ridge of trachyte or trachytic breccia.
- Near Waiau on a tributary of the Waiau called "Hinau Creek" by Hochstetter: *Kohlen* = coal.
- Great Mercury Island in two places. *Weisse Tr. Tuffe* = White trachytic tuff (rhyolite / ignimbrite). N.B. the high cliffs of this lithology on the SE edge of the island are recorded as 800 feet high (244m.), which is not a bad estimate, given there is high point near Omataonga Point of 226m. Southern end: *Chert* = Chert (probably rhyolite).

Conclusions

This digital copy of Heaphy's 1857 map is important for a number of reasons. It appears to be the only publicly available copy anywhere of this work by Heaphy and also has a unique record of Hochstetter's annotations based on personal observation and other information. It also contains important mid 19thC historical and geographical information.

Acknowledgements

My thanks to Sascha Nolden for reviewing the paper, for information and discussions and Jill Kenny as editor.

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HOCHSTETTER'S LEGACY IN NEW ZEALAND NAMES

Christine Major

Ferdinand von Hochstetter (1829–1884) was a German geologist who voyaged around the world as geologist on the Novara expedition. During this period, he spent 9 months in New Zealand (1858–1859), employed by the Auckland and Nelson Provincial Governments, to make the first geological survey of the country.

Working with Julius Haast, Hochstetter was the first to describe and interpret many features of New Zealand geology. He produced the first significant geological maps of Auckland and Nelson as well as his iconic map of the Auckland Volcanic Field. The rock type dunite was named by Hochstetter after Dun Mountain near Nelson.

Each year the Geoscience Society of New Zealand invites a member to give the annual Hochstetter Lecture. The lecture is delivered to many audiences of both Geoscience members and the general public on a nationwide tour.

Hochstetter's name is also remembered in the names of places and native flora and fauna:

Hochstetter Dome at the head of the Tasman Glacier →

Hochstetter Dome.
Photo: Bruce Hayward, 2021.

Hochstetter Glacier / Icefall below Aoraki and Mount Tasman contributes to Tasman Glacier

Mount Hochstetter in Grey District, West Coast

Lake Hochstetter in Grey District, West Coast

Hochstetter locality in Grey District which contains Lake Hochstetter (and not much else)

Hochstetter Pond a water filled collapsed lava cave in Onehunga, Auckland.

Leiopelma hochstetteri – Hochstetter's frog

Porphyrio hochstetteri – South Island takahē

Entoloma hochstetteri – werewere-kōkako, the sky-blue mushroom on NZ$50 notes

Powelliphanta hochstetteri – one of our large carnivorous snails

Navicula hochstetteri – a diatom presently living in New Zealand

Hexathele hochstetteri – the banded tunnel-web spider from New Zealand

Helophilus hochstetteri – a New Zealand insect - bottle blue hover fly

Polyascosoeciella hochstetteriana – fossil Miocene bryozoan from New Zealand collected by Hochstetter

Australobuchia hochstetteri – Jurassic bivalve from New Zealand

Lentipecten hochstetteri – described from fossil material collected in New Zealand by Hochstetter

Liarea hochstetteri – landsnail from New Zealand collected by Hochstetter

Octotremacis hochstetteri – a fossil octocoral collected by Hochstetter in Java on Novara expedition.

Any more?

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MEMORIES OF PETER DAYMOND-KING

Bruce W. Hayward

Peter Daymond-King was a stalwart contributor to the successful running of Auckland Geology Club for 20 years and was a much-liked and admired friend to all of us. He joined Geoclub in 2001, when his daughter Rhiannon developed a crush on geology while still at secondary school. Peter decided to be an encouraging and supportive parent and drove her in to Auckland from Helensville to attend our monthly meetings and field trips. It was too far to drive home again before returning to pick her up, so Peter stayed with her and soon he too was hooked on rocks.

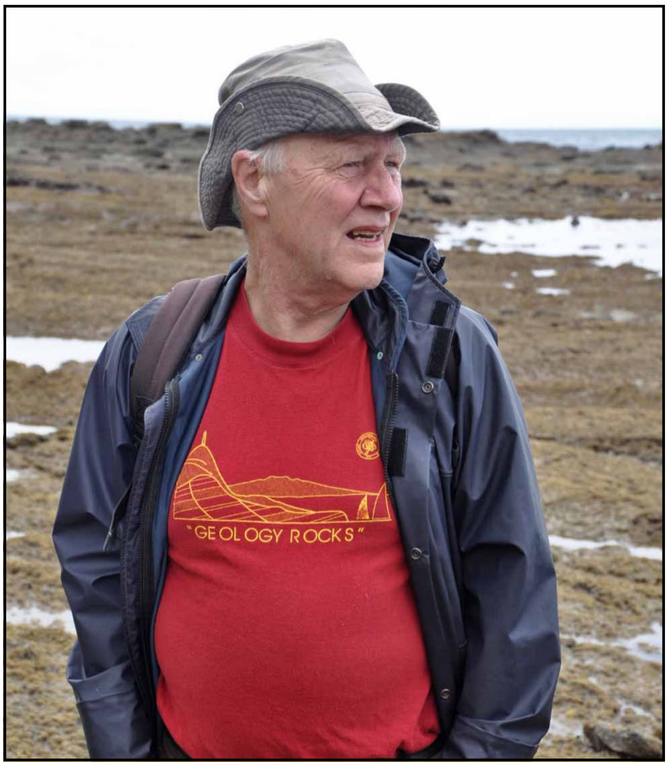

Fig. 1. Peter Daymond-King on a Geoclub field trip, 2012.

Fig. 2. Peter Daymond-King, and daughter Rhiannon, lunching on a Geoclub trip at Ohakuri Dam, 2009.

It was not long before Peter had become Auckland Geology Club's most dedicated member, attending every meeting, trip and event that was organised. His contribution to Geology Club in the years that followed was enormous. In 2016 he volunteered to join the committee, but he had already been a de facto member for many years. He was always the first to arrive at the Epsom Community Centre venue for monthly meetings and on the dot of 7.15 PM he would unlock the code on the door. Once inside, Peter would organise the early bird people to put out the chairs and set up the tables. He would also shoot out to the boot of my car to help carry in boxes of books, projector, laptop and rock trays. Peter was also the last to leave every meeting, being there to pack up the tables and help us carry everything back out to my car.

Peter attended almost every field trip run by the club since he joined 20 years ago – that is over 250 one or half day trips all around Auckland. He also came on almost all of our 4- and 7-day trips in autumn and spring to all parts of the country. There are photos of Peter at Spirits Bay, East Cape Lighthouse, Cape Egmont, Bluff Hill Lookout and on the lighthouse steps on the tip of Farewell Spit.

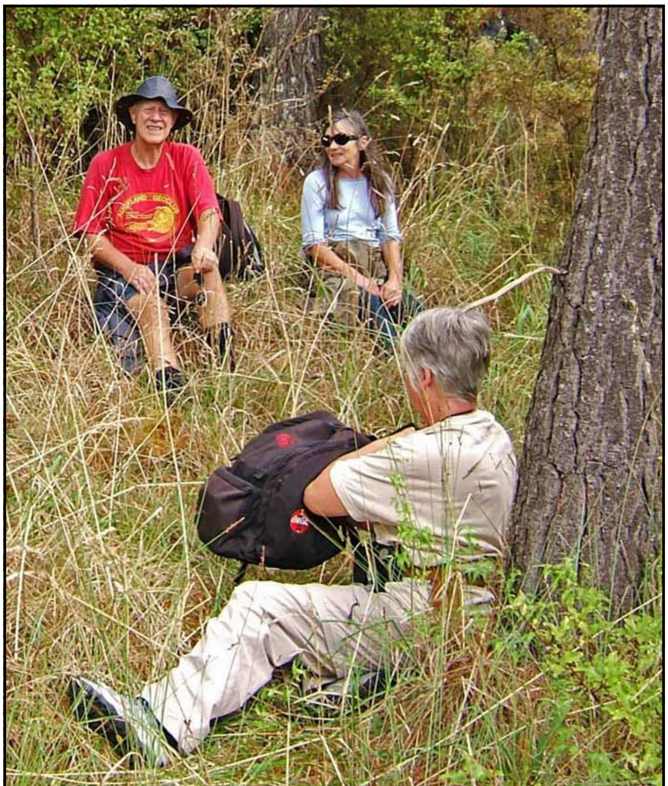

Fig. 3. Peter and Julie Daymond-King relaxing on a Geoclub trip to Ātiu Regional Park, 2008. Glenys Stace in foreground.

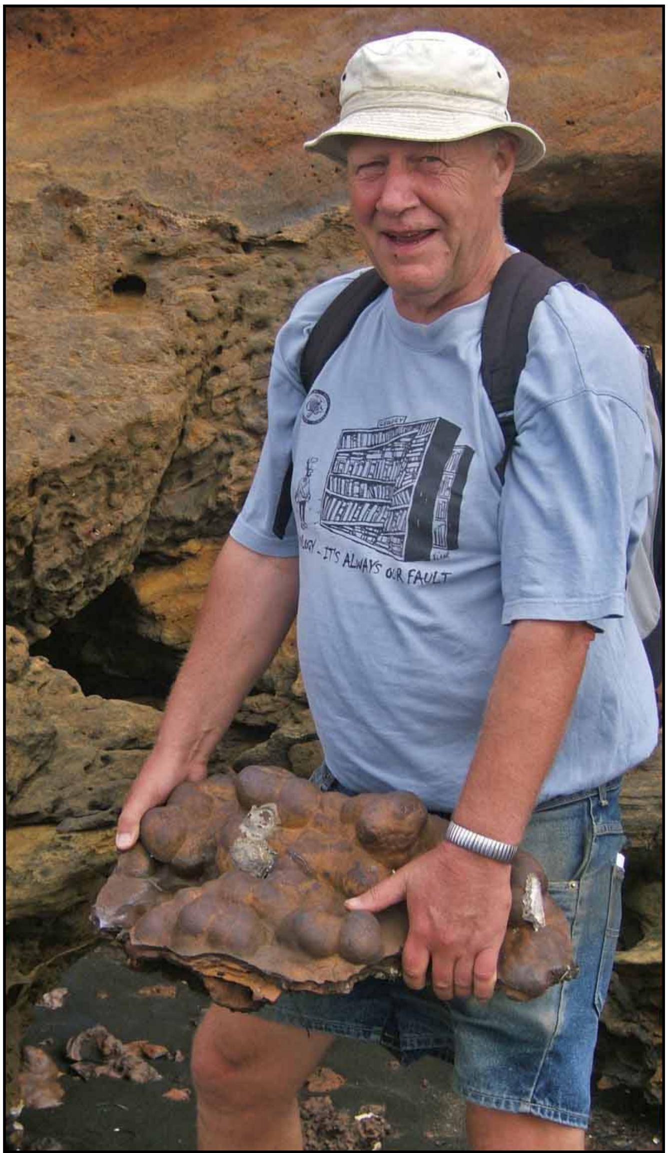

Fig. 4. Peter Daymond-King was so fascinated by the botryoidal shapes in this limonite slab that he carried it 2 km along the coast and up to the road, Kaipara South Head, 2006.

Fig. 5. Peter Daymond-King (right) with Warren Spence and Malcolm Simpson (centre) look skyward for a break in the rain while on a Geoclub trip around the former shoreline of Auckland City, 2007.

He must have attended about 35 of these longer trips for a total of 150 days away with us. In all, Peter spent more than a whole year since 2001 on Geoclub trips. There is only one other person who has been on more *[- and that would be the writer - Ed.]*. Peter would often travel down early to our starting point in some distant city and stay overnight in a youth hostel or the like. And sometimes he might stay afterwards, as he (and others) were forced to do in Nelson in 2019 when the airport was closed by low fog and there were no available seats to fly out for several days. So he and Peter Turnwald shared a pokey little room in a backpackers for the two extra days.

Around Auckland, Peter was almost always the first one at the appointed field trip start point. That, in itself, always amazed me, for he had lost his sense of direction. When travelling in my car he was forever completely lost. In later years he relied a great deal on his car navigation guide to get him to and from our many varied localities. The only field trips he missed were when he was down in the South Island following his passion of gold panning, usually on the South Island west coast. On several of our longer trips, Peter would break away from the main group when we were doing something more energetic or that he had seen before, and he and several others would head off for a relaxing day of gold panning, usually to a spot he had picked out on google several months in advance. One time he proudly showed us a speck of

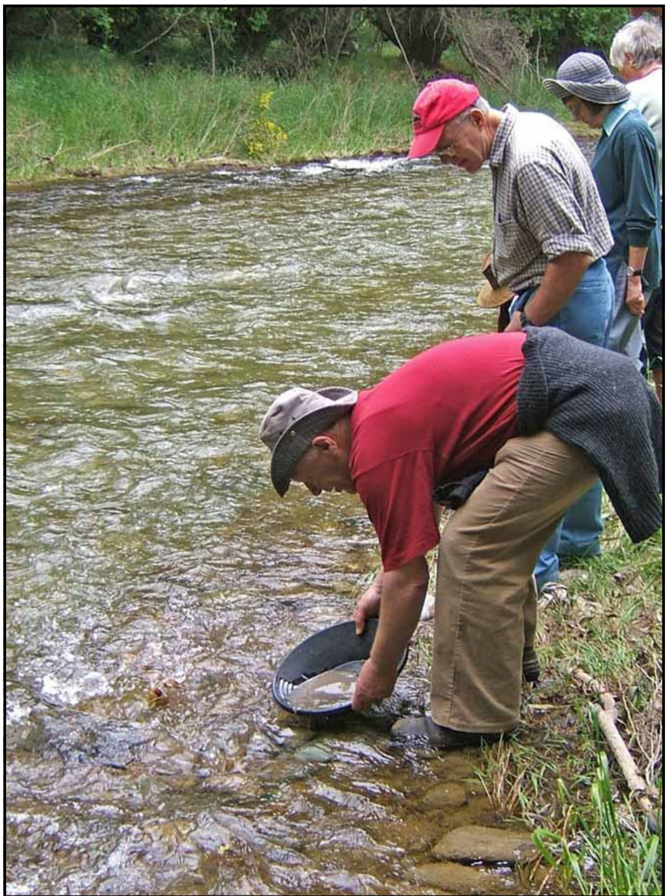

Fig. 6. Peter Daymond-King shows us how to pan for gold at the Earnscleugh Tailings, Central Otago, 2009. Peter Scott watches on.

sparkling gold that he found in his first pan near Oreville Battery on Great Barrier Island, but he found no more for the rest of the day.

Peter did not like cliff edges or high places but, in spite of my warning, he still came on our long walk in 2003 to Te Waharoa Bay on the Te Henga Walkway. He was the only one who did not come down the steep grassy slope to the rocks, but later that afternoon suffered from heat exhaustion on the way back up the track to the cars. Peter also did not like tight spaces and refused to go into places where he might feel claustrophobic. Yet he drove all the way to Wiri Lava Cave from Helensville one Sunday morning in 2014 to spend 3 hours at the cave entrance trapdoor as everyone else took their turn to go in for an hour in groups of ten. Without being asked he became the voluntary "guard" making sure nothing untoward happened at the entrance while people were inside (such as someone closing and locking the heavy door over the only entrance).

In Geoclub, Peter will be well remembered for his detailed observations and his incisive questions that often emanated from these. Peter loved a challenge or a puzzle and often went out of his way on each Geoclub trip to find geological questions that we had not been able to answer, or more often had not thought of asking, and then he would spend the next few days trying to find evidence to test his or other peoples' hypotheses in true scientific fashion. Many of these observations and ensuing questions were made during his early morning forays away from the motel we were staying at, when almost everyone else was still asleep. Like: How did the large boulders get thrown up above high tide on the north side of Rangitoto, especially as it is only 600 years old (2015)? What processes concentrate the black sand in different parts of a west coast beach (2019)? How did the large debris avalanche mounds south of New Plymouth overcome the friction to be transported 10 km or more away from Mt Taranaki across the almost flat ring plain (2021)?

At the annual Geoclubbers' presentation evening in December, Peter would usually have prepared something to tell us about that he had been researching, or something that had been puzzling him, always presented with a touch of humour. For example: Questions about the growth of shells (2020); a new group of trace fossils (2019); his ill-fated gold panning trips around New Zealand (2018); useful hints for Aucklanders in the event of a volcanic eruption (2017); seismic insulators (2016); Pongoroa earthquakes (2015); medieval weddings and fossil rock anthem (2013); the St Kentigern conundrum (2012); puzzling questions about Northland geology (2010); peat formation (2009); and coal musings (2008). From these titles you get a sense of Peter's broad interests.

But for Peter there was much more than Geology Club and he was always full of amazing information and stories he had picked up over his long and full lifetime. He had spent 42 years in science administration in New Zealand

Fig. 7. Peter Daymond-King (left), Peter Scott (centre) and Mark Robbins (right) kitted out with safety helmets for visiting the disused quarry in an Ohakune basalt crater in 2012.

Fig. 8. Peter Daymond-King (centre) enjoys wading the mouth of Waitakere Stream at Te Henga beach with Peter Crossley (left) and Warren Spence (right) on a 2016 Geoclub trip.

and he would often regale us with stories of events that had happened in his various roles while at Head Office of the DSIR in Wellington. He was renowned as the person who could get things done in spite of the red bureaucratic tape, and scientists would come up with some of the most unlikely and preposterous requests that Peter found challenging and enjoyable. He had a fantastic memory and could recall many of these in great detail. At the last Geoclub meeting he attended, just two weeks before his sudden death in 2021, he told me how the arrival of ball point pens had indeed been a major game changer in everybody's lives in the 1960s, but their introduction did not come easy even in the world of scientific endeavour. Right up to 1966, if a scientist in the DSIR requested a ball point pen, they required the signature of the head of the division to be issued with one. Peter was an innovative, efficient and reliable organiser, teacher and problem-solver, and his services were much appreciated every three years in his managerial role helping to organise the polling places in his Helensville electorate for every general election.

Peter Daymond-King led an amazingly full life and took an interest in so many things:
* He knew all about stone masonry from his early days as an apprentice in his father's masonry business back in England. He would always examine the old stone buildings we visited, pointing out flaws in the construction or where he could see where repairs had been made.
* He was a talented wood turner and would examine any potential felled trees we came across for suitable wood for working if he took it home.
* With the help of a few friends, Peter built a home at Helensville for his wife Julie and daughter Rhiannon with more room for growing fruit trees. Back in the day, Peter had considerable interaction with scientists in Horticultural Division of DSIR and when he and Julie set up their new home, Peter planted many different varieties of fruit trees, especially apples and feijoas. We all recall the largest feijoas we had ever seen that Peter would share with Geoclubbers during the harvesting season. Peter also grew superb vegetables and the best of these, together with fruit and preserves, were entered by him and all members of the family at the annual Helensville A and P show and won many prizes. There are not many Geoclubbers who have not been recipients of jars of Peter's famous marmalades and jams – he would experiment very successfully with all sorts of combinations.

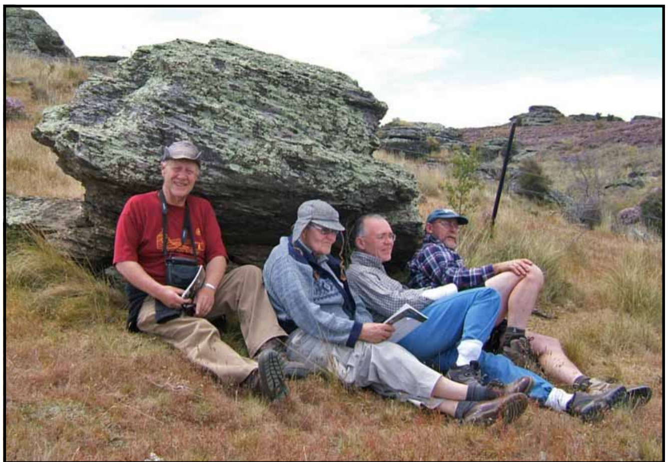

Fig. 9. Geoclub's four Peters rest in the partial shade of a large schist boulder at Butchers Dam, Central Otago, in 2009. Left to right – Peters Daymond-King, Stewart, Scott and Turnwald.

But did you know Peter was a stock market aficionado, avidly researching the best stocks to invest in for the best return; or that he was a rugby fan, especially supporting the All Blacks and Blues? He could cook well and years ago owned and ran a steak house in Wellington after work hours.

Peter was wonderful company as a field companion as we studied trace fossils together around Auckland in the last few years. There I learnt of Peter's craving for a sweet kick after a few hours walking around the coastal rocks. As we returned to the car he would always ask where was the nearest shop. About five years ago I introduced him to cornetto ice creams - the $2 version of the more expensive Tip Top trumpet - and he became hooked on those ever after.

The lives of Auckland Geoclubbers were greatly enriched by having Peter Daymond-King as such a wonderful friend. We will all remember his generosity and the great times we had together. Peter's wife Julie and daughter Rhiannon, now married with her own young family in Lower Hutt, remain members of Geoclub.

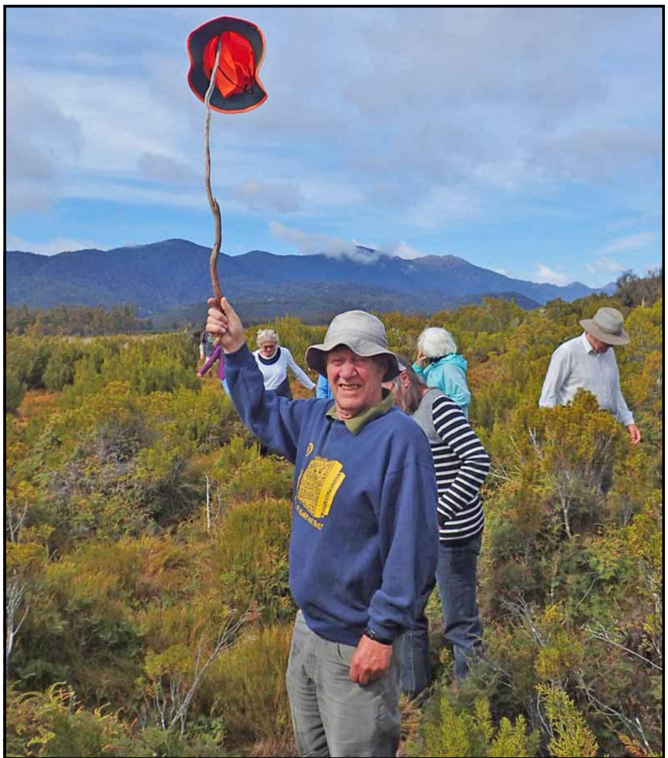

Fig. 10. Peter Daymond-King assists other Geoclubbers find their way through Borland Mire, Southland, in 2017 by hoisting my brightly-coloured hat on a stick above the level of the scrub we had been pushing through.

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HYPERLINK INSTRUCTIONS

Hyperlinks have been added to the contents page numbers column (coloured blue) to simplify finding each article. To activate a hyperlink, click on the coloured page number and you will be sent to the article beginning on that page.

At the end of each article there is another coloured hyperlink, which will take you back to the contents page.

If you wish to return to the previous page you were reading, and you have Windows operating system and standard Adobe Reader, just right click and chose 'previous view' on the drop-down menu, or you can use a shortcut Alt + left arrow. For Macintosh or Ubuntu operating systems, contact the Editor for instructions.

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