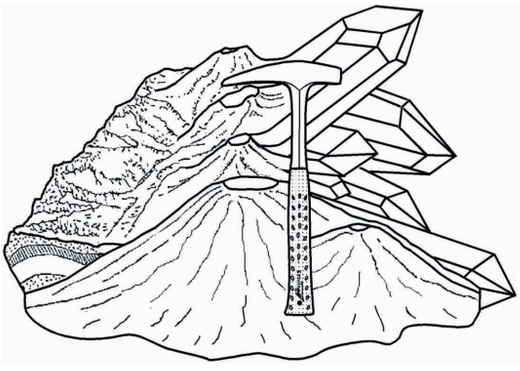


Geocene

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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.

Please contact Jill Kenny <jill.kenny_at_xtra.co.nz> (substitute @ for _at_)

CURRENT-ALIGNED MIDDLE JURASSIC BELEMNITE GUARDS FROM NEW CALEDONIA

Jack Grant-Mackie

Abstract

Medium to coarse sandstones and fine conglomerates of the Testard Formation, Baie de St-Vincent Group, Téremba Terrane, on the northwest coast of île Mathieu, Baie de St-Vincent, southwest New Caledonia, contain many guards of the belemnite *Eobelemnopsis compressa* (Avias, 1953) aligned dominantly in an east–west direction. Numbers of guards, falling off almost symmetrically either side of this orientation, indicate deposition under the influence of an apparent north–south current, although the amount of post-depositional rotation of the Terrane in unknown.

Introduction

During field work in New Caledonia, I encountered on the coast of île Mathieu, southeast Baie de St-Vincent, a closely spaced set of bedding planes containing many aligned belemnite guards. The guards are preserved in sandstones and fine conglomerates. Collected samples are held by the School of Environment, University of Auckland, as collection AU7257 (NC/f426 in FRED, the database of localities of fossil collections held in New Zealand institutions and run jointly by the Geoscience Society of New Zealand and GNS Science, Lower Hutt, New Zealand); grid reference 61320.75572 on Sheet 4832, La Tontouta (Serie Orange, 1: 50,000, Institut Géographique National, Paris, 1987); collected by JAG-M, 27 October, 1975, and by JAG-M and N. Hudson, 26 October, 1983.

Setting

The belemnites occur in medium to coarse sandstones and fine conglomerates of the Moziman Member, Testard Formation (Campbell *et al.* 1985), and occupy a stratigraphic thickness of 0.5 m, dipping at 17° and striking 120°. They are identified as *Eobelemnopsis compressa* (Avias, 1953), which was dated by Challinor & Grant-Mackie (1989) as Early Bajocian. More recently (Challinor & Hudson, 2017) sequences with this belemnite have been correlated with the late Middle Temaikan Stage of the New Zealand scheme, with an international age of latest Aalenian to late Early Bajocian. Although *E. compressa* is not recorded from New Zealand sequences, it occurs in New Caledonia with and just below *Retroceramus (Fractoceramus) inconditus* (Marwick, 1953), a marker bivalve for Hudson's (2003) early Middle Temaikan.

Guards are calcareous, well preserved, and the largest collected vary in size up to ~130 mm long, 15 mm diameter; the largest seen in the field but not collected was 130 mm X 18 mm. Occurring with the guards are subrounded rhyolitic pebbles and granules up to ~40 mm diameter, disseminated plant and silicified wood fragments and rare bivalves and gastropods.

The beds are part of a sequence exposed along the northwest coast of île Mathieu, in Baie Sud, at the southwestern corner of Baie de St-Vincent, consisting mainly of green-blue or grey-tinted medium sandstones, with coarse sandstones, fine volcanic conglomerates and rare purplish argillites, with individual beds up to 1–2 m thick (i.e., massive) but more generally 0.1–0.2 m thick.

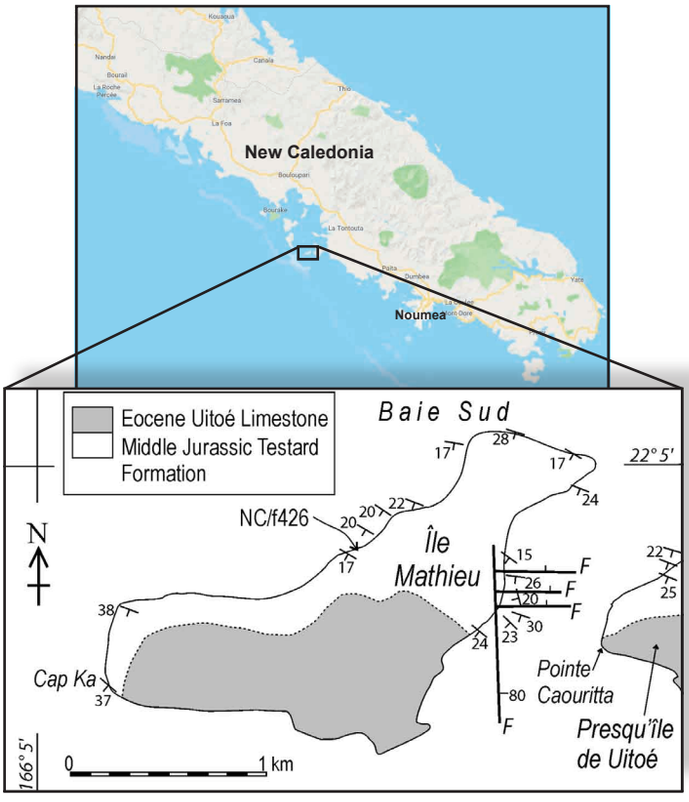


Fig. 1. Locality map, showing île Mathieu and the aligned belemnite locality, NC/f426, Baie de St-Vincent, New Caledonia, and attitudes of exposed strata nearby (part of map no. 4832, La Tontouta, in the Serie Orange, 1:50,000, of the Institut Géographique National, Paris, 1987). Contour interval is 20 m.; 'F' marks fault lines. Upper map courtesy of Google Maps.

Conglomerates may be graded, with belemnites contained in the basal third of the bed. The sequence dips variably but continuously to the southwest (Fig. 1) and is part of the Baie de St-Vincent Group within the Téremba Terrane (Campbell *et al.* 1985).

Methods and Results

As belemnite animals died, their guards settled to the sea floor whilst the soft parts were scavenged. On the bottom, the isolated guards were subject to current action. Their cylindrical shape meant that they were readily rolled, becoming aligned with their long axes perpendicular to the current direction. Bedding plane specimens were collected

after a north-south arrow had been drawn on the sample. It was noted that when closely spaced, some guards interfered with the orientation of others. Some simply gathered parallel to each other (e.g. Fig. 2, specimens C2142–C2151 (in the School of Environment's Catalogue of Cephalopod Type & Figured Specimens)), but others had their alignment interrupted and were preserved in other orientations (e.g. Fig. 3, specimens C2152–C2160). Most remain in the bedding plane but some are inclined, as though having dug into the substrate (e.g. Figs 4, 5, specimens C2161–C2163). The orientation of all specimens was measured by the degree of their departure from the orientation of the N-S arrow and each azimuth was plotted on a half-rose diagram (Fig. 6).

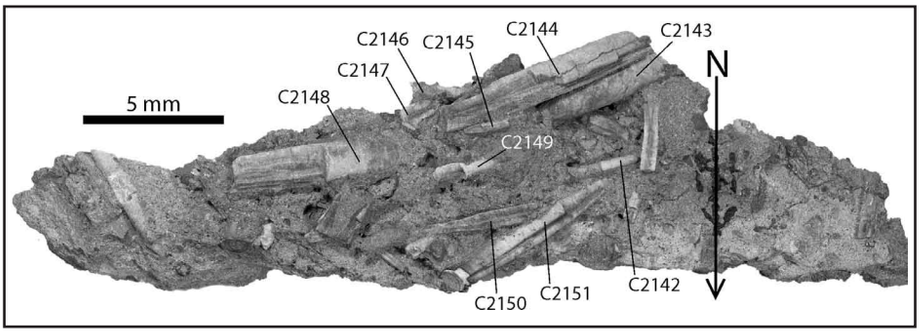


Fig. 2. Segment of the sequence shown in Fig. 1, including parallel aligned belemnite guards (C2142–C2151) lying in the bedding plane, from NC/f426, île Mathieu, New Caledonia.

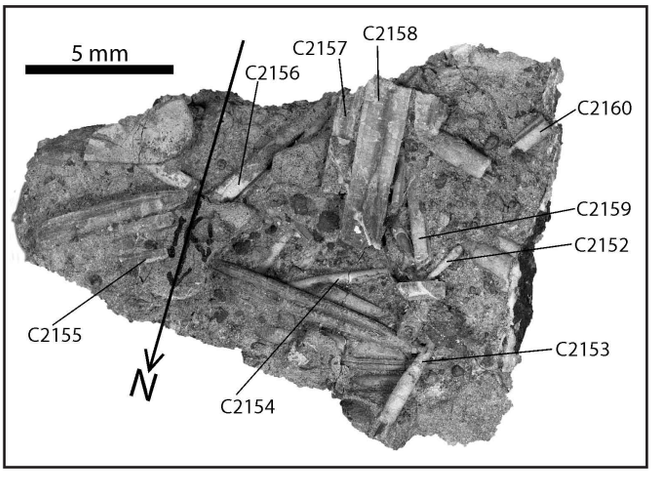


Fig. 3. Segment of the sequence shown in Fig. 1, including belemnite guards C2152–C2160 randomly oriented within the bedding plane, from NC/f426, île Mathieu, New Caledonia.

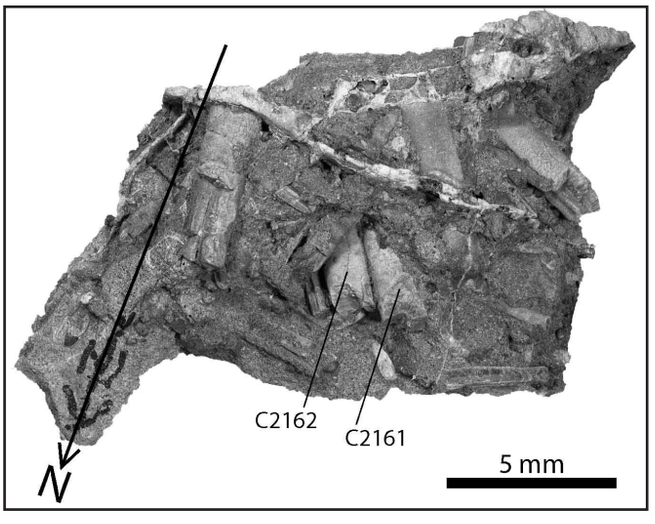


Fig. 4. Segment of the sequence shown in Fig. 1, including belemnite guards C2161–C2162 oblique to bedding at locality NC/f426, île Mathieu, New Caledonia.

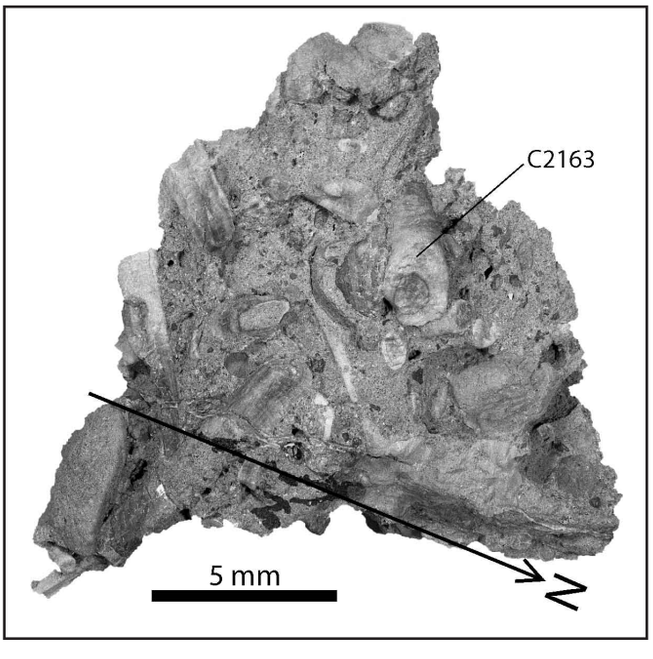


Fig. 5. Segment of the sequence shown in Fig. 1, including belemnite guard C2163 oblique to bedding at locality NC/f426, New Caledonia.

There are 288 data points and they cluster about the 80–99° quadrant, i.e., east–west, with 129 points in the 0–079° segment and 104 in the 100–179° segment, thus grouped almost symmetrically about the E–W line and diminishing in number away from it (Fig. 6). Given that elongate cylindrical objects will align perpendicular to the current, then at the time of deposition the current in the area must have been north–south, with significant variation each side of that line, as one would expect, with the spread of alignments resulting from such current action. Whether the current was north–flowing or south–flowing cannot be determined from these data; one would need the presence of current bedding or some other indicator.

How much the results have been affected by post-depositional tectonic activity is unknown, but the sequence is less faulted than much of the Terrane and strata are shallow-dipping, so perhaps disruption has not been as extreme. Paleomagnetic data have not been gathered for this area, and calculations have not been published for rotation of the Téremba Terrane during post-depositional tectonic activity. Recent work on the Murihiku Terrane in the North Island of New Zealand (van de Lagemaat *et al*. 2018), considered to be the southern tectonic equivalent of the Téremba Terrane, indicates that considerable post-depositional rotation of that terrane has occurred in the Cenozoic, and this is likely also for the latter terrane.

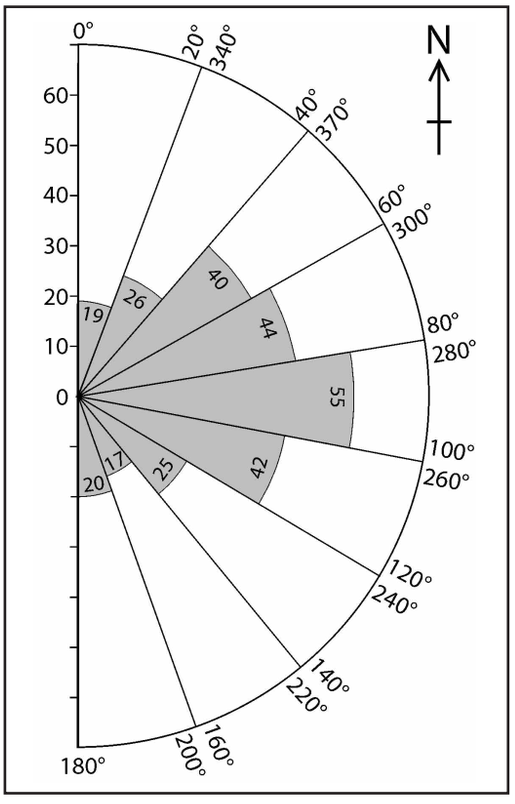


Fig. 6. Half-rose diagram of directions of aligned belemnite guards at locality NC/f426, île Mathieu. Measurements were made on 288 specimens in ten collected slabs, including those shown in Figs 2–5.

Acknowledgements

Transport to and from île Mathieu was freely provided by M.M. Greppo, La Tamoa, and Genet, île Mathieu. I thank Neville Hudson, Collection Manager, School of Environment, University of Auckland, for assistance with the material detailed herein and for the provision of locality and catalogue data, and Louise Cotterall, also of the School of Environment, who provided the illustrations. I am grateful to Lieutenant Jonathan Benton and Lieutenant Commander Colin Marshall, Maritime Warfare Training Centre, Royal New Zealand Navy, Devonport Naval Base, Auckland, for the use of a Bi-rola Rule PR 500 to measure orientation of the belemnites.

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ORIENTATION OF TURRET SHELLS ON A BEACH, GREAT BARRIER ISLAND

Bruce W. Hayward

During Auckland Geoclub's trip to Great Barrier in May 2018, we visited Whangapoua Beach on the east coast at the northern end of the island. We had lunch at the northern end of the long flat hard sand beach (Fig. 1). When wandering around this part of the beach, while waiting for some to finish their lunch, I noticed that almost all of the tapered shells of the small turritellid gastropod, *Stiracolpus pagoda* (turret or tower shell) had the same orientation, where they had been left stranded by the outgoing tide. All were oriented parallel to the gentle slope of the beach and perpendicular to the shoreline and approximately 90-95% had their apices pointing up the beach (Figs 2–3).



Fig. 1. North end of Whangapoua Beach, Great Barrier Island.

They had clearly been oriented by the gentle swash of the waves, likely the very last wave to touch them. The beach at this end was moderately sheltered and the waves on the day were less than 0.5 m high. The waves would surge up the beach and then retreat back. I assume it was the retreating back surge that was the last water to influence the shells' orientation and thus shells were oriented parallel to the current direction of the last outgoing wave with their apices facing up-current. This orientation would present the least resistance to the flow.

There seems to be very little literature that I can find via google recording the preferred orientation of high conical shells on wave-impacted beaches or where moved along by currents. The only publication I found was Nagle (1967) who undertook experiments on the orientation adopted by a number of shell shapes in a flume (Fig. 4) and a wave tank. He recorded that the diagnostic orientation adopted by turret shells in the flume was parallel to the current with the apex pointed up-current, just as seen on Whangapoua Beach. However, in his wave tank, Nagle (1967) found the dominant orientation was with the turret shell long axis oriented perpendicular to the wave direction, which is not observed on this part of Whangapoua Beach. It is perhaps noteworthy that Nagle's wave tank produced ripples on the sand



Fig. 2. Two turret shells, *Stiracolpus pagoda*, oriented with their apices pointing up Whangapoua Beach (left). Shadows are on the south side of the shell at midday. Width of photo 15 cm.
Note the scour downslope from the shell (upper).



Fig. 3. Seven turret shells (*Stiracolpus pagoda*) oriented perpendicular to the slope of the beach with their apices pointing up the beach. My sandal for scale.

substrate and maybe this irregular surface and the greater strength of the waves resulted in this opposite orientation with the shells rolling down the ripple slopes.

Turret shells are periodically found fossil in large numbers with a preferred long axis orientation. If the apices are dominantly in one direction, then they likely indicate a current or outgoing wave orientation. If the apices show no dominant direction, then the shells were likely oriented perpendicular to waves.

Reference

Nagle, J.S. 1967. Wave and current orientation of shells. *Journal of Sedimentary Petrology* 37: 1124–1138.

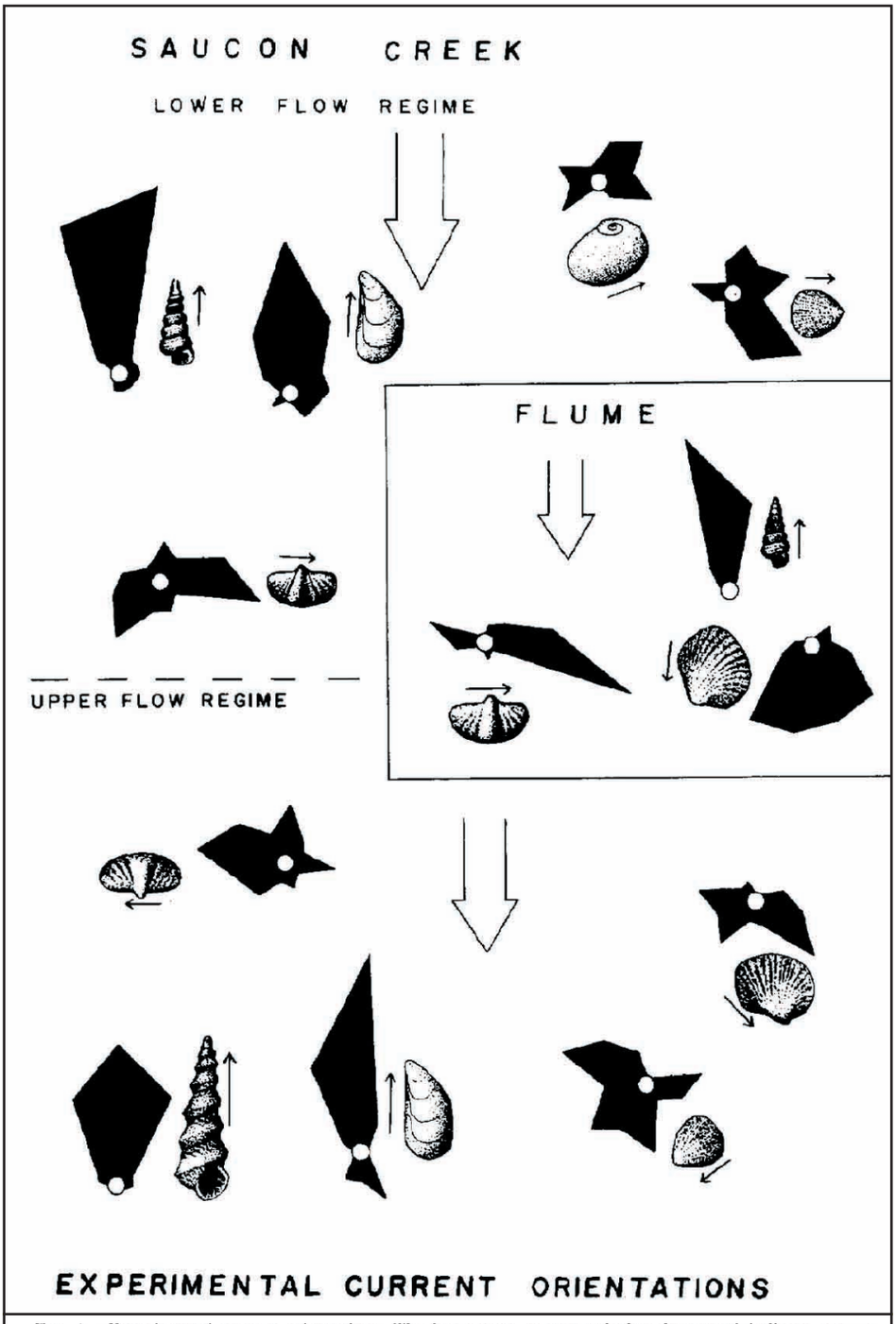


FIG. 4.—Experimental current orientations. The large open arrows pointing downward indicate current direction; the small arrows next to the shells depict the orientation convention. The shell position roughly indicates the principal orientation developed under the experimental conditions. Note the diagnostic current orientations of *Mytilus* and *Turritella;* other orientation patterns may or may not bear some relationship to current direction, and are non-diagnostic.

Fig. 4. Diagnostic shell orientations of turret and other shells adopted under a current from top to bottom in a flume experiments undertaken by Nagle (1967). Note the orientation of turret shells is parallel to the current with the apices pointing upcurrent.
The figure and caption are Nagle's (1967) Fig. 4.

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ANAWHATA PILLOW LAVA AND GLASSY BRECCIA

Bruce W. Hayward

In May 2018, members of the Auckland Geology Club visited Anawhata Beach on the west coast of the Waitakere Ranges. At one point we ventured around the intertidal platform at the north end of the beach to look at the mushroom-shaped intrusion in the shaded cliffs on the north side of the next small bay (Figs 1, 2). When I mapped this section of the coast in the early 1970s (Hayward, 1975, 1983) I came here when the swell was up and the low tide was probably neap and for my own safety I was not prepared to try and clamber around and over the large boulders to get close to this northern face. Instead I was content to photograph and draw it from about 50 m away (Fig. 1). The south-facing vertical cliff never receives the sun and is almost always wet which makes it hard to make out much detail from a distance except for the prominent columnar jointing of the intrusion.

When we visited in May 2018, the swell was small and it was a spring low tide. Hugh Grenfell thought some rounded features to the east of the intrusion might be pillows and so several members clambered around

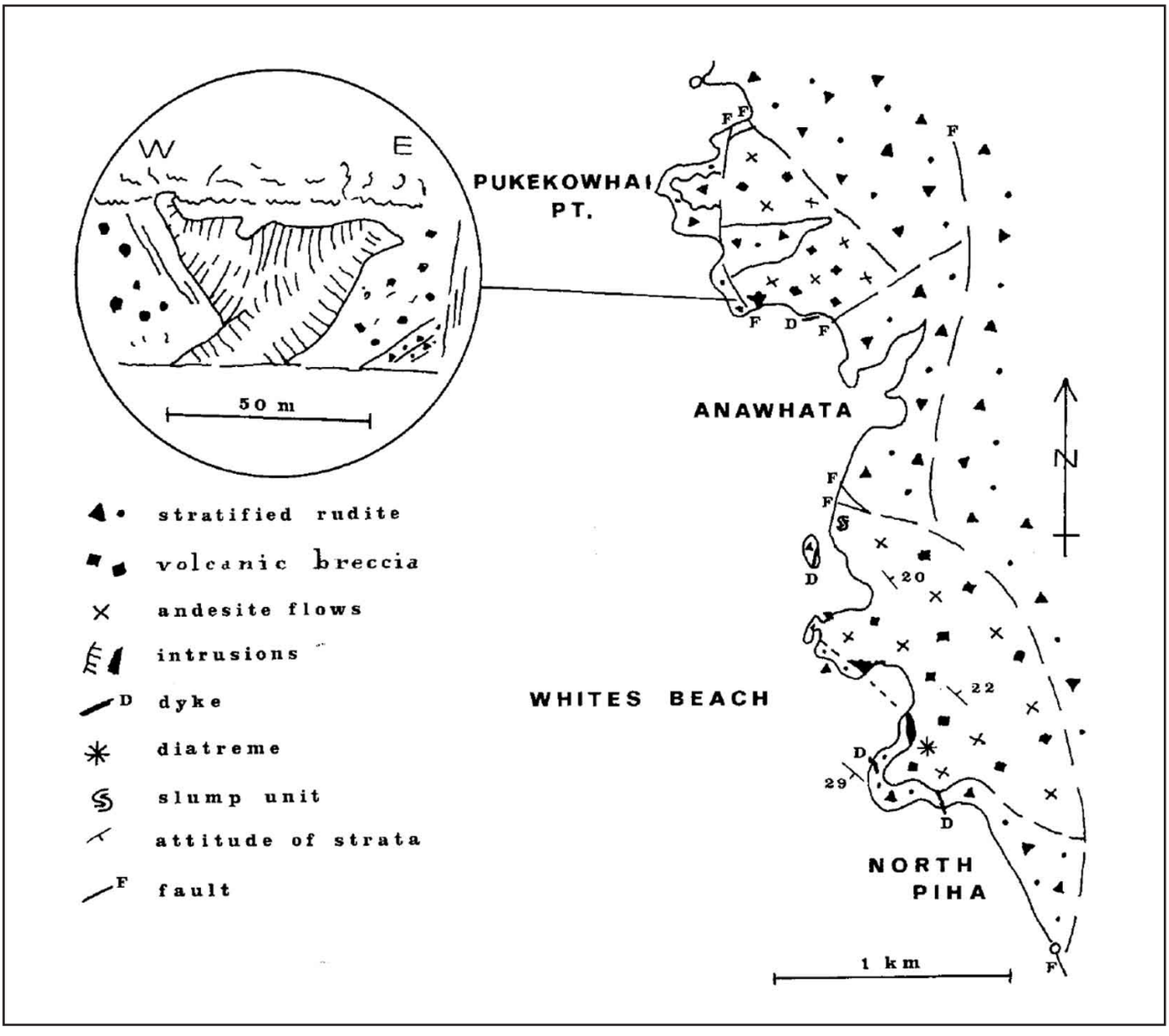


Fig. 1. Part of my figure 4 in Hayward (1977) showing the mushroom-shaped intrusion (top left) north of Anawhata. The unit that is now recognised as consisting of glassy breccia with lava pillows is shown as volcanic breccia and lava flows.

the rocks and took a closer look. Indeed there were several distinct lava pillows, each 1–2 m in diameter, hosted in a massive glassy breccia (Fig. 3) that volcanic geologists would probably call peperite. A peperite is "a genetic term applied to a rock formed essentially in situ by disintegration of magma intruding and mingling with unconsolidated or poorly consolidated, typically wet sediments. The term also refers to similar mixtures generated by the same processes operating at the contacts of lava flows".

Similar glassy breccia (hyaloclastite or peperite) can be seen forming Raeakiaki Pt at the south end of Te Henga Beach, 1.5 km north of Anawhata. At that locality the pillows and associated feeder dikes are more extensive and better developed than at Anawhata. They might be of similar age and the lava might even have been extruded into the seafloor sediment from the same vent on the submarine slopes of the Waitakere Volcano.

This note records another occurrence of lava pillows and glassy breccia that can be seen exposed in the cliffs on the west coast of the Waitakere Ranges.

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Fig. 2. Mushroom-shaped intrusion in south-facing cliff in small embayment just beyond point on north side of Anawhata Beach. The lava pillows are in the cliff at the bottom right of the photo. Height of photo 20 m.



Fig. 3. Several rounded lava pillows (1–2 m diameter) in glassy breccia on the east side of the columnar-jointed intrusion, north Anawhata. Height of photo 8 m.

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QUIZ Know your North Shore beaches. Match maps 1 – 14 with beach names A – N. Suburbia has been blanked out and is shown as green. So how well do you know those beaches without the hinterland to help? The maps are not at the same scales but are at the same orientation (north towards top of page). (Answers on last page)

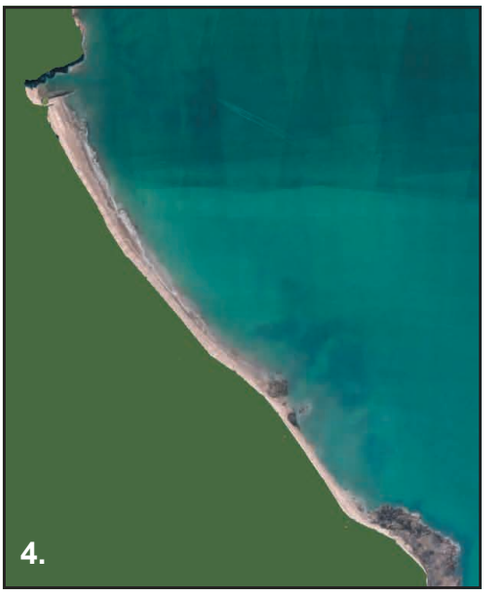
Beach names to choose from, north to south:

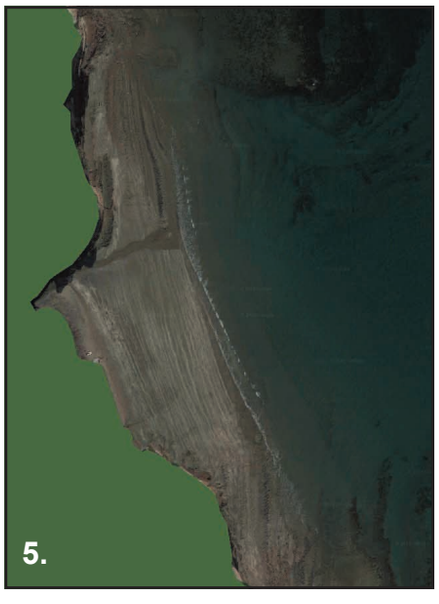
A. Long Bay
B. Waiake Bay
C. Torbay
D. Browns Bay
E. Rothsay Bay
F. Murrays Bay
G. Mairangi Bay
H. Campbells Bay
I. Castor Bay
J. Milford Beach
K. Thorne Bay
L. Takapuna Beach
M. Narrow Neck Beach
N. Cheltenham Beach













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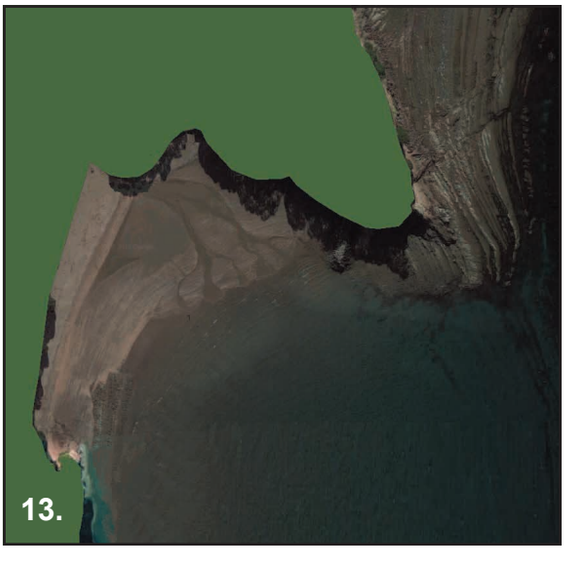

8.


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(Answers on last page)

THE USE OF GEOLOGY (MINERALOGY AND GEOCHEMISTRY) IN IDENTIFYING THE SITE OF MIGRATORY DISPERSAL FOR ONE GROUP OR GROUPS OF SOUTHERN MAORI NAVIGATORS

Ross Ramsay

A recent re-evaluation of radio carbon dating (Wilmshurst *et al*., 2011) demonstrates that colonisation of East Polynesia comprised two distinct phases, with the first eastwards into the Society Islands (1025–1120 AD), followed by a second phase to Hawaii, Rapanui, and New Zealand/Auckland Islands in the period 1190–1290 AD.

In the case of migration to New Zealand, the point source for this dispersal has been uncertain and has been regarded as comprising a range of possible islands in the East Pacific (*Hawaiiki Zone* – Walter, 1994). Methods used in attempts to identify more securely this point source have relied on oral history and legends, mDNA, linguistics, and comparison of stylistic features of cultural items.

Of late, studies of fine-grained basalt artifacts using petrology and geochemistry have been used to identify colonisation and trading routes in East Polynesia (Weisler and Woodhouse, 1995; Collerson and Weisler, 2007; Weisler and Walter, 2017), but as yet no such cultural item securely located in a Maori occupation site has been located that has provided unequivocal information as to a particular island in the *Hawaiiki Zone* from whence such Polynesian navigators originated.

The recovery of several shaped basaltic scoria blocks from Maori occupation sites in the South Otago and Rakiura regions promises to provide more incisive and unambiguous information as to where this southern group or groups of seafarers commenced their 3,000+ km journey across the Pacific.

Current studies by joint researchers (W.R. Ramsay, E.G. Ramsay, G. Kelly, M. White, and G. Collett) demonstrate that these scoria blocks are aluminous basaltic trachyandesite to phonotephrite with total alkalis 7.3–9.6 wt%, TiO_2 2–2.3 wt%, MgO 2–3.2 wt%, and Al_2O_3 ~19 wt%. Mineralogically, these blocks contain fine crystals of Ti-Al clinopyroxenes, minor olivine (*Fo ~65*), plagioclase (*An ~65*), minor alkali feldspar, and highly titaniferous magnetite, all set in a fresh glassy matrix. Mineralogy and major element studies of these scoria blocks has allowed rapid separation from the extensive young sub-alkaline volcanics of the Central Volcanic Plateau, Taranaki, Coromandel Ranges, and the Tonga-Kermadec arc (Fig. 1, following page). Based on mineralogy and major, minor, and trace element compositions, the most likely source within New Zealand is the Auckland, South Auckland, and North Auckland volcanic fields, but these have now been excluded based on isotopic studies. These scoria blocks can now be shown to be exotic to the New Zealand mainland, the Subantarctic Islands and the Chatham Islands.

A fourth scoria block shown in Fig. 1 came from the island of Mehetia, Tahiti, in the early 1930s. That block is now undergoing detailed microsampling and geochemical analysis.

Work is in progress to identify the initial source or sources for these shaped scoria blocks within the Pacific.

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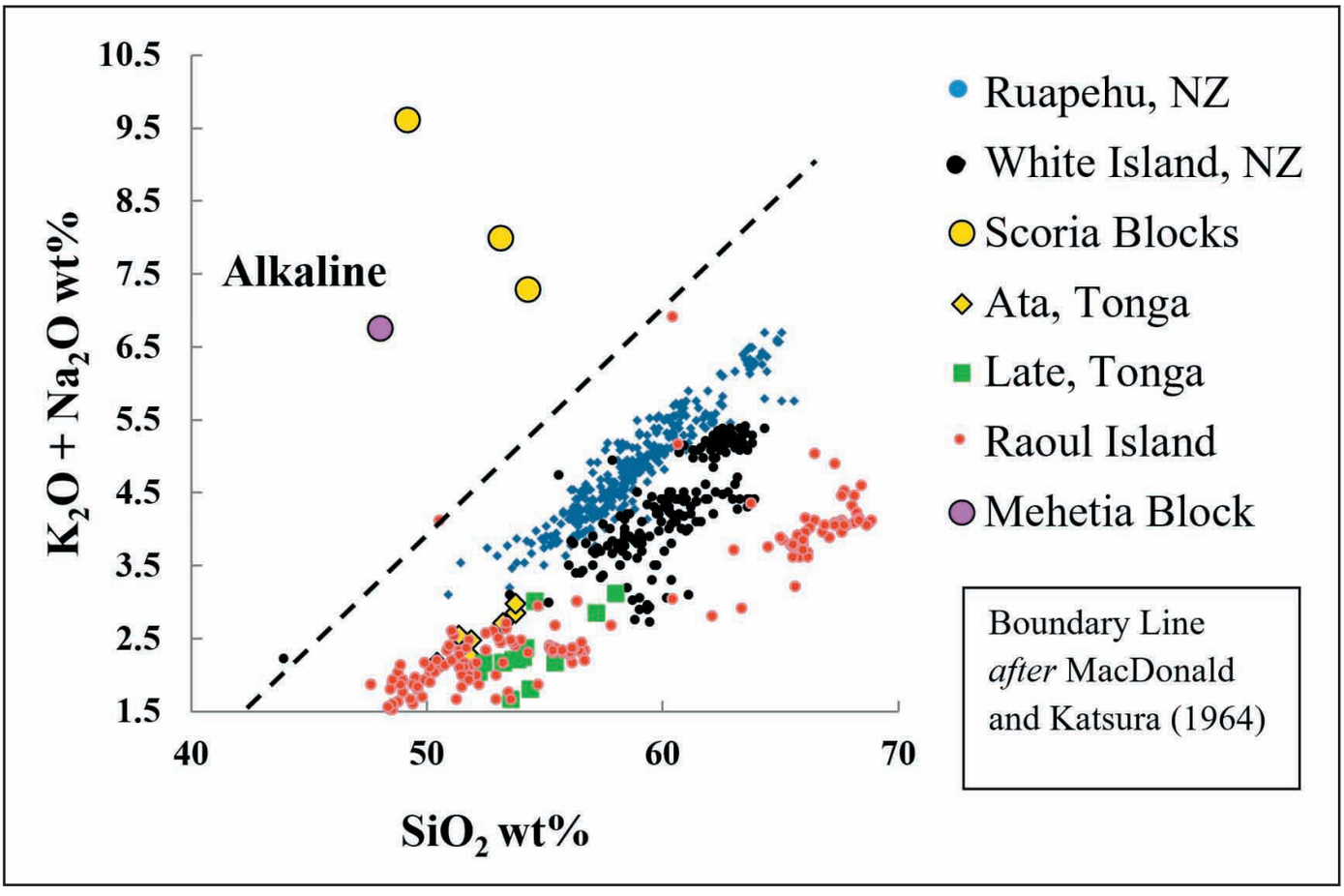


Fig 1. Plot of SiO_2 vs total alkalis ($Na_2O + K_2O$). The position of the three scoria blocks plots in the alkaline field of MacDonald and Katsura (1964). Two of these blocks are held privately while the third is in the collections of Otago Museum (D.39.1269). This diagram separates these alkaline scoria blocks from the young volcanics of the Central Volcanic Plateau (Ruapehu and White Island analyses used as indicative sub-alkaline compositions) and lavas from the Tonga – Kermadec arc.

Also shown is the composition of a shaped scoria block collected by H. D. Skinner from the island of Mehetia, Society Islands (Otago Museum, D.31.327).

Analyses of lavas for the Central Volcanic Plateau, NZ and Tonga – Kermadec arc courtesy of *Georoc* – Max Planck Institute for Chemistry in Mainz.

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BEACHROCK, DRAVUNI ISLAND, FIJI

Garry Carr

I had the privilege to visit Dravuni Island in Fiji late in 2017. Dravuni Island is one of a number of islands enclosed by the Great Astrolabe coral reef. The island has a central 'spine' of volcanic rock both basalt and andesite flanked by carbonate sediments.

Beachrock is exposed intertidally on the beach (Fig. 1). Not surprisingly it dips seaward. Schneider *et al*. (1995) state the beachrock extends 3m below low tide level, where it has coral and other marine organisms growing on it. Higher up the beach the sand is loose.

Schneider *et al*. (1995), who examined the Dravuni beachrock microscopically, stated, "Lithologically the rocks are poorly sorted biocalcarenites and biocalcirudites whose particles are angular to subrounded. Their skeletal components of molluscs, corals, green algae (Halimeda), red algae (Lithothamnium), bryozoans, and benthic foraminifera dominate volcanoclastics (rock fragments, pyroxenes, feldspars) and some intraclasts (reworked elder beachrocks) by far." (Figs 2–4).



Fig. 1. Beachrock exposed on the beach at the north-western end of Dravuni Island.

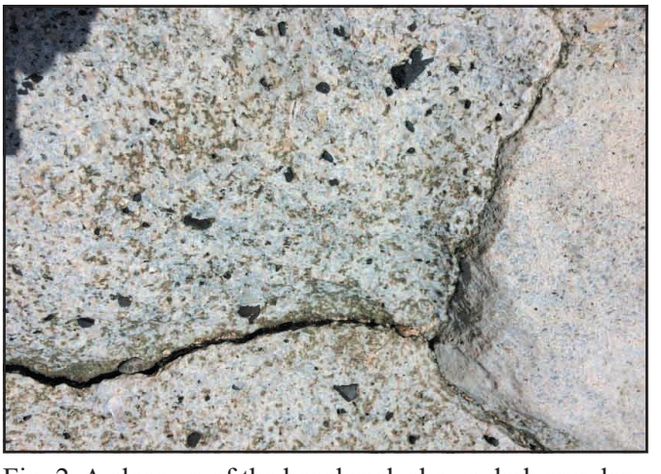


Fig. 2. A close up of the beachrock shows dark angular volcanic fragments set in the carbonate sand.

Formation of beachrock

Beachrock forms where meteoric (fresh) ground water meets marine water in beach sediments. The resulting perturbations to the carbonate/bicarbonate equilibria cause calcite (aragonite or calcite) to precipitate from solution, resulting in beach sand becoming cemented. According to Schneider *et al*. (1995) at Dravuni, this process was happening very recently. It was reported to them that items from World War 2 period have been cemented into the beachrock at Dravuni island. This has not been confirmed by the author. Mauz *et al*. (2015) have suggested that beachrock could be used as a proxy for sea level, based on the characteristics of beachrock and the rapidity of their formation.

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Fig. 3. A rounded volcanic cobble cemented in the beachrock. (toes for scale!).



Fig. 4. A giant clam cemented into the beachrock.



Fig. 5. The modern beach at Dravuni Island. Beachrock is in the foreground.

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DEVONPORT'S MT CAMBRIA REVEALED AND REMOVED

Bruce W. Hayward

Up until 2010 (Hayward *et al*. 2011), the only known images of Devonport's smallest volcano, Mt Cambria, before it was substantially destroyed by quarrying, were of its skyline profile from the east (Fig. 1) and the north (Fig. 2). Since then, there has been an avalanche of digitised historical photographs placed on-line from such repositories as Auckland Museum, Auckland Libraries and Alexander Turnbull Library. Now through the magic of google searching, it is possible to leaf through this great wealth of images and find the gems we have been hoping for for years. Now we have several images of Mt Cambria from North Head (Fig. 3) and Mt Victoria (Figs 4–8) that give us, for the first time, a much better idea of what Mt Cambria was like before it was destroyed by quarrying. There are also aerial photos available that now document the progressive loss of the cone (Figs 4, 7–12).

Ferdinand Hochstetter visited Mt Cambria in 1859 (translated by Fleming, 1959) and wrote that it was "a scoria cone perhaps 100 ft high, with fairly perfectly

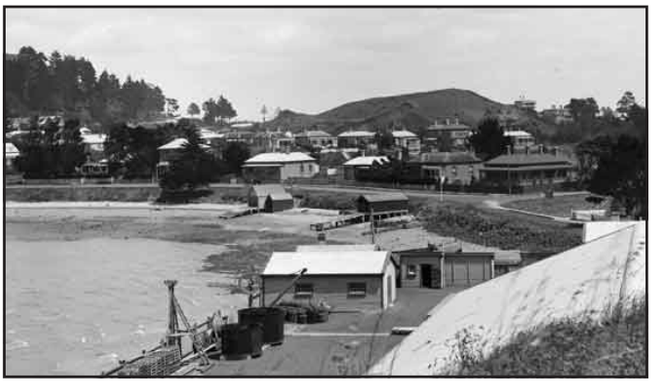


Fig. 1. View northwest from Torpedo Bay wharf showing the profile of Mt Cambria in 1904. The southern part of Mt Cambria cone is already partly quarried away. Photo: James Richardson.



Fig. 2. View southeast to the skyline profile of Mt Cambria in 1899. Photo: Hugh Boscowen.



Fig. 3. Sketch from the east of Mt Victoria (left) and Mt Cambria (right) from North Head by James Richardson, 1872.



Fig. 4. Eastern half of Mt Cambria from Mt Victoria in 1875, showing quarrying well advanced on the southern high part of the crater rim (bottom right). Photographer unknown.



Fig. 5. Unquarried northwest slopes of Mt Cambria from Mt Victoria about 1880. Photographer unknown.



Fig. 6. Unquarried northwest slopes of Mt Cambria from Mt Victoria, 1907. Photographer unknown.



Fig. 7. Top of Mt Cambria from Mt Victoria in 1908 showing partly quarried face of eastern ramparts (bottom right) and quarrying beginning on east side of northern ramparts (right). Photographer unknown.



Fig. 8. Unquarried northwest half of Mt Cambria and crater from Mt Victoria, 1912. Note some quarrying has moved onto the eastern rim of the cone (far right). Photographer unknown.

preserved crater. The crater margin is somewhat lower on the south-east side, where a small lava flow has flowed in the direction of the sea. I named this cone 'Heaphy Hill' as a tribute to my friend Charles Heaphy, Provincial Surveyor of Auckland."

Of Mt Cambria, Ernie Searle (1964) wrote that it was "a low squat scoria cone" … with … "very small flows. The cone was a low broad one – a hill little more than a hundred feet high. It has been quarried away and little now remains." Clearly most of his description is based on what Hochstetter wrote. Hochstetter's name of Heaphy Hill did not catch on and was later replaced with the attractive name of the Hill of Sheep, but this was changed later to Mount Cambria.

Les Kermode (in Kermode *et al*., 1992) also described Mt Cambria as "A simple scoria cone about 30 m ASL, now almost completely removed by quarrying." Kermode makes no mention of Hochstetter's small lava flow, nor shows it on his 1:50,000 geological map (Kermode, 1992). Modern LiDAR contours do not clearly show that there was or was not a lava flow to the southeast – if there was, it did not flow more than 50 m and did not



Fig. 9. Mt Victoria (left) and Mt Cambria from North Head, 1923. The southern part (left) has been quarried away. Photographer unknown.

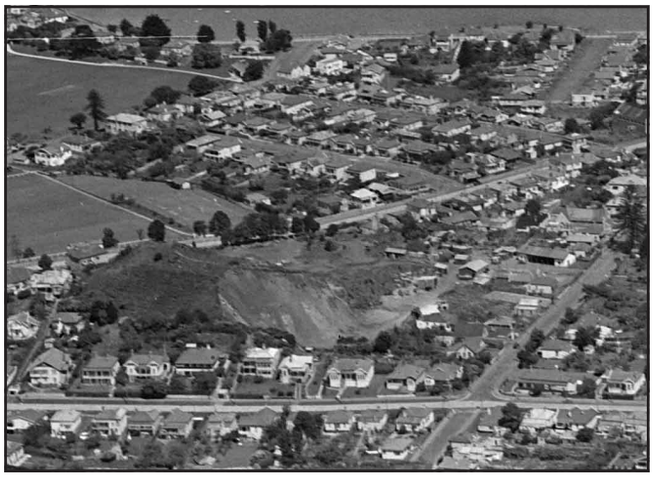


Fig. 10. Mt Cambria from northwest with only part of northern section remaining in 1930.
Photo: Whites Aviation.



Fig. 11. Mt Victoria and the remains of Mt Cambria (bottom right) from the east, 1939.
Photo: Whites Aviation.

reach as far as present-day Vauxhall Rodd. From his research, Les Kermode (in Kermode *et al*., 1992) noted that quarrying started pre-1885 (by private operators, and by Devonport Borough Council after 1928) and ceased in 1977. It was rehabilitated and opened as a public reserve in 1990.



Fig. 12. Only a few mounds of unquarried scoria remained of Mt Cambria when viewed from Mt Victoria in the 1950s. Photo: Whites Aviation.

The newly available images confirm Hochstetter's description of Mt Cambria as a simple cone with a large well-developed crater (Figs 3–8) with relatively narrow scoria cone rim. The highest part of the cone rim was on the northern side with a secondary high point on the south with a low saddle in between (Fig. 3). Several of the photos confirm the record that Mt Cambria had been used as a defensive pa by pre-European Maori (Figs 4, 6–8).

The 1875 photograph from Mt Victoria (Fig. 4) shows that quarrying was well advanced on the southern rim of the cone by that time and possibly started in the 1860s. Quarrying progressed on the southern half of the cone first, and by 1930 it and some of the northern high point had been quarried away (Figs 9–11). By 1950 there were only minor unquarried inner remnants of Mt Cambria's former scoria cone remaining (Fig. 12). Quarrying activity dwindled after this as most of the site was used as the Devonport Borough's works depot with all quarrying ending by 1977. By this time almost all extractable scoria inside the quarry's legal boundaries had been removed. The highest area of the former cone remaining today is on the old quarry's northern boundary with several private properties (Fig. 13). LiDAR shows that this area is still 25 m above sea level and clearly indicates that the original height of this northern peak was more than the estimated 30 m of Hochstetter and probably nearer 40 m, as estimated by comparing its height with 82-m-high Mt Victoria (Figs 1, 3).

Acknowledgement
Many thanks to Jill Kenny for assistance improving the historic images and page setting the article.

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Fig. 13. Mt Cambria Reserve from Mt Victoria in 1994 is the rehabilitated quarried stump of this former scoria cone. Photo: Bruce Hayward.

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AETOMYLAEUS, AN EAGLE RAY GENUS NEW TO THE OLIGOCENE OF NEW ZEALAND

Jack Grant-Mackie

Abstract
Most of the tooth-plate of an eagle ray, judged to belong to the genus *Aetomylaeus* Garman 1908, and possibly related to *A. cubensis* Iturralde-Vinent *et al.*,1998, of the Cuban and Brazilian Miocene, is recorded from the Glen Massey Formation, possibly the Dunphail Siltstone Member, of Whaingaroan-Duntroonian age (Early-Middle Oligocene; 34.6-25.2 Ma) in the Karamu Quarry, Raglan, area. It constitutes the first report of this genus in New Zealand.

"Myliobatis" altus Davis, 1888, described from the Tertiary of Trelissick Basin, Canterbury, may have been another member of the genus *Aetomylaeus,* but the two known remnants are now so shattered as to be unidentifiable and Davis' name must be regarded as a *nomen dubium.*

Introduction
The modern New Zealand ray fauna (Batoidea) includes but one species of eagle ray, *Myliobatis tenuicaudatus* Hector, 1877, generally occupying shallow water sands and seagrass meadows. Fossils rays are widespread but not abundant in the New Zealand Tertiary marine record (Fordyce 1991) and virtually all have been referred to the large genus *Myliobatis* Cuvier 1817. Davis (1888) described three new species from the Oligocene and Miocene of Trelissick Basin, Canterbury, with one of the species reported also from other South Island localities. The same three species were also recorded by Chapman (1918) and many isolated teeth have been reported subsequently at generic level from many sites of Cenozoic age around New Zealand (Fordyce, 1991).

The earliest-known fossil rays are from the European Early Jurassic (Long, 1995; Family Rhinobatidae), but Myliobatidae, the eagle rays, appear in the Late Cretaceous and rapidly become widespread throughout the Tertiary. They are found generally as isolated teeth or tooth-plates, in common with all Chondrichthyes, in Tertiary marine deposits worldwide.

In New Zealand deposits, they are not common enough yet to have chronostratigraphic value, nor well enough known at species level to have a clear view of evolution or species distribution and longevity. So any additional information will assist future work in this direction.

Paleontology
The present report deals with a partial tooth plate, almost certainly from a lower jaw, in calcareous siltstone from a quarry near Raglan, west of Hamilton, and presented to the then-Geology Department (now part of the School of Environment), University of Auckland, by quarry worker, Mr D. Dunn. The date and circumstances of this gift are unknown now, but the gift was pre-1987, because the donor presented a further collection in that year. Efforts during the preparation of this report to locate the donor have so far been quite unsuccessful. The specimen is recorded as V564 in the Catalogue of Type & Figured Specimens of the School of Environment, University of Auckland, in collection AU11066, from locality S15/f13 (in the national Fossil Record File – FRED – run jointly by the Geosciences Society of New Zealand and GNS Science, Lower Hutt; grid reference S15/000700 in NZTopo50, the 1:50,000 topographic map series for New Zealand). The tooth plate came from the Karamu Quarry, off Fillery Rd, near Raglan, southwest Auckland (Fig. 1). It was collected in situ in the Glen Massey Formation, possibly the Dunphail Siltstone Member, of the Te Kuiti Group, of Duntroonian or Whaingaroan, Early to middle Oligocene age, ~34–25 Ma (Kear & Schofield, 1978; Raine *et al*. 2015).

Classification:
Class Chondrichthes Huxley, 1880
Subclass Elasmobranchii Bonaparte, 1838
Cohort Euselachii Hay, 1902
Subcohort Neoselachii Compagno, 1977
Superorder Batomorphii Cappetta, 1980
Order Myliobatiformes Compagno, 1973
Superfamily Myliobatoidea Compagno, 1973
Family Myliobatidae Bonaparte, 1838

Comment
The eagle rays (Fam. Myliobatidae) first appear in the Late Cretaceous and still thrive today. Fossils occur generally as isolated teeth or tooth plates. They have complex pavement-type dentitions consisting of several rows (files) of broad, flat crushing plates flanked by many smaller polygonal units with which they grind up crabs, molluscs etc. (Long, 1995). Today they are most abundant in shallow waters of tropical to warm temperate seas. This group lacks tail spines, 'stings'.

***Aetomylaeus* Garman, 1908**
Type: *Myliobatis maculatus Gray, 1834, Recent.*

Diagnosis: Tooth plate of seven files of teeth, with one median file and three paired lateral files; median teeth much broader than long, with crown thicker at centre than at edges, arched at front, labial face covered with dense network of depressions; lateral files reduced, asymmetrical, polygonal; root not very high, directed backwards, with oblique labial and lingual faces; prominent narrow visor juts out over labial face of root (after Cappetta, 1987).

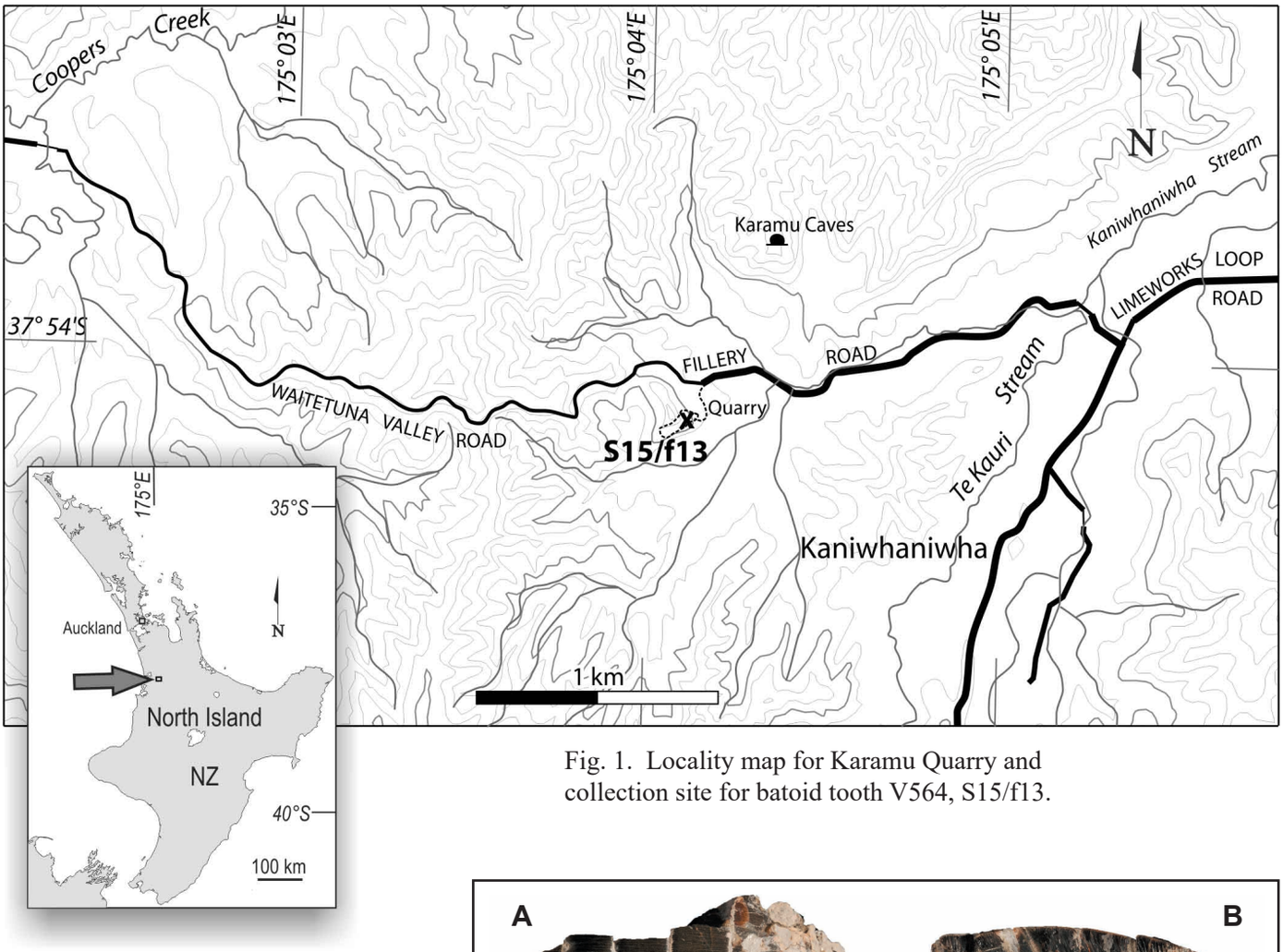


Fig. 1. Locality map for Karamu Quarry and collection site for batoid tooth V564, S15/f13.

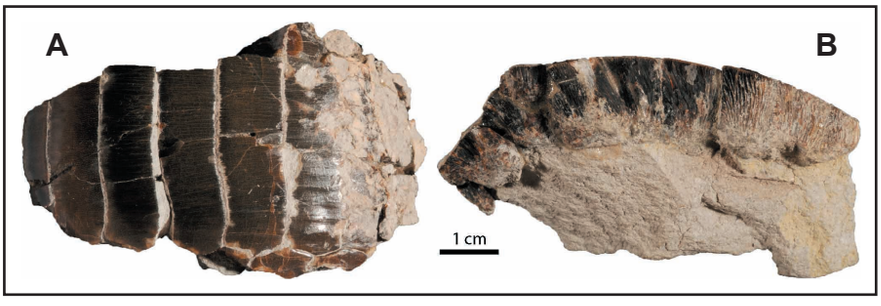


Fig. 2. *Aetomylaeus* sp. cf. *A. cubensis* Iturralde-Vinent *et al*., 1998, V564, from S15/f13, Karamu Quarry. A, occlusal view. B. right lateral view.

Comments

This genus is most diverse today in the western Pacific Ocean, although not found in New Zealand waters, and extends into the eastern Pacific, Indian Ocean and Red Sea. Wikipedia lists three Tertiary records of named species (*A. cojimarensis, A. cubensis,* both of Iturralde-Vinent *et al*., 1998, in the Cuban Miocene, and *A. meridionalis* Gervais, 1852) from the French Pliocene – see also Cappetta (1987), and another three in open nomenclature this genus: Early Eocene of Virginia (USA), Late Oligocene of Hungary, and Middle Miocene of Austria.

***Aetomylaeus* sp. cf. *A.cubensis* Iturralde-Vinent *et al*., 1998.** (Fig. 2)

1998. cf. *Aetomylaeus cubensis* Iturralde-Vinent *et al*., fig. 7 C–H.
2017. cf. *Aetomylaeus cubensis,* Aguilera *et al*.

Material

A single articulated tooth-plate series of flat crushing teeth (V564), lacking most of the lateral files, preserved undistorted in light grey-brown calcareous siltstone. The tooth-plate is probably from the lower jaw, showing the occlusal surface.

Description

Part of large articulated tooth-plate, probably ventral, with 8 median teeth, damaged to greater or less extent, especially lacking lateral articulations with lateral files, and posterior two median teeth partly covered with matrix; teeth individually 6–7 times wider than long, with slightly corrugated shiny grinding surface very slightly convex laterally and almost flat antero-posteriorly, very gently anteriorly projecting medially by ~2 mm, lateral ends of median teeth similarly curving gently forward, resulting in median teeth having gently sinuous anterior

and posterior edges; no clear separation of crown and root; tooth material fibrous, with fibres normal to tooth occlusal surface. Whole ensemble markedly curved antero-posteriorly, more strongly in posterior third, with total 'inflation' of 20 mm at posterior third tooth. Fragments of three inner lateral file teeth on LHS present, apparently polygonal in outline, slightly longer than median teeth.

Dimensions (in mm)
Length overall 73.8, maximum width 43.3, length of single median tooth 11.8, width of most complete median tooth 41.0, total thickness (tooth at presumed median posterior 6th level – crown + root) 14.8 thinning to 4.4 at outer end, length of inner file tooth 11.4.

Comment
This fossil can be placed in *Aetomylaeus* on the basis of its assemblage of broad median teeth and apparently much-reduced laterals, its slightly forwardly arched median teeth, with the crown thicker centrally than at the edge, although not showing any clear separation of crown and root or the number of lateral files. Features of specific significance include the gentle anterior curvature of the median teeth, the level of inflation of the plate as a whole, and the difficulty in recognising the crown-root division, which are features which allow comparison with the Cuban and Brazilian Early Miocene *A. cubensis* (Iturralde-Vinent *et al*., 1998; Aguilera, 2017). The Raglan specimen is the same size as Cuban specimens and has similarly sinuous anterior and posterior margins, although the median arch is broader and more developed. The extent to which these differences may be individual variations or of specific significance is not known and must rely on the examination of further specimens of each.

The Karamu specimen also differs from *A. meridionalis* figured by Cappetta (1987) from the French Pliocene by having much less forward curvature of the teeth in the median file which are also longer than in the French specimen.

Associated Fauna
The calcareous siltstone contains a scattered but varied marine invertebrate macrofauna including the octocoral *Graphularia longissima* Squires 1958, the scleractinian *Flabellum,* echinoids, and the bivalves *Cucullaea, Neilo, Lentipecten hochstetteri* (Zittel 1864), *Serripecten hutchinsoni* (Hutton, 1875), *Athlopecten athleta* (Zittel, 1864), and *Panopea*, a soft bottom fauna characteristic of an outer shelf setting. Such a setting would not normally be associated with eagle rays, so this specimen is likely to have been transported down slope from the living site of the ray.

***?Aetomylaeus altus* (Davis, 1888)**

1888. *Myliobatis altus* Davis, p. 40, pl. 7, fig. 1, 2.
1918. *Myliobatis altus*, Chapman, p. 23, pl. 7 (not 6, as stated in text), fig. 1, 2.

Type Material
Two syntypes described and figured by Davis (1888) and registered as zfp144 (Davis, 1888, pl.7, fig. 1) and zfp143 (Davis, 1888, pl. 7, fig. 2) from limestone of the Thomas Formation, Broken River, north Canterbury (Gage, 1970), are held in the Canterbury Museum. Chapman (1918: 23), who repeated Davis' figures (Chapman 1918, pl.7, fig.1, 2), stated that "the type specimen had, unfortunately, suffered from fracture since it was first described" without indicating which specimen he regarded as 'type', although it seems likely that he judged which was the larger, more complete specimen, zfp144, as type. The species has not been referred to since that date.

When seeking to borrow the syntypes for this study, Canterbury Museum Curator Dr Paul Schofield informed me (in litt., 2017) that the larger specimen has further disintegrated and was in no safe condition to be loaned. It is therefore quite unsuitable for designation as a lectotype.

The second syntype, zfp143, which came from the same site as the first, was smaller, a small triangular fragment of pieces of perhaps two teeth (Davis, 1888, pl. 7, fig.2), and is also now shattered and fragmented.

Comments
This species has not been identified in the New Zealand fauna since Chapman (1918). It is characterised by its relatively large size and considerable thickness. Tentative allocation to *Aetomylaeus* is on the basis of laterally elongate (?median) teeth which are quite thick centrally (v. Davis, 1888, pl. 7, fig. 1), but the specimens figured in Davis (1888) are too incomplete to allow certain identification. With its shattered state and in the absence of more material it must now be considered a *nomen dubium*, until the collection of more material from the type locality ('Broken River, Trelissick Basin' – Davis, 1888).

Acknowledgements
Dr Paul Schofield, Canterbury Museum, Christchurch, arranged photography of the syntypes of *"M." altus* and unsuccessfully searched their collections for additional specimens. Dr Neville Hudson, University of Auckland School of Environment, was responsible for specimen curation and assisted with locality data and literature, and Louise Cotterall, also of the School of Environment, provided the illustrations.

Belated acknowledgement should be made here to D. Dunn, presumed to work at the time at the Karamu Quarry, for the gift of the eagle ray tooth-plate to the Geology Department, University of Auckland – a valuable acquisition – and it is with regret that efforts to track him down for fuller locality and collection details and acknowledgement in the present study were unsuccessful.

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QUIZ ANSWERS

Know your North Shore beaches.

1. Campbells Bay
2. Cheltenham Beach
3. Mairangi Bay
4. Milford Beach
5. Rothsay Bay
6. Torbay
7. Waiake Bay
8. Thorne Bay
9. Takapuna Beach
10. Narrow Neck Beach
11. Murrays Bay
12. Long Bay
13. Castor Bay
14. Browns Bay

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