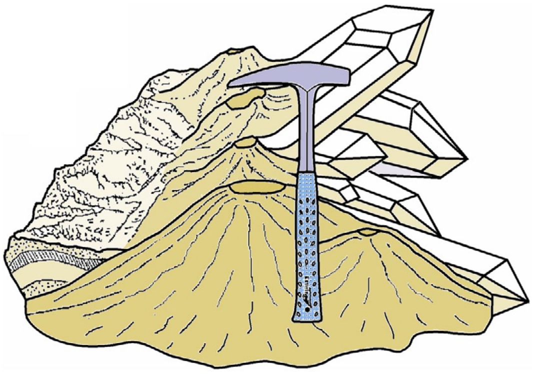

Geocene

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Editor: Jill Kenny

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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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A RAFT OF TUFF RING IN LAVA FLOW FROM MAUNGAREI / MT WELLINGTON

Bruce W. Hayward

In December 2023, Auckland Geology Club had their Christmas BBQ in Maungarei Springs Reserve, inside the old Lunn Ave / Mt Wellington Quarry, Stonefields. We walked right around the old quarry wall on one of the benches that has been turned into a public walking track. At the time we saw nothing particularly unusual in the old quarry walls cut into the 30–35 m thick basalt lava flow that most of the quarry once worked (Fig. 1).

Fig. 1. View east over Maungarei Springs Reserve in 2018 with Maungarei / Mt Wellington scoria cone behind. The walls of the former Lunn Ave / Mt Wellington quarry extend right around the reserve with the light-coloured fence beside the walking track on the higher bench clearly visible. Stonefields suburb is being developed in the footprint of the old quarry.

In February 2024, however, work began on preparing ground along the foot of the southeastern quarry wall for housing. One aspect of this was to clear all the scrub and loose rock and earth from the quarry walls above the building area. To my surprise, a large block of tilted and bedded sedimentary rock emerged from beneath the once scrub-covered face (Fig. 2). It had been hidden by vegetation (Fig. 3) since before development of the huge Stonefields subdivision began almost 20 years ago and I have seen no mention of it anywhere.

Fig. 2. Part of the southern wall of the old aggregate quarry with all the scrub recently removed showing the block of bedded sediment (tilted down to the east) just above the lowest bench and underlain and surrounded by solid basalt lava. The walkway fence is on the higher bench with Lunn Ave commercial buildings on the skyline.

Fig. 3. Aerial view looking west over Stonefields suburb inside the basalt walls of the former Lunn Ave quarry, in 2018. The location of the block of sediment (hidden beneath scrub) is circled.

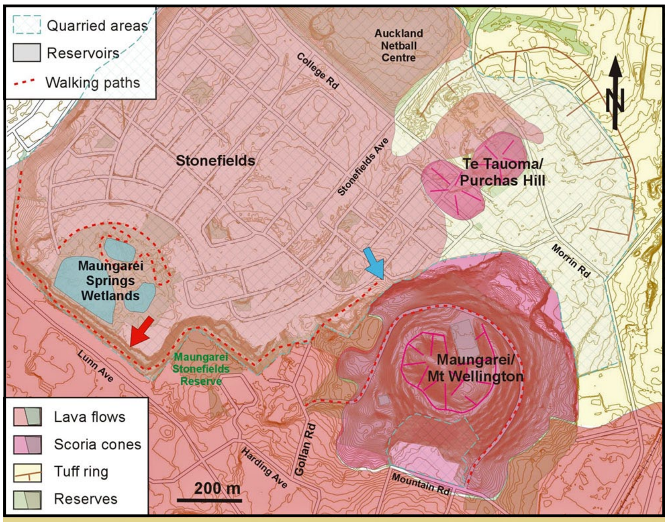

Fig. 4. Plan of Stonefields suburb inside the former Lunn Ave aggregate quarry on the west side of Maungarei / Mt Wellington and Purchas Hills scoria cones. The location of the sediment block within the thick lava flow is arrowed red and the location of similar volcaniclastic sediment (now hidden beneath vegetation) is arrowed in blue.

This block of volcaniclastic sediment is now exposed in the quarry wall at the southern end of Maungarei Springs Reserve, beneath part of the Lunn Ave commercial development (red arrow in Fig. 4). There is solid basalt lava flow exposed in the wall all the way along, beneath the sediment block below the lowest bench. The block is exposed from the level of the lowest bench up to the second bench (with the walkway) and appears to extend above this bench beneath scrub almost all the way to the top of the old quarry wall (Fig. 5).

Fig. 5. View from bench walkway showing block of tilted sediment within basalt lava exposed between two old quarry benches. The scrub-covered face above the highest (fenced) bench seems to contain an extension (circled) of the sediment block.

Fig. 6. Partially red-baked, cream rhyolitic sediment at the base of the block overlying solid basalt lava that is sometimes rubbly. It is overlain (upper left) by fine basaltic lapilli.

The block of sediment is tilted to the east at ~25° (Fig. 2) and appears to be completely surrounded by thick, massive basalt lava (except at the top which is not exposed). The sediment sequence in the block is ~8 m thick and is visible for 25 m along the bedding planes. The size of the block along strike (quarried away and extending back into the quarry face) is not known.

The sediment sequence within the block consists of 2 m of massive, partially red-baked, creamy rhyolitic siltstone (Fig. 6) overlain by poorly exposed fine basalt lapilli. Above this is a massive ~5 m thick rubbly tuff breccia containing angular cobbles and pebbles of Waitematā Sandstone and basalt lava in a fine-grained sandy matrix (Fig. 7). This unbedded deposit is overlain by an 0.8 m thick bed of red-baked, sandy, basaltic tuff and then by

Fig. 7. Massive, unbedded deposit of tuff breccia that comprises ~5 m of the 8 m sequence within the sediment block. Note angular blocks of Waitematā Sandstone and smaller angular pebbles of basalt. Photo width 2 m.

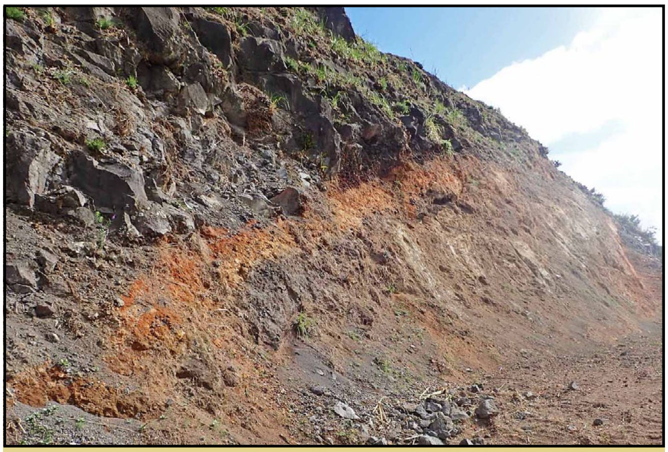

Fig. 8. The top of the tilted block of sediment overlain by basalt lava. The thick sediment unit (lower right) is massive tuff breccia overlain by a tuff bed that is increasingly baked towards the top beneath the lava flow.

lenses of well-sorted basalt lapilli/scoria between it and the overlying basalt lava flow (Fig. 8).

The bottom and top of the sediment block appear to be partially red-baked, but not the centre of the block. The contacts with the lava are parallel to the bedding in the block and either sharp, or mantled by rubbly breccia or scoria lenses between the sediment block and the basalt lava.

Interpretation

The eruption of Maungarei / Mt Wellington scoria cone and lava flows, 10,000 years ago, appears to have followed on directly after the phreatomagmatic and small scoria fountaining of Te Tauoma / Purchas Hill volcano (Fig. 4) just to the north. They were probably formed by the dominantly wet explosive initial phase (Purchas Hill) and subsequent dry fountaining and lava flow phase

(Maungarei / Mt Wellington) of one volcano (Hayward, 2019). The vent (s) that erupted Maungarei had shifted 600 m to the south of the initial Purchas Hill vents. Similar massive tuff breccia and thin tuff used to be exposed at the northwest base of Maungarei in the cuttings around the lower part of the track from Stonefields to Gollan Rd (blue arrow in Fig. 4). Previously these exposures have been inferred to have been part of the wide tuff ring produced by the phreatomagmatic (wet explosive) eruptions of Purchas Hill.

Nearby drillholes around Purchas Hill (BH66138, 101730 in NZ Geotechnical database) show that a thin sequence (2 m in one hole) of Quaternary rhyolitic sediment is sandwiched between the underlying Waitematā Sandstones and the overlying tuff and scoria from Purchas Hill. I thus infer that the sediment block described here consists of the top of the Pleistocene rhyolitic sediment overlain by part of the Purchas Hill tuff ring. It would appear that a branch of molten basalt lava rising inside the throat of Mt Wellington's volcano has intruded laterally, possibly along the contact between the soft Pleistocene rhyolitic sediment and more competent Waitematā Sandstones, beneath Mt Wellington's growing scoria cone. Continued pressure from rising magma has broken this sediment block off and rafted it along within the main lava flow that was flowing out from the western base of the scoria cone. The unusually thick basalt flow that can be seen in the old quarry walls has been explained as a deep pond of lava that accumulated in the wide, flat valley west of the mountain. A vast quantity of fairly fluid lava flowed out in this direction and off down a stream valley system as far as the head of the Manukau Harbour near Westfield.

Thus, I infer this block is a raft of part of Purchas Hill's tuff ring and a small portion of the underlying sediment that has been incorporated into the massive Mt Wellington lava flow and transported 600 m away before the lava around it came to a stop and slowly solidified, baking the outside of the block in the process.

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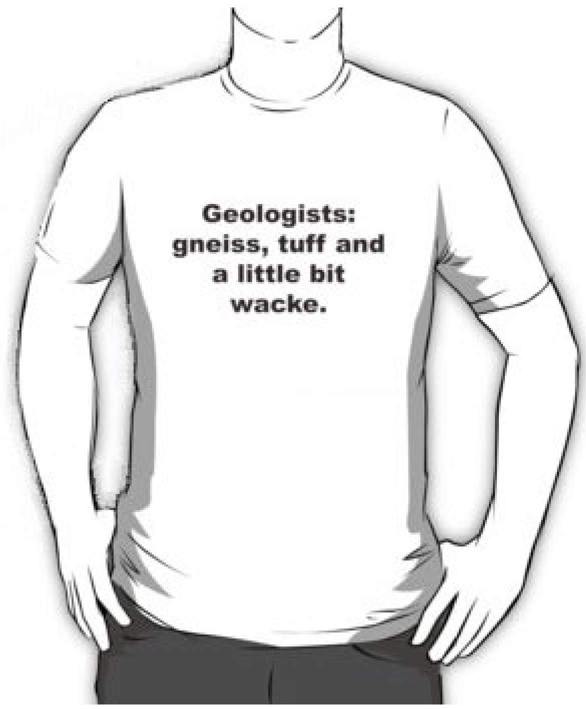

KAIPARA HARBOUR CAVES, OMOKOITI BEACH

Peter Crossley

In May 2024, I went up to the last road access to the South Kaipara Harbour, just before the Heads. Way beyond Shelly Beach, but just before Mosquito Bay, Bruce Hayward was leading the trip. This last road access was in the Auckland Council's new Te Rau Puriri Regional Park by the old Prawn Farm.

Our purpose was to look at the old sand barrier between the harbour and the wild west coast, but on the protected harbour side.

Fig. 1. Locality map of the beach on the northeastern side of South Kaipara Head.

Fig. 2. Location at the back of Omokoiti Beach.

Fig. 3. A cave formed around an upright crack.

Bruce spent some time explaining the formation of the soft sandstone cliffs with current bedding and dune layers, and the provenance of the sand. But my eye was immediately taken by the large number of littoral sea caves in the 5–7m-high sea cliff; more than my excitement could contain; more than a dozen in the short distance we walked. Each one varied between 2 and 8 m in depth, 1–2 m wide and up to 1.5 m high.

The rock was what I would call soft sandstone or palaeo sand dunes, brownish from the iron sand mixed in with it from the volcanics in the south. Not something I would expect deep caves to form in.

Usually, caves are formed by big waves bashing against some fault or fracture in the rock. This aspect has only a short, less than a kilometre east facing fetch. Not like the Waitākere caves further south, which are in hard volcanic breccia facing the whole of the Tasman Sea (Hayward 2017, Crossley *in prep.*). The Waitākere caves are world significant and up to 200 m deep. These Kaipara ones are small but significant.

Fig. 4. Looking out at the low tide beach platform.

Fig. 5. The inner part of the cave showing the vertical crack and limonite on the floor.

Two factors appear significant in their formation. Firstly, the odd fracture in the rock due to slippage, which could be called a local fault, has resulted in a high narrow cave.

Secondly, hardening of the rock by limonite (an iron oxide/ hydroxide) leaching down to the water table and forming when it becomes exposed to air. Some of the caves had 'flowstone' limonite similar in appearance to calcite in limestone caves, but very different in composition and colour.

Overall, a very successful day.

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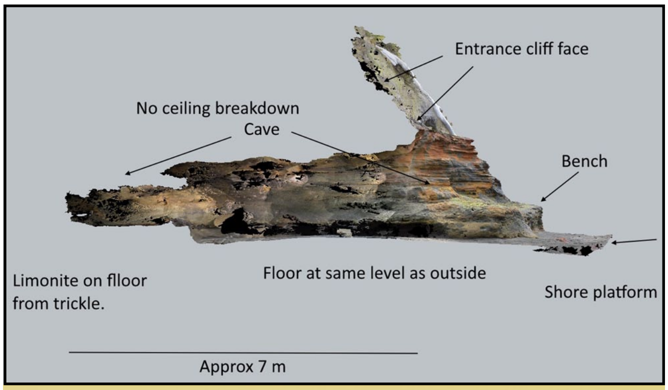

Fig. 6. Lengthwise section of above fault-controlled cave. The roof is uneven and there is no breakdown rubble. The limonite is deposited from a small trickle coming in at the inner end, probably at the water table.

Fig. 7. A cave showing the flat roof of an 'iron pan' of limonite.

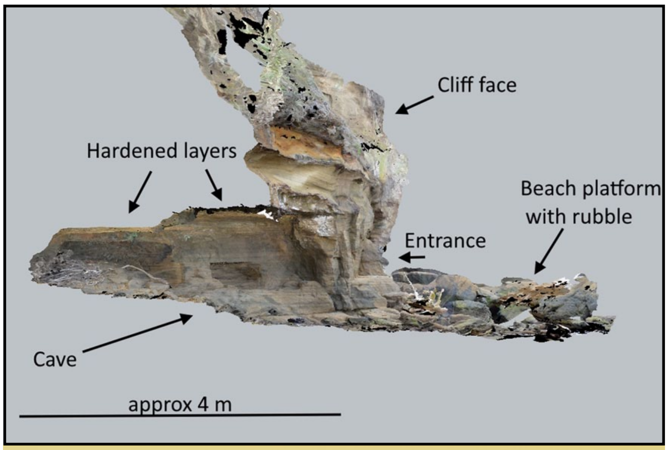

Fig. 8. A 3D slice through the cave above. There is lots of temporary rubble from the cliff on the beach and some inside the back of the cave. The cave itself is broad in cross section with a flat roof.

Fig. 9. A cliff face showing the hardened layers with softer bands underneath. A micro slip/fault cave is seen on the left.

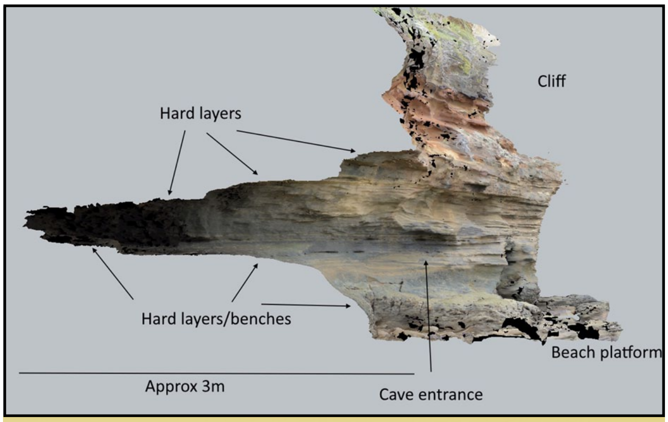

Fig. 10. Long section of above cave showing the formation control of several hardened layers.

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ROCK HEWN BY HUMAN HAND: FROM BEACH FIND TO INSIGHTS INTO AOTEAROA NEW ZEALAND'S 'FIRST GEOLOGICAL SURVEY'

Louise Cotterall

Walking along Opito Bay towards the headland pa during GeoClub's May 2024 Whitianga fieldtrip, Coromandel, I picked up a rock that was unnaturally symmetrical. It was recognisable as a rough, unfinished adze, though much water-worn from being rolled around the beach (Figs 1 & 2).

Fig 1. Back side Tahanga basalt adze with bevel (cutting edge) on right. Flaked, chipped and worn surface.

Fig. 2. Side view. The left poll end and the wider blade end are tapered more smoothly than the other surfaces.

Kath Prickett, archaeologist and former Human History Collection Manager at Auckland War Memorial Museum, had described the uniqueness of the grain of Tahanga basalt at an outcrop on the beach earlier. It has tiny flecks of feldspar crystals, a very fine grain for basalt, allowing it to be easily shaped, by flaking, into adze forms.

A visit to the Mercury Bay Museum in Whitianga revealed displays showing that Opito is well known in Aotearoa archaeology as the source of Tahanga basalt, a fine-grained stone prized for making toki adzes by Maori throughout the northern North Island. Basalt is a rare rock type in the Coromandel Peninsula, comprising less than 0.1% of the exposed rocks of the Coromandel (Source: Mercury Bay Museum). It formed from low viscosity, iron rich lava that erupted from the earth's mantle.

I showed the photos to geologist and archaeologist, Phil Moore, who hinted the location of the source rock was a quarry sited directly inland from the adze found on the beach. The quarry is on private land under the jurisdiction of Ngāti Hei and may be the earliest known stone quarry in New Zealand. The distribution of Tahanga basalt adzes in New Zealand was first established by Moore (1975, 1976). Current research indicates people first arrived in New Zealand sometime between 1250 and 1280, and probably closer to 1280 (Bunbury *et al*. 2022).

Fig. 3. Location map. Area of Fig. 4 in red rectangle.

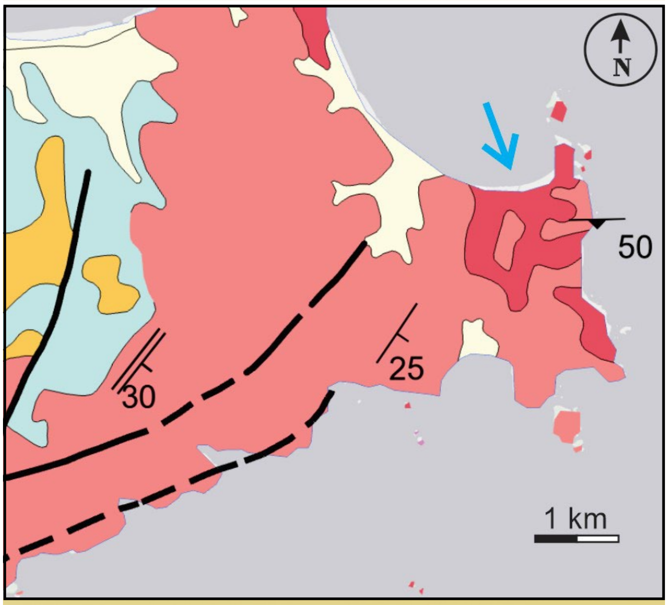

Fig. 4. Geological setting - GNS QMAP.

Past archaeological evidence suggested the arrival of the first humans in New Zealand took place around AD 1200 (Anderson 2009), with archaeological dating of sites on the Kuaotunu Peninsula demonstrating occupation between 1280 and 1400 (Davidson 1984).

This unique fine-grained volcanic basalt was considered so valuable for its purpose that it was widely traded throughout the country, with examples found at archaeological sites throughout New Zealand, reinforcing the importance of this area as a centre of trade networks (Jones 1987, 2007). The majority have been found through the northern half of New Zealand. Tahanga's main products were adzes, used for timber felling and woodworking, and perhaps particularly canoe manufacture.

The main production at Tahanga appears to have been the creation of rough adze preforms on working floors within the complex. 'Finishing centres' to complete products through further flaking have been found both nearby and up to 60 kilometres away. The adzes sourced from Tahanga were mainly quadrangular and very rarely, side hafted. The subject adze fits the description of Type I long narrow variety after Duff (1956), Type 1d, e. Simon Best (1977) noted that hundreds of adze roughouts and flakes have been found in this area.

Similarities between early adzes, such as those from Tahanga and those produced in Eastern Polynesia, suggests direct contact between New Zealand and other Pacific communities.

Being such an important source of basalt for the creation of stone tools in New Zealand during the first centuries after human arrival, Tahanga Quarries forms part of an important landscape linked with early settlement in New Zealand and reflects significant connections with East Polynesian culture (ref: Heritage NZ).

Tahanga's significance as a stone source to Maori can be supported by an oral tale that describes how Poutini, a guardian taniwha protecting the mauri or spiritual essence of greenstone, lit a fire on the beach before travelling on to other locations of value for their stone products (Toitu Te Whenua 2008).

This story is really an oral map, an atlas, of the ancient quarries from which the tūpuna took their valued stones. Tūhua gave them Mayor Island obsidian, a volcanic glass with its own special colour; Tahanga was the great quarry for basalt used in making adzes; Whangamatā takes its name from matā, the ordinary black obsidian.

Rangitoto, D'Urville Island, is the site of the huge quarries where pākohe, metamorphised argillite, was sourced. Pākohe was also taken from the high hill Whangamoa. Onetāhua, Farewell Spit, is where 'floater' stones from the Nelson mineral belt are washed up in convenient sizes for shaping into tools and ornaments. The Pāhua flints are found embedded in limestone near Punakaiki. These were specially valued for drilling holes in pounamu. Takiwai at Piopiotahi, Milford Sound, was the quarry for bowenite jade, a soft, translucent stone valued for ornaments but useless for tools because it is not tough and hard like pounamu - the tungsten steel of our tūpuna. The finest pounamu lies in the bed of the Arahura River (Toitu Te Whenua 2008).

The story of Poutini effectively provides a map of stone resources in New Zealand, and has been described as the country's first 'geological survey' (Toitu Te Whenua 2008).

Acknowledgements
Thanks to Bruce Hayward, Phil Moore and Kath Prickett for their expert guidance.

The adze has been registered at Auckland Museum, thanks to Josh Emmitt, curator of Archaeology, under The Protected Objects Act 1975, Taonga Tūturu Temporary Custody Form, where it is held until the Ministry of Culture and Heritage assigns iwi ownership. Research is ongoing with Ngāti Hei.

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REVERSAL OF THROW ON SCENIC DRIVE FAULT, WEST AUCKLAND

Bruce W. Hayward

Summary

Geological mapping of the sedimentary strata along the east side of the Waitākere Ranges indicates that there was 200–300 m more uplift on the east side of the Scenic Drive Fault than the west, during eversion of the deep bathyal Waitematā Basin ~18–15 myrs ago. This was followed by erosion of a coastal plain (the Auckland Erosion Surface, AES) right across the region during the following ~10 myrs of tectonic stability. In the last ~5 myrs, the Waitākere Ranges have been uplifted, in part as a result of reversal in vertical throw direction on the existing Scenic Drive Fault, with 100–200 m of uplift on the western side of the fault, recorded in displacement of the AES.

Introduction

A long-held simplistic model of Auckland's topography holds that there has been large-scale block faulting within the Pliocene-Quaternary that has upthrown the Hunua and Waitākere Ranges with respect to Auckland Isthmus and downthrown the Manukau lowlands block (Searle 1964). Thus, when I mapped the Waitākere Ranges for my PhD in the early 1970s, I was somewhat surprised that I could find no stratigraphic evidence for a fault along the east side of the Waitākeres with uplift on the west side. Indeed, I was surprised that my mapping indicated that there had been relative *downthrow* on the western side of a fault running along the eastern Waitākere Ranges in the vicinity of the Scenic Drive (Hayward 1975, 1976).

Soon after finishing my PhD, I presented my results in a lecture for the Auckland Branch of GSNZ. In question time I clearly remember the late David Skinner standing up and asking what was the origin of the flat top on the Waitākere Ranges. I was taken aback as I had never observed or conceived that the Waitākeres were flat on top, I had been so focused on mapping the early Miocene geology that I failed to stand back at 5–20 km distance and see the obvious. Ever since then I have been puzzled that my mapping showed downthrow of the Waitākeres, whereas the uplifted Auckland Erosion Surface (flat top) of about 5 myrs age clearly indicated they had been uplifted.

Now, 50 years after I first recognised and mapped a long NNW-trending fault along the eastern margin of the Waitākeres in 1974, I decided to revisit the questions: Is the Scenic Drive Fault real? What was its likely history?

Prior to 1974, no fault had been recognised or mapped along the east side of the Waitākeres (e.g., Schofield 1967). In the early 1970s, my base map was the old NZMS1 inch to the mile sheet N41 with 100 ft contours that I soon discovered was not terribly precise or accurate. So I used a stereographic pair of air photos and a portable stereoscope in the field to navigate and map with. I would have used this tool to identify a lineation in the topography and map an unnamed Scenic Drive Fault (Hayward 1975, 1976) (Fig. 1). In the mid-1970s a draft 1:25,000 metric map (Q11) with 20 m contours became available and this became my new base map for redrawing the geology and faults for publication of the Q11 Waitākere geological map at 1:50,000 (Hayward 1983). The Q11 sheet only showed the northern portion of the fault - my mapped southern half (south of Opanuku Road) appeared on the western edge of Les Kermode's (1992) R11 geological map in the same series.

Since my original mapping, the fault has appeared unchanged on several subsequent derivative maps (e.g., Edbrooke 2001, Kenny *et al*. 2012, Hayward 2017), although its throw was changed to uplift on the west by Kenny *et al*. (2012) and named by them East Scenic Drive Fault (Fig. 2). I inadvertently shortened the name to Scenic Drive Fault on my map in Hayward (2017, fig. 10.1) (Fig. 3) and now prefer this latter name, as the Scenic Drive crosses it between Waiatarua and Arataki and the fault is west of the Scenic Drive at its southern end.

A map showing the more-precisely determined locations of epicentres of larger earthquakes (M> 2, depth <40 km) in the Auckland region between 2000 and 2016 (Fig. 4) shows three along the line of the Scenic Drive Fault and two several kilometres to the east (Hayward 2017, fig. 10.19), suggesting that maybe the Scenic Drive Fault is potentially still active.

Remapping of the Scenic Drive Fault

It had been years since I looked at my mapped route of the fault and so I decided to remap it on the now available LiDAR base map (Auckland Council 2024) using 10 m contour intervals (Fig. 5). When I had finished, I compared it with my original (Fig. 1) and found the route was virtually the same, except that now I had been able to extend it southwards to the Manukau Harbour.

Pukematekeo to Mountain Road (Fig. 6)

Here the steepest part of the eastern Waitākeres runs as a straight NNW-striking line of 130–200 m steep, mostly bush-clad slopes just east of the Scenic Drive. In Walkers Bush there are several waterfalls that cascade down this steep slope.

Parekura Peak (Figs 7–8)

The line of the fault crosses Stoney Creek about 500 m downstream from Fairy Falls, which likely exists because of the fault scarp but has eroded back upstream. Between Opanuku and Forest Hill roads is Parekura Peak (280 m) and the line of Scenic Drive Fault runs through the saddle between the peak and 400 m-high Scenic Drive ridge to the west.

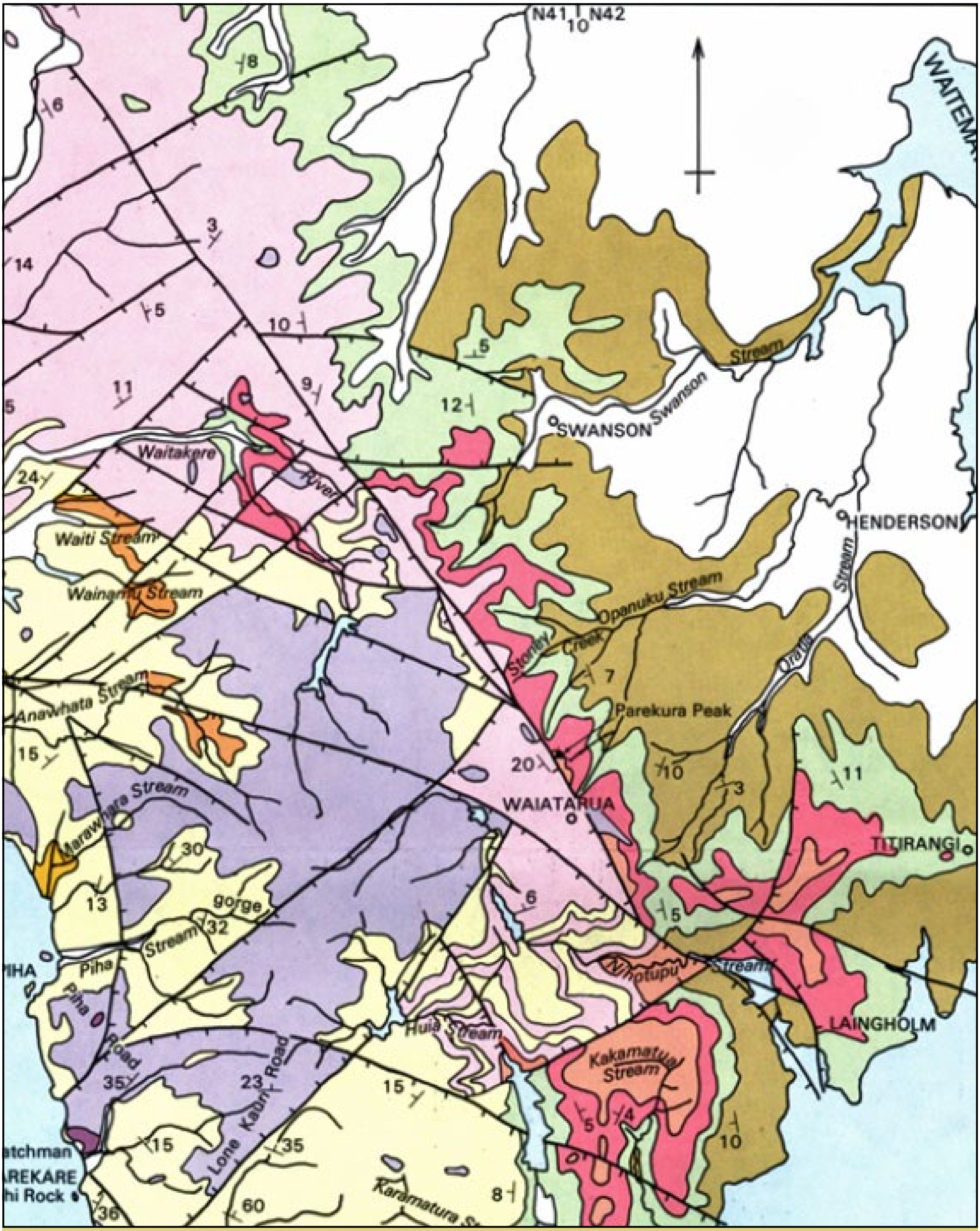

Fig. 1. Geological map of the eastern part of the Waitākere Ranges showing faults inferred from stratigraphic mapping and topography (Hayward 1976). Note the long fault bisecting the map from top left to bottom right (now named Scenic Drive Fault) with uplift indicated on the east side.

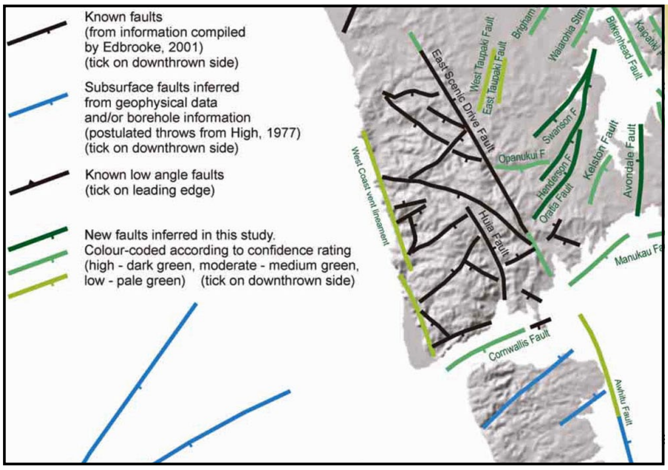

Fig. 2. "Known" and inferred faults with different confidence status in west Auckland from Kenny *et al*. (2012). Note the newly named East Scenic Drive Fault with uplift on the west side.

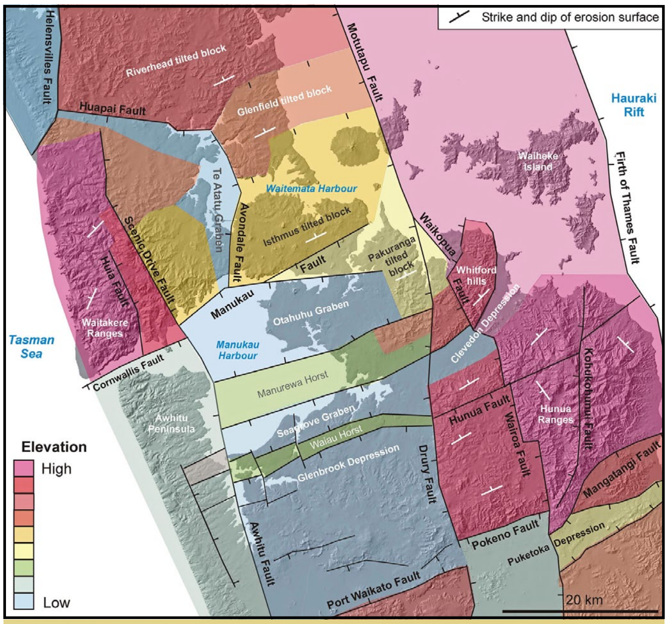

Fig. 3. Map of block faulting in the greater Auckland area, inferred from the elevation of the Auckland Erosion Surface. From Hayward (2017) modified from the work of Kenny (2013a, 2013b).

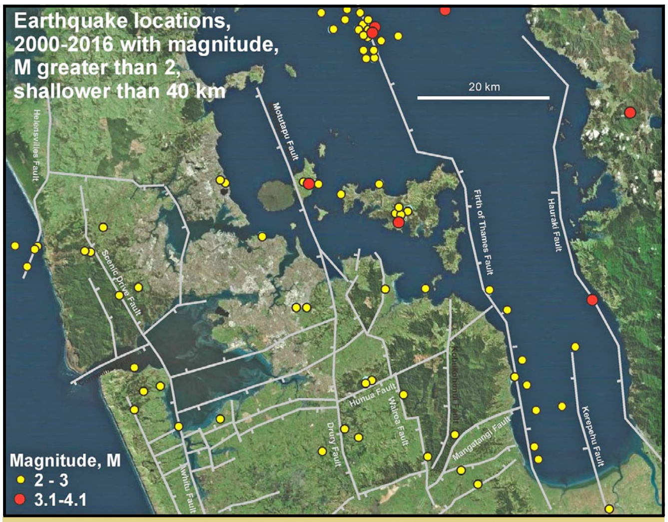

Fig. 4. Location of all earthquakes greater than magnitude M = 2 and shallower than 40 km depth recorded in the Auckland region between 2000 and 2016. Note the correspondence of many with known major faults including the Scenic Drive Fault. From Hayward (2017) generated from Geonet.

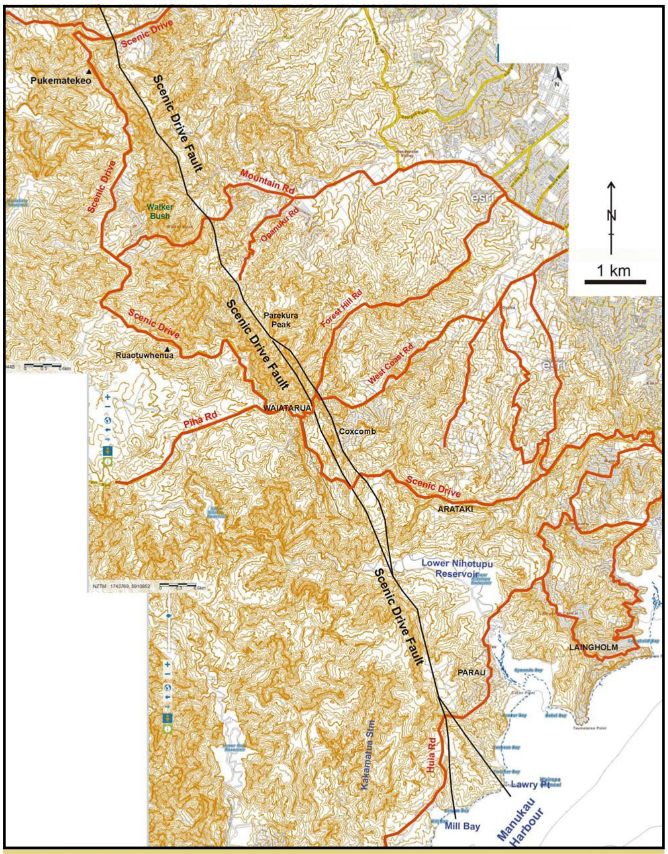

Fig. 5. Remapped trace of the Scenic Drive Fault based on linear features in the topography displayed in the LiDAR contours.

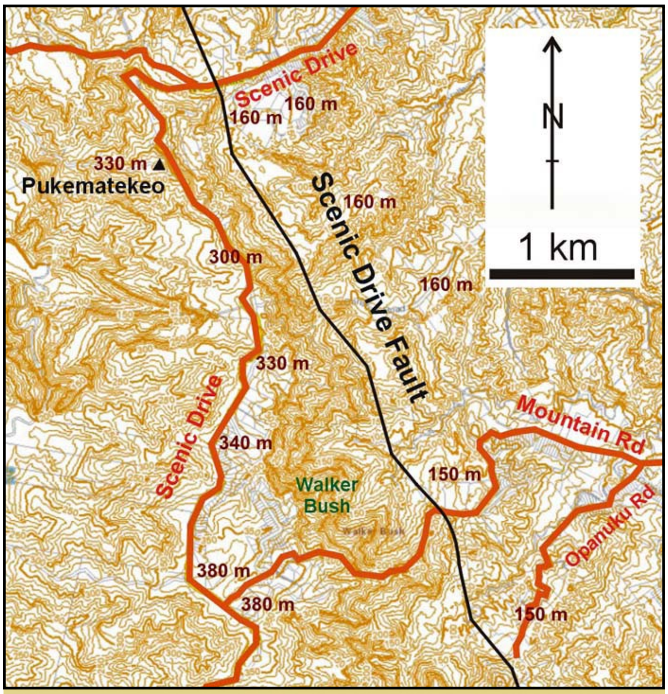

Fig. 6. LiDAR contour map showing the trace of the northern third of the Scenic Drive Fault. Elevations of the highest flat topped ridge crests and hills on either side of the fault provide evidence of the amount of upthrow on the west side of the fault.

The "Coxcomb" (Figs 7, 9)
Three hundred metres east of Scenic Drive and just south of West Coast Road at Waiatarua is a unique elongate ridge (the "Coxcomb"), oriented NNW–SSE parallel to the Scenic Drive Fault with further sections to the north and south. The fault could pass either to west or east of this steep-sided ridge. A possible alternative interpretation here is that the "Coxcomb" was produced by a section of the Scenic Drive ridge (to the west of the fault) sliding 400 m down and across part of the fault scarp, where there is now an unusual flat-floored, swamp valley parallel to the fault.

South of Scenic Drive (Figs 9–10)
Just south of the "Coxcomb", the fault trace (possibly as several strands) crosses the Scenic Drive, down a deep valley and across Nihotupu Stream in the vicinity of the head of the Lower Nihotupu Reservoir. From here I infer the fault passes along the base of the steep slopes along the east side of the ridge between Parau and Kakamatua Stream. About 1.5 km north of the Manukau coast, the topography suggests that the fault could split into two strands with one following Duncan Gully and the other Hemsley Creek down to the Manukau Harbour.

Evidence for vertical displacement
When viewed from a distance, the Waitākere Ranges clearly have a flat truncated top that appears to be tilted towards the northwest with a step down to the east in the vicinity of Huia Valley (Fig. 11). This flat top is preserved in the high ridge crests and would appear to be relic from the Auckland Erosion Surface that seems to have been eroded down to sea level about 5 myrs ago (Hayward 2017). This is the surface that was first recognised by Bartrum (1937) and named by him as the Auckland peneplain. Part of this surface is the Scenic Drive ridge (west side Scenic Drive Fault), which ranges between 330 m above sea level in the north (Pukematekeo), 430 m in the middle (Ruaotuwhenua) and 390 m west of the "Coxcomb" (Figs 6–7). In the south, the flat-topped ridge west of Parau (Panto Track) is 250 m above sea level (Fig. 10). There is probably fault displacement in the vicinity of Nihotupu Valley that has downthrown this southern part of the erosion surface by ~150 m. (e.g., Fig. 1).

On the Tāmaki Isthmus, the flat-topped ridges show that the Auckland Erosion Surface here is now 50–100 m above sea level (Fig. 3). This indicates that in the last ~5 myrs, there has been ~ 200–300 m differential displacement between the Waitākeres and Tāmaki Isthmus. By no means all of this displacement has occurred on the Scenic Drive Fault, however. There must have been other faults or eastward down-tilting that have displaced the surface between the Scenic Drive Fault and New Lynn-Massey.

A better estimate of the amount of topographic downthrow that has occurred across the Scenic Drive Fault itself in the last ~5 myrs is gained by comparing the ridge heights (AES) on either side of the fault (Figs 6, 7, 10). The elevation of ridge crests east of the Scenic Drive Fault is

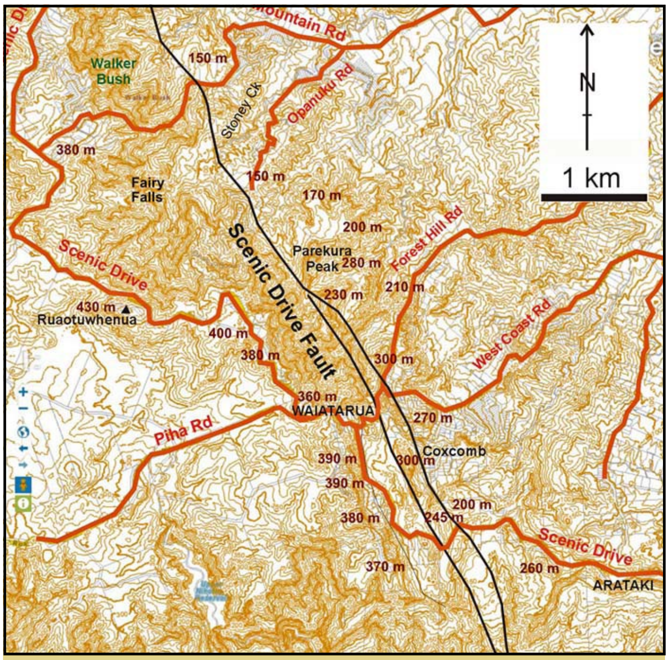

Fig. 7. LiDAR contour map showing the trace of the central third of the Scenic Drive Fault. Elevations of the highest flat topped ridge crests and hills on either side of the fault provide evidence of the amount of upthrow on the west side of the fault.

Fig. 8. View south to Parekura Peak - an upstanding ridge of west tilted volcanic conglomerate on the east side of the Scenic Drive Fault.

Fig. 9. View northwards from Kauri Grove to the linear "Coxcomb" ridge on the line of the Scenic Drive Fault near Waiatarua.

consistently 150–160 m above sea level in its northern half between Pukematekeo and Opanuku Road, giving a vertical displacement of 140–230 m on the fault. In the middle sector, between Parekura Peak and the "Coxcomb", the elevation of ridges and high points east of the fault is 200–300 m, compared with 360–400 m on the west, giving a displacement in the order of 100–200 m. At the southern end, between Nihotupu Valley and the Manukau coast, the elevation of the flat-topped ridges east of the fault (e.g. Laingholm ridge) is 135–150 m compared with 250 m to the west, giving 100–120 m displacement. In summary, the displacement of the elevation of Auckland Erosion Surface across the Scenic Drive Fault itself ranges between 100 m in the south and ~150–200 m in the centre and north.

It is difficult to be so precise when considering any displacement of the early Miocene stratigraphy beneath

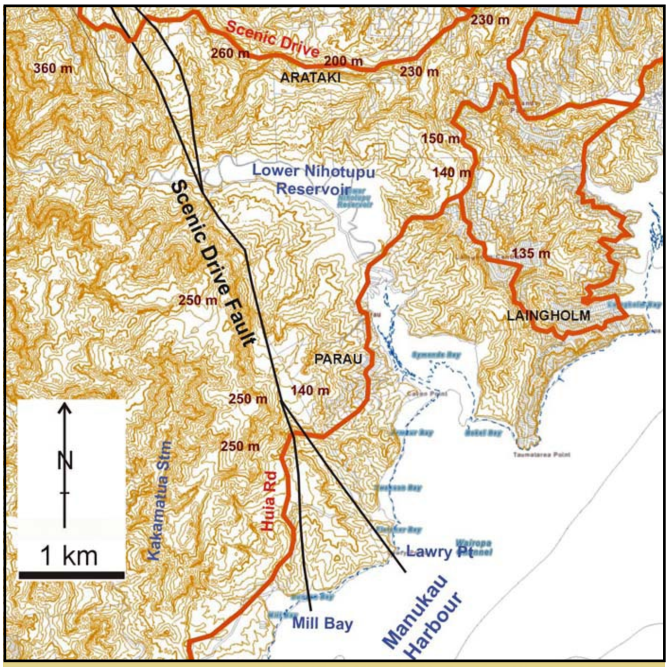

Fig. 10. LiDAR contour map showing the trace of the southern third of the Scenic Drive Fault. Elevations of the highest flat topped ridge crests and hills on either side of the fault provide evidence of the amount of upthrow on the west side of the fault.

the Auckland Erosion Surface because of the lateral changes in the rock types that accumulated on the lower eastern slopes of the Waitākere Volcano, 20–15 myrs ago. The coarse volcaniclastic Piha Formation and the overlying Lone Kauri Formation terrestrial lava flows only outcrop to the west of the Scenic Drive Fault (Hayward 1976), but have largely thinned out before reaching it. In the eastern foothills of the Waitākeres, the volcanic-poor (East Coast Bays Formation) and mixed volcanic-poor and volcanic-rich (Blockhouse Bay Formation) facies of the Waitematā Group (Ballance 1976) only outcrop east of the fault as does the overlying Cornwallis and Swanson formations (Hayward 1976, 1983; Kermode 1992). Based on this stratigraphy, I inferred 80–120 m of downthrow on the western side of the Scenic Drive Fault (Hayward 1976) and have no new evidence to change this. Four shallow andesite intrusions and an eruption centre with flows, occur along the line of the Scenic Drive (Hayward 1977), which possibly provided the broken rock conduit for the rise of magma.

In the south, on the Manukau Harbour coast, the Waitematā Group outcrop is limited to the east of the western strand of the Scenic Drive Fault (Mill Bay) and the overlying Cornwallis Formation is essentially confined to the west of it. So here a downthrow of 50–100 m to the west is inferred, based on this stratigraphy.

Interpretation

The sedimentary rocks on either side of the Scenic Drive Fault were deposited at bathyal depths of about 1000–2000 m depth, 20–18 myrs ago. Tectonic forces in the late early-mid Miocene (~18–15 myrs ago) are inferred to have uplifted the whole region out of the sea (Hayward 1976). For the next 10 myrs or so the region is inferred to have been eroded down to sea level forming the Auckland Erosion Surface. Thus, if the interpretation of vertical displacement on the Scenic Drive Fault is correct, the Auckland isthmus area was uplifted 200–300 m higher than the Waitākeres along the fault during the early–mid Miocene. In the last 5 myrs (possibly mostly in the Pliocene) it follows that there has been a reversal of throw on the fault with uplift on the west side of 100–200 m, so that today there is still a relic of about ~100 m downthrow on the west side in the stratigraphy.

Fig. 11. Distant view from south of the Waitākere Ranges showing their flat top displaced by the Huia and Scenic Drive faults.

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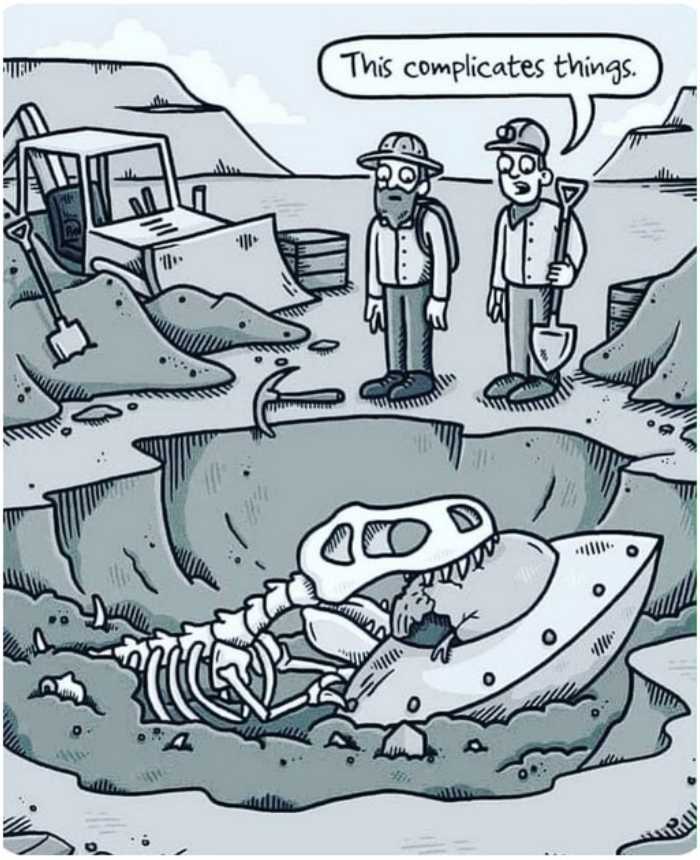

FLUORESCENCE AND MAGNETISM IN THE INNER MANUKAU HARBOUR

Lori Dale

In the Manukau Harbour (Fig. 1), a recent slip near St Anne's Foreshore (Fig. 1, inset location 2) exposed a large, rounded rock and corresponding hollow in an eight-metre-high bank (Figs 2A & 2B).

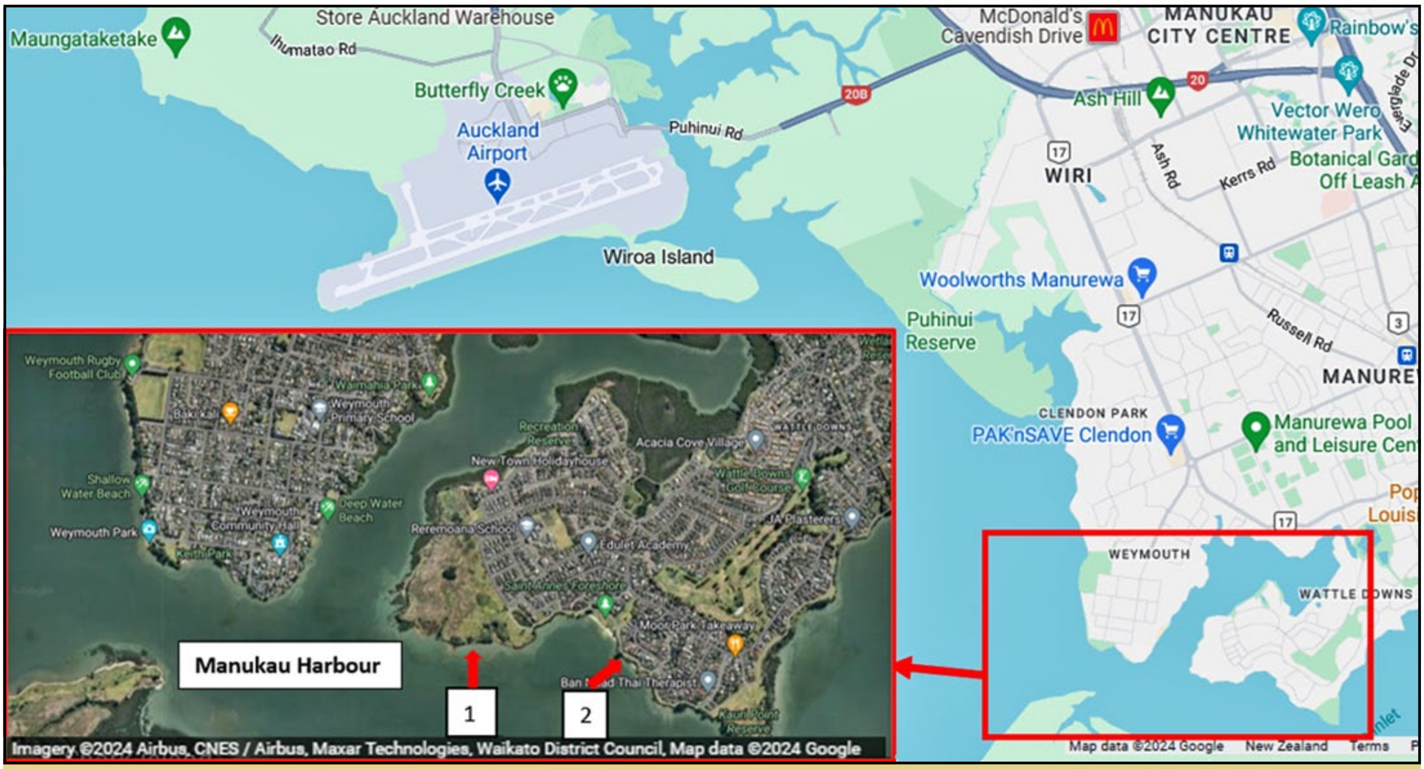

Fig. 1. Map of Manukau Harbour, Auckland, New Zealand, with locations of fluorescent rocks numbered (Google 2024). Maungataketake volcano is at top left.

Fig. 2A. Slip area with rock end hollow circled in red and position of rock arrowed (pers. obs.).

Fig. 2B. Rock hollow with remnant crust at top right and magnetic lens at bottom left (pers. obs.).

Rock hollow: The hollow was 10 cm in diameter. A lens of blue-tinged salt-and-pepper, silky-feeling, friable material lay under the entirety of the hollow and the rock. Another pocket of the salt-and-pepper material lay exposed one metre away to the northwest (left of hollow) (Fig. 3).

Fig. 3. Magnetic salt-and-pepper lens to northwest (L) of hollow, and under hollow with distinct sedimentary layers visible above and below magnetic material.

Rock: The rock was almost fully encased in the seaward slip material with only a small end-portion visible. After three return visits, incoming tide permitting, the rock was finally extracted, revealing a 40 cm long x 28 cm wide x 16 cm deep cemented sandstone rock weighing 50 kilograms (Figs 4A & 4B pers. obs.).

Fig. 4A. The rock.

Fig. 4B. Close up of landward end of rock.

Fluorescence: A 365–395 nanometres (nm) torch light was shone over the rock several nights later. The rock shone a bright purple-blue, radiating outwards to deep violet, with pockets of vibrant pink under 365 nm fluorescent light (Fig. 5).

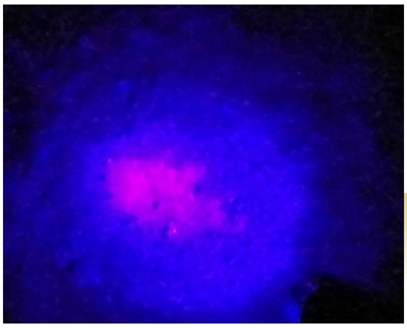

Fig. 5. Rock under 365 nm fluorescent light.

The colour is reminiscent of calcite with a manganese activator. Calcite does not usually fluoresce unless an activator is present, with the brilliance of the pink fluorescence varying with the amount of the manganese activator. For comparison, Australian mangano-calcite samples fluoresce bright pink (Fig. 6A). Sterling Hills, USA samples from a zinc and manganese ore deposit show bright pink fluorescence in white calcite due to manganese inclusions (Fig. 6B) (Stephen Hui, Geological Museum 2024).

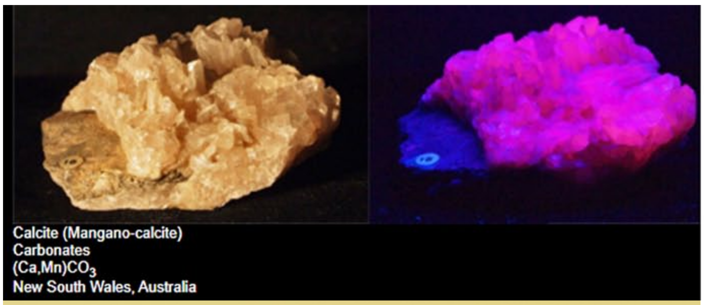

Fig. 6A. NSW, Australia, mangano calcite.

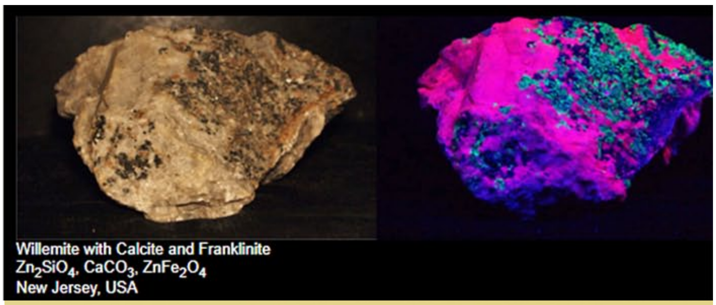

Fig. 6B. Sterling Hills, USA, fluorescent pink calcite.

Possibilities for the purple-blue fluorescence include the presence of albite, benitoite, hydrozincite, magnesite, or scheelite. Baryte with zinc compounds may also fluoresce purplish-pink (Fluorescent Mineral Society 2024).

A check on similarly dense rocks found nearby turned up another fluorescent rock (Fig. 7). The density and blocky crystals in this rock suggest baryte. The rock has a faint yellowish-green tinge under 395 nm.

Fig. 7. Suspected baryte-containing rock under 365 nm light (Refer Fig. 1, Inset location 1 for site it was found).

How did the 50kg fluorescent rock get there?

Calcareous sandstone boulders are known to have been thrown from Maungataketake volcano (Augustin-Flores *et al*. 2014, Fig. 8), and presumably other volcanoes, during phreatomagmatic activity in the Auckland Volcanic Field circa 260 kya–600 ya, and the South Auckland Volcanic Field circa 1.56–0.5 mya. The boulders are believed to have originated in the Te Kuiti Group (Hayward 2018, Hayward 2019, Hayward *et al*. 2023). But this boulder is lying in a much older seam of material and was possibly part of fluvial and estuarine sediments carried by the late-Pliocene Clevedon River that circa 3.5 mya flowed westward from the Coromandel Peninsula (Battey 1949, Hayward *et al*. 2006). This would also explain the (potentially reworked) jasper pebbles, carried originally from the Coromandel / Waiheke by the Clevedon River.

To assist with dating, of note a late-Pliocene mudstone layer replete with *Xenostrobus huttoni* estuarine mussel casts and beech leaf casts, forms a 2 m layer above current beach level (Fig. 8).

Fig. 8. Casts of *Xenostrobus huttoni* from the late-Pliocene layer beneath the rock location (pers. obs.).

The nearest registered fossil record bearing *Xenostrobus huttoni* is 50 metres southeast at R12/f86 (Hayward 2022). A further two large late-Pliocene shell casts have recently been located at that site (Figs 9A & 9B). The slipper shell cast (Fig. 9B) is similar in appearance to *Maoricrypta profunda* shells (Beu & Raine 2009) found in the Watercare Central Interceptor Māngere Shellbed Member 3.7–3.0 mya layer believed deposited in a subtidal channel (Fig. 10) (Hayward *et al*. 2023).

Fig. 9A. Unidentified bivalve located at R12/f86. Despite the appearance in the first photo the shell cast is not actually levitating! Measures 7 cm long x 6 cm wide x 4.5 cm deep (pers. obs.).

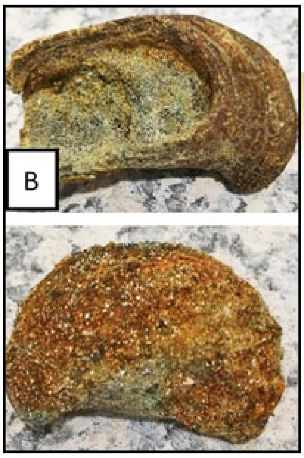

Fig. 9B. Slipper shell cast from R12/f86. Measures 6.5 cm long x 4 cm wide x 2.5 cm deep (pers. obs.).

Fig. 10. *Maoricrypta profunda* from the Watercare Central Interceptor site. The largest measured 5 cm long x 4 cm wide x 1.5 cm deep (Auckland Museum 2022 - AWMM MA12605).

Magnetism: A neodynamic magnet was passed over the rock and some of the salt-and-pepper material buried beneath it. The rock was not at all attracted to the magnet. However, the salt-and-pepper lens was strongly attracted (Fig. 11).

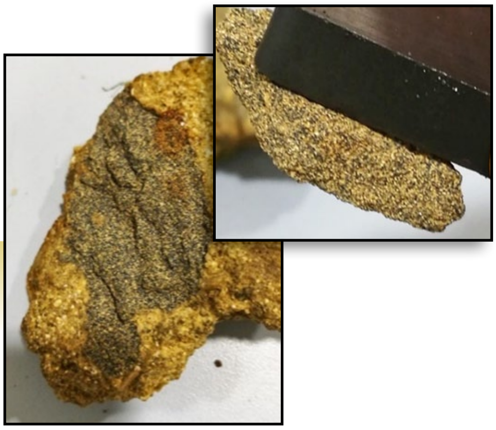

Fig. 11. Salt-and-pepper material highly attracted to magnet (pers. obs.).

The best guess for the magnetic lens material is organic matter potentially becoming trapped under the heavy rock, and sedimentary layers, becoming cemented with west coast magnetite-bearing black sand.

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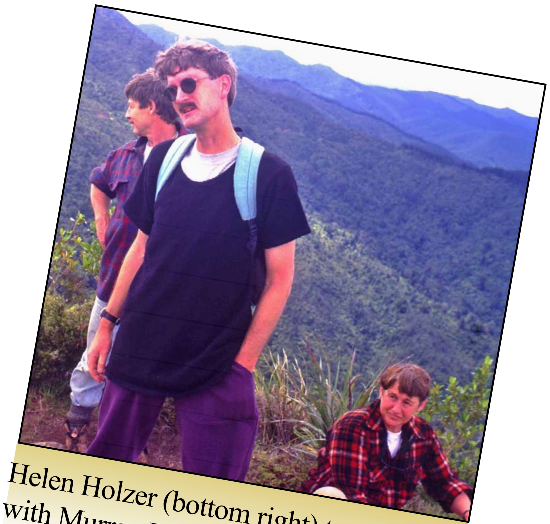
REMEMBERING HELEN HOLZER - AUCKLAND GEOCLUB COMMITTEE MEMBER 2003–2018, BOOKINGS OFFICER 2005–2015 AND FIRST GEOCENE EDITOR 2005–2015

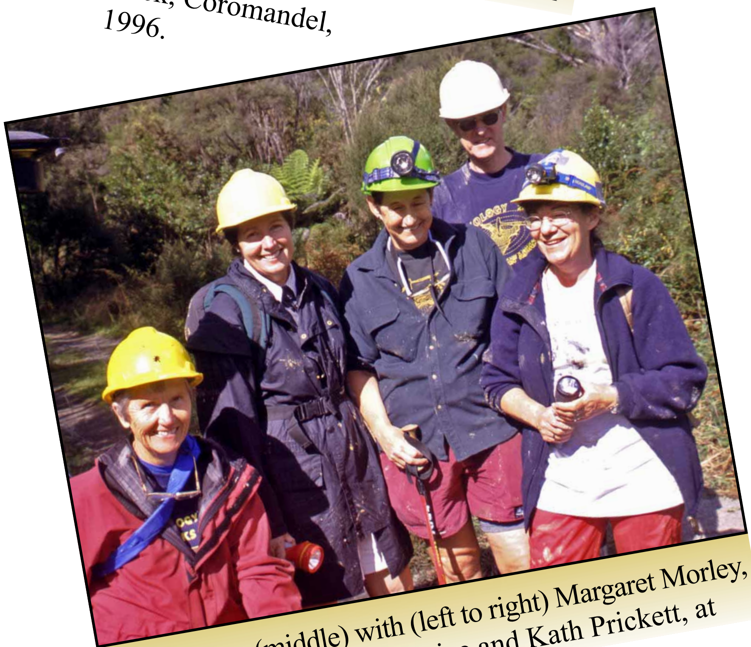
Bruce W. Hayward, Peter Turnwald

Helen Holzer, 1944–2024, was one of Geoclub's most enthusiastic members and contributors during her 27 years of membership, 1994–2020. Her background was a little different from most of us, having gained a BA degree and taught English, History and German at St Mary's College in Ponsonby as a young nun in the Sisters of Mercy. After leaving teaching in the early 1980s, she spent time researching and writing about the early history of the Sisters of Mercy in New Zealand in the 1850s and 1860s. After leaving the convent, she maintained her career in education, which included a stint teaching English as a second language at Auckland University of Technology. In the mid-1980s, Helen travelled around Auckland on a motor scooter, but had an unfortunate encounter with a car which left her with a significant injury to her lower leg, though this never stopped her energetic outdoor life as a tramper and world explorer.



Helen Holzer (bottom right) together with Murray Baker and Hugh Grenfell on the top of Castle Rock, Coromandel, 1996.

In addition to her humanities background, Helen developed a love for nature and the environment. In the 1990s–2000s she was an active participant in the revegetation of Tiritiri Matangi and in regular baiting of trap lines in the Waitākere Ranges' Arc in the Park "mainland island" project. She and a colleague (often Geoclub's Christine Major) would follow a predetermined path up and down through the untracked forest wilderness checking and rebaiting all "their" predator traps.



Helen Holzer (middle) with (left to right) Margaret Morley, Glenys Hayward, Doug Denize and Kath Prickett, at Broken Hill gold mine, Tairua, 2001.

Within a year of its formation, Helen joined Auckland Geology Club, along with a number of other members of Les Kermode's Auckland University geology night class, and from then on, she was hooked on rocks. She attended almost all of our monthly lectures and field trips for the next 25 years, with her attendance only waning as her memory deteriorated in the last few years. In a talk or in the field, if a feature was not adequately explained, it was often Helen who spoke up for the rest of the bewildered group to ask for clarity. During the 1990s–early 2010s, Helen was very active and organised and took herself off on a number of overseas trips to experience nature in places like Africa, Antarctica, the Himalayas and New Zealand's subantarctic and Chatham islands. With Geoclub, she saw most of New Zealand, as well as Norfolk Island and New Caledonia.

In the early 2000s she became more proactive within the club, first volunteering to help with the printing of Geoclub T-shirts and then joining the committee. Immediately she volunteered to take over in the role of booking's officer. For the next 13 years, Helen would take bookings for boat trips, and for all our longer trips she would book

Helen Holzer excavating Jurassic fossils, Whakapirau Road, Kawhia, 2001.

motel units (mostly by telephone), accept bookings from members (mostly by email) and allocate them to share accommodation. This was a thankless task that occasionally led to misunderstandings which Helen took in her stride.

Helen was always keen to share the enjoyment she had in belonging to the Geoclub, and invited a number of people who became long-term members to join, including Christine Major. She often took the children of friends and her nieces on nature- and geology-related trips, looking to implant her enthusiasm for nature in a new generation.

When the idea of a Geoclub journal was mooted in 2005, Helen volunteered to be its first co-editor along with Hugh Grenfell (who provided the technical computer expertise). She and Hugh put together the first 12 issues of Geocene between 2005 and 2015, before her failing health forced her to step down. Helen authored or co-authored short articles in the first four issues of Geocene on: the rhodoliths of Takahiwai Peninsula, Whangarei Harbour (#1); basal Waitematās of The Outpost, Leigh (#2); Panmure Basin tuff ring (#3); and sediment baked by Puketutu lava flows (#4). She also gave a short talk to a monthly meeting in 2005 on her recent trip to the Auckland and Campbell islands.

During her time, Helen was one of the club's most colourful and outgoing characters. She was a wonderful friend to many of us, always helpful and generous. In the 2000s–early 2010s she would often call up our Geomarine Research group's little office and say she was coming around for morning tea with takeaway coffees for us all (Hugh Grenfell, Margaret Morley, Jill Kenny, Ashwaq Sabaa and myself). At Christmas time she sometimes came around with a car-load of food and provided us with a delicious sit-down lunch. On day-long Geoclub field

Helen Holzer with thin-bedded Waitematā Group strata, Shakespear Regional Park, 2002.

Helen Holzer investigating the fluid conduit at Runaruna mud volcano, Northland, 2003.

Helen Holzer and Kath Prickett settle-in to an exotic field lunch, North Taranaki, 2004.

Peter Daymond-King and Helen Holzer wade through deep mud to the small scoria cone inside Māngere Lagoon explosion crater, 2005.

trips it was Helen, along with her group of Kath Prickett, Maureen Burke and Liz Hoskin, who would usually turn up with a whole delicatessen of exquisite foods - the envy of the rest of us. Geoclub has missed Helen these last few years while she was in care, but we remember her with great fondness and appreciation for all she did.

Her family would like to pass on their very deep appreciation of all the many messages of sympathy they received from Geoclub members, and the presence of so many of them at her final farewell. Helen loved and appreciated the Club and its members, and felt deeply the support and friendships she received.

(From left) Kath Prickett, Maureen Burke and Helen Holzer (photographer) at Bobs Cove lime kiln, Lake Wakatipu, 2009.

Helen Holzer took photos and recorded geology notes on most trips. Henderson Bay, Far North, 2007.

Helen Holzer at Punakaiki Rocks, West Coast, 2008.

Helen Holzer out the front of a group of Geoclubbers on Norfolk Island, 2015. From left: Malcolm Simpson, Helen, Trevor Goldschmidt, Bill Jamieson, George Wingate and Liz Hoskin.

(From left) Murray Baker, Helen Holzer and Maureen Burke sit down for lunch at Ohakuri Dam, Waikato River, 2009.

From left: Maureen Burke, Helen Holzer and Jill Kenny with Hamish Campbell explaining the significance of the James Hector plaque in central Wellington, 2017.

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