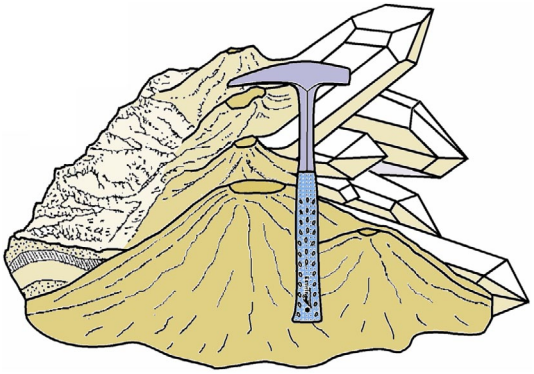


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CONTENTS

Instructions on use of hyperlinks	*last page*	26
WHO WAS FREDERICK SEPTIMUS PEPPERCORNE?	Hugh R. Grenfell, Philip Heath	2 – 9
IMPROVED EXPOSURES ALONGSIDE NORTHCOTE ROAD PROVIDE GREATER INSIGHT INTO PUPUKE VOLCANO ERUPTIONS	Bruce W. Hayward	10 – 14
SOUTH AUCKLAND VOLCANO QUIZ	Wendy Goad	15 – 15
GEOLOGY TRIVIA QUESTIONS	Wendy Goad	16 – 17
THE ORIGIN OF UNUSUAL BEACH DEPOSITS AT ACHILLES POINT, MUSICK POINT AND OTATA ISLAND, AUCKLAND	Ian Simpson, Bruce W. Hayward	18 – 20
THE PERILS OF ChatGPT	Editor	20 - 20
A LATE CRETACEOUS SHELL FRAGMENT WITH EARLY MIOCENE BRYOZOA FROM THE WAITIITI FORMATION, HOKIANGA, REVEALS A COMPLEX HISTORY AND PALEOECOLOGY	Seabourne Rust	21 – 23
MEMORIES OF WARREN SPENCE, GEOCLUBBER EXTRAORDINAIRE 1992–2019	Bruce W. Hayward, Hugh R. Grenfell	24 – 25
Corresponding authors' contact information		26

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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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WHO WAS FREDERICK SEPTIMUS PEPPERCORNE?

Hugh R. Grenfell & Philip Heath

Frederick Septimus Peppercorne (1813–1882) was one of thousands of men and women who immigrated from Britain (the UK) and Europe to the Antipodes in the mid-19thC for various reasons. Oddly, despite a discernible trail of activity, he is a somewhat obscure yet notable figure. Peppercorne was a civil engineer and surveyor, who as well as using his training among other things, became a Pacific trader, had mining interests, wrote about New Zealand and Australian geology and was associated with the very earliest history of the Auckland Museum. Here we document what we know of him in a chronological order, starting in London and then his years Down Under.

London

Frederick was christened at Saint Mary's Church, Lambeth, London on 6 March 1813. Through a Dickensian lens (Dickens 1870), Septimus, because six brother Peppercornes had preceded him - William Henry (chr. 1804), James Watts (chr. 1804), Edward (chr. 1805), John (chr. 1807), George Ryder (chr. 1807), Francis Stephen (chr. 1811). Their father, William Peppercorne (1781–1874), and "inestimable" mother, Harriet Letitia Watts (1788–1858), both of Kennington, had married at Lambeth on 19 February 1803. William served as an officer in the Lambeth Volunteers, promoted to rank of lieutenant in December that year (London Gazette 1803). By 1817 he'd established himself as a reputable stockbroker in Token House Yard, Throgmorton Street, and later around the corner in Old Broad Street.

At the time of Frederick's christening, the family lived at Walcot Place, Upper Kennington Green, seemingly no. 56 in those times. It was a large three-storey house with a basement, but even so, it must have been a squeeze for seven young masters. Walcot Place (51°29'39.58"N 0°6'38.23"W) no longer exists, but was a residential section of the street later renamed Westminster Bridge Road, now Kennington Road, which linked Westminster Bridge Road with Kennington Common (Oatland Heritage 2012). Bethlehem Hospital (now the Imperial War Museum), was to the north and the later Walcot Square to the east.

The Peppercornes had a long association with the South London Water Works, established in 1805 to supply water to south London customers. When the firm's financial failure seemed likely by 1815, William Peppercorne, a shareholder and a director, personally intervened to turn it around with effective onsite financial and managerial control. The works (51°29'7.93"N 0° 6'52.88"W) were c.1km from the Peppercorne residence in Walcot Place (Greenwood & Greenwood 1828) and situated adjacent to Kennington Oval (the Oval), home of the Surrey County Cricket Club from 1845. The water works drew water from Vauxhall Creek, part of the Effra tributary of the Thames, with the engine located next to Vauxhall Bridge. In 1834, the firm was renamed Vauxhall Water Works (Guy 2011, Wikipedia 2022). Over the decades, William held office as a director, chairman and resident director, with James Peppercorne as a director, son James W. as chief clerk and secretary in or before 1827 to 1835, and son George R. as secretary from 1835 (Oatland Heritage 2012, Guy 2011). Frederick might have been employed in an engineering capacity. James W. followed his father into stockbroking and partnership as Peppercorne & Son, and then together, at some point, with Charles Peppercorne as Peppercorne & Co. Three of the sons ultimately immigrated to the Antipodes, William Henry (1829), George Ryder (?1853) and Frederick (1843).

Frederick, aged 28, was elected an Associate of the Institution of Civil Engineers (ICE) in 1837, giving his address as 15 Buckingham Street (Institution of Civil Engineers, 1838); the 1841 census indicating that the building was also home to others. Built before 1680, it was a large four-storied house overlooking the River Thames (51°30'29.77"N 0°7'23.20"W), next to the York Water Gate (Fig.1). The Gate was built in 1626 to a design attributed to Indigo Jones amongst others, and in Peppercorne's time it still provided direct access to and from the Thames. It survives today as a remnant of the grand private river entrance to the residence of the Dukes of Buckingham (Villiers family), York House, that once occupied the Adelphi district and is now marooned in the Victoria Embankment Gardens created between 1865 and 1875. The buildings at 15 & 16 Buckingham Street were demolished and replaced in 1906, only to be bomb damaged in WWII. The current building on the site, Burdett House, dates from 1968.



Fig.1: The York Watergate with 15 & 16 Buckingham Street directly behind. Painting by John O'Connor (1830-1889).

A number of notable people had resided at 15 Buckingham Street. William Smith, the Father of English Geology, from 1804 to 1819, had produced his geological maps there. Fitting to Smith's work as a civil engineer and surveyor, the newly formed Institution of Civil Engineers under the leadership of Thomas Telford had their first offices here from 1821 to 1823 after Smith's bankruptcy in 1819 (Henry 2016). At some point, the building was let in

lodgings or chambers under the charge of the laundress (Mathew *et al.* 1842). Charles Dickens (1812-1870), a year older than Frederick, took lodgings there in about 1834. In his 1849 novel, 'David Copperfield', landlady Mrs Crupp let lodgings to Copperfield at Buckingham Street. In later years, 1856–1875, William Burges, whilst pursuing the aesthetics of Gothic Revival, transformed the décor of his architectural practice there. Much earlier, Samuel Pepys had lived across the street at different times at 12 & 14 Buckingham Street in the late 1680s.

Whilst living at Buckingham Street and associated with the water works, Frederick published what appears to be his first papers; a work on the economy of fuel (Peppercorne 1839) followed by a substantial paper dealing with the vexed question of the supply of water to London (Peppercorne 1840).

London's 1832 cholera epidemic, bearing a strict relationship to the impure nature of water-supply, had cut through the population, with Southwark, supplied by Southwark Water Works, suffering a high mortality rate of 110/10,000 people. Consequently, many changes were made in the supply of London's water between 1832 and 1849. Repeal of restrictions preventing the South London Water Works from laying their pipes within two miles of the Lambeth Water Works had followed in 1834, and the South London (Vauxhall from 1834), Southwark and Lambeth water companies engaged in active yet senseless competition for years (Snow 1855). On a personal level, brother Edward, a brevet captain of the 16th Regiment, Native Infantry, Madras, had died of cholera in camp near Coodoor in October 1838 (Asiatic Journal 1839). With issues of impure water, aging pipes and failing engine, a time when capital and customers on company books needed to be increased, the Vauxhall Water Works came under attack.

Also, in the High Court of Chancery, July 1840, William Peppercorne was compelled to take back twenty-one shares in the Vauxhall, or South London Water Works, which he, as stockbroker and owner of the shares, whilst a director of the water works, had sold to Gillett in 1826, 1830 and 1831 (Beavan 1842). In consequence of mounting pressure on the Peppercornes' strong interests in Vauxhall Water Works, James left as director in 1840, William resigned as director in March 1842 and George R. resigned as secretary in June 1842. William Peppercone stepped down completely from the stock-broking firm Peppercone & Co. on 22 December 1842 (London Gazette 1842). Eventually, in 1845, the Southwark and Vauxhall companies amalgamated to form Southwark and Vauxhall Water Company, and in 1847 the aging Kennington works were dismantled (London Metropolitan Archives 2023).

This train of unsettling events, along with the early 1840s economic depression, probably spurred Frederick Peppercorne's decision to head to the Anitpodes and join his brother William Henry Peppercorne in 1843. His surveyor brother Francis S. stayed on at 15 Buckingham Street throughout the 1840s (The Royal Court Guide 1842, English 1849). After roles as a director of railway companies, brother George R. headed for a new life at Cape Colony later in 1849, where, after taking on and resigning the post of magistrate in the Colony of Natal, he left to join family in Australia in about 1853 (Guy 2011).

Down Under

Frederick boarded the barque 'James' in London on 4 June 1843, bound for Port Phillip, and the settlement of Melbourne, Australia. He arrived there on 12 October 1843 and was employed by a relative (see below), Ranulph Dacre (1797–1884), and Henry Elgar (1816–1852) to survey the 'Boroondara Estate' (Whitehorse 2023). Whilst living in Russell Street, Eastern Hill, Melbourne, he advertised himself as "civil engineer, architect and surveyor". He also sold and hired portable iron horse-gear for horses, oxen etc., for application "to mills, thrashing machines, chaff cutters, corn crushers and other machinery" (Port Phillip Gazette 1844).

Fifteen years earlier, in 1828–29, Frederick's eldest brother, William Henry Peppercorne (1804–1879), and cousins James Sea (1806–1851) and Margaret Sea (1809–1883), had immigrated to New South Wales on the 'Surry'. The 'Surry' was captained by Ranulph Dacre (Rogers 1990) who married Margaret Sea (i.e., Peppercorne's first cousin) at West Maitland in the Hunter Valley on 13 September 1831. William wasted no time establishing a farm (1920 acres) at what is now called Tomago on the Hunter River north of Newcastle. In 1830 he gives his address as *Eyeball Reach, Hunter's River* (Willets 2023). *Eyeball Reach* is unknown today and has not been found on 19thC maps. It is assumed here that *Eyeball Reach* and his farm, which he appropriately called *Kennington* after his home suburb, are one and the same area (32°49'14.21"S 151°41'56.87"E). It appears that later in 1844, Dacre owned land nearby or had a residence on his cousin-in-law's *Kennington* land (White 1844). The New Zealand Herald (1884) refers to a move by Dacre to Hexham, Hunter Valley, which was nearby. Interestingly, Hochstetter visited this area in 1858 and stayed very close by at Ash Island on the Hunter River with the Scott family (Nolden & Darragh 2023).

Presumably, again because of the family connections, Frederick soon joined company with Ranulph Dacre, the adventurous former naval officer and merchant. With a general cargo on the brig 'Diana', they headed for New Zealand and the South Sea Islands on the 18 July 1844, where Dacre already had many interests (Rogers 1990). They arrived in Auckland on the 4 August 1844, but departed soon after (Daily Southern Cross 1844). On the 23 December 1844, Dacre and Frederick returned to Auckland from Tahiti via the Bay of Islands on the 'Rambler' (Auckland Chronicle and New Zealand Colonist 1845). So began Peppercorne's life in New Zealand.

Dacre had for a number of years carried out trading and other ventures in Australia, New Zealand and the Pacific

Islands from NSW (New Zealand Herald 1884). He first came to New Zealand about 1820. He knew American-born William Webster well (AKA Big Webster / Wephiha / King of the Waiau, 1815–1897). Webster had a base at Herekino (Aropawa Bay, 36°46'31.17"S 175°27'22.01"E) on Whanganui Island, Coromandel Harbour from 1836 (Adams 1990). In 1845 Peppercorne, Dacre and Webster purchased 600 acres for £160 at the Waitataramoa Block, near Cape Colville, Coromandel District (Turton 1882, p. 517). Frederick later appears to become the sole owner. This block north of Colville Bay (Cabbage Bay) appears to be directly below Mount Moehau (36°33'55.38"S 175°22'54.44"E and see below re Heaphy 1857). According to Turton (1882, p. 637), Frederick appears to have had 2 blocks, the Colville block and another at Coromandel (total 715 acres). In his diary recording his trip to Coromandel in June 1859, Hochstetter mentions a Mr Peppercorne and a copper claim at Kowhai Point (unnamed today but in the vicinity of the present-day Coromandel wharf, 36°45'42.14"S 175°29'16.45"E, named in Heaphy 1857) (Nolden & Grenfell in press). This is probably the same venture with Webster and Dacre at Coromandel, mentioned in Roberts (2009). Some later successful underground gold mines are in the vicinity of Kowhai Point. On Hochstetter's annotated copy of Heaphy's Coromandel map (Heaphy 1857), both blocks are indicated with pencilled additions. Peppercorne was known to Maori as *Peni Rori* (Roberts 2009). In November 1844 *Te Apakarame* (Peter Abercrombie) and *Pene Rori* (FS Peppercorne) advertised for 50 workers to work at Great Barrier (Maori Messenger 1844). This was probably for the copper mine at Miners Head (Moore 1991).

In September 1846, Peppercorne became one of the 'Memorialists', which included the likes of Charles and Francis Ring (discoverers of gold at Cormandel), Thomas Russell, Frederick Whitaker and 42 others (New Zealander 1846). These were landowners who were crying foul to George Grey, having been "caught" by the Government's and Fitzroy's earlier decision in 1844 to "extinguish" certain land claims (thousands of acres). For example, although not one of the Memorialists mentioned in the New Zealander, Webster, Abercrombie and Nagle at one stage claimed the whole of Great Barrier Island. It's a messy, complicated story but some compensation appears to have been paid to most of them, and some of the detail is described in Turton (1882, e.g. p. 637). Peppercorne apparently received £125 in 1848 to extinguish one of his claims (Turton 1883, p. 81). In 1872, however, Peppercorne put in a claim for his Kowhai Point land (Daily Southern Cross 1872c), by then very valuable mining real estate, and next to what was at the time known as Wynyardton - a proposed Coromandel "suburb" that never happened. The outcome of Peppercorne's claim is unknown.

In 1849, Frederick had the 40 ton schooner 'Éclair', built in Coromandel. It was built by John Gillies at his shipyard at Aropawa Bay, Whanganui Island (Herekino - Webster's former base) and was launched 29 September 1849 (Armitage, 2009). He apparently then became a successful Pacific trader. Examples of the manifest in January 1851 (New Zealander 1851) and February 1851 (Maori Messenger 1851) attest to this enterprise.

January 1851:

> "Eclair, 40 tons, F.S. Peppercorn, from Tahiti, the 5th of January, with 12 boxes tobacco, 16 boxes souchong tea, 1 doz congou [tea], 2 cases brads, 1 doz buttons, 1 doz thread, 1 doz cotton, 1 doz snuff, 2 tubs knives, 1 case plates, 1 doz paintings, 1 doz cloth, ?rass, 1 doz pongees [silk], 6 bales oakum, 12 potatoe forks, 1 case ironmongery, 1 box soap, 291 ash oars, 51 harpoons, 22 lances. 160 small blocks, 1,300 cocoa nuts. James Macky agent."
>
> Also reported "The Eclair schooner, Capt. Peppercorn, has had a fine run of twenty one days from Tahiti; experienced fine easterly winds for seven days, after that has had to contend with head winds and calms. This handy vessel was built at Coromandel last year, and left this port about eight months ago for Tahiti and Honolulu, and has been trading for some months amongst the Sandwich Islands; to enable her to do so, she obtained a Hawaiian register, and now sails under the Hawaiian flag."

February 1851:

> "Eclair, 40 tons, T.J. [F.S.] Peppercorne, for Tahiti and Honolulu, with 78 cases, 20 bags potatoes, 12 cases carrots, 10 boxes onions, 8,000 feet sawn timber, 3 cases drapery, 2 boxes soap, 6 doz. frying pans, 11 cases pickles and mustard, 25 cases geneva [gin], 5,000 cigars, 8 packages rope, 4 cases wine, 2 kegs and 1 case butter."

Widely advertised for sale as a pamphlet in 1852 (Daily Southern Cross 1852) Frederick's published article "Geological and Topographical Sketches of the Province of New Ulster" (Peppercorne 1852) is one of the earliest on New Zealand geology. He displays a pretty good knowledge of the geography and geology of northern New Zealand at that time for someone who doesn't pretend to be a geologist. Despite occasional rambles, he made some valid comparisons with European geology, for example, between the Auckland Volcanic Field and the Eifel or Auvergne regions. He uses, perhaps for the first time by anyone, the words Waitemata, Tertiary and basin in the same sentence. He acknowledged and quoted the earlier work of Ernest Dieffenbach (1811–1855) (e.g. Dieffenbach 1841) and the exploration of others, such Surveyor General Charles Whybrow Ligar (1818–1881) on the Waikato Coal Fields. He wrote about the geology of the Coromandel, Great Barrier and Kawau Island from his own knowledge and mining interests in those areas. Sadly, in this apparently self published work, he apparently lacked the resources to illustrate his work with maps or diagrams.

Also on geological matters, Frederick donated some of the very first specimens which had catalogue numbers dated 20 August 1852 to the fledgling Auckland Museum, which opened on 24 October, 1852 (Original Museum Catalogue AWMM MUS-2015-1). He had, in fact, left New Zealand in July, suggesting donation occurred sometime before cataloguing began. The very first specimens (1–45),

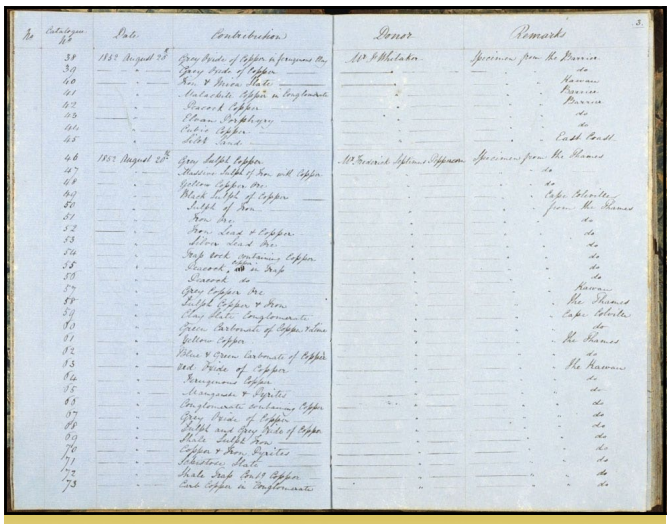


Fig.2: Auckland Museum Catalogue 1852 (AWMM MUS-2015-1), p.3 with the first 27 of Peppercorne's specimens.

mostly minerals, from Kawau and Great Barrier Islands, were donated by the scurrilous Frederick Whitaker. Peppercorne donated specimens 46–92 (AWMM MUS-2015-1 pp. 3–4), again mostly minerals, from the Coromandel and Kawau Island (Fig. 2). None of these early specimens, like those donated by Hochstetter in 1859, seem to have survived (Grenfell 2023).

In 30 July 1852, Frederick left New Zealand for almost 20 years, returning to Sydney, Australia on the 'Raven' (New Zealander 1852a). He arrived in Sydney on the 22 August. In September 1852, the Sydney Morning Herald reviewed his prospectus for a "hydrostatic slip" for repairing ships (Sydney Morning Herald 1852, republished in the New Zealander 1852b). In 1853–54, he tendered his resignation and retired from the Institute of Civil Engineers in London (Manby 1854). He apparently became employed by the NSW Survey Department as a surveyor and among other work established the town of Lismore in 1855 (Gahan 2003, The Daily Telegraph 2014). Frederick, now aged 42, married Hannah Ward, aged 32, daughter of William and Sarah Ward in NSW (Sydney Morning Herald 1855). According to his publications at this time, Frederick was living in the Richmond River area (e.g. Peppercorne 1858e) and apparently settled at Tatham on the Richmond River for a time (Smythe Family 2001). In 1857, William Yabsley, at Coraki, Richmond River built the 18 ton launch 'Quicksilver' on commission for Frederick Peppercorne. The boat was supposed to use quicksilver (mercury) / steam technology, but it didn't work and Frederick did not keep it. Yabsley kept the launch for his own use (Smythe Family 2001). The proposed technology was probably similar to the 19thC mercury powered concepts described in Self (2019).

Over these years in Australia, Frederick had a number of publications dealing with a range of topics (e.g. Peppercorne 1856, 1858a–e, 1864 [on Australian geology], 1870, and Fig. 3 [on railways, a very detailed work of almost 100 pages]). He also patented some inventions, No. 6, the "Gravitation" or "Automatic Engine" on 31 May 1858, and No. 26, the "Atmospheric Pressure Engine" on 14 December 1859 (NSW Legislative Assembly 1867).

After his wife Hannah died at Glen Innes, NSW, on 25 August 1867, aged 46 (Sydney Morning Herald 1867), and his daughter Henrietta married William Adolphus Blanton of Richmond, Virginia, in Sydney on 13 September 1870 (Sydney Morning Herald 1870), Frederick returned to Auckland, New Zealand, in 1871. He soon advertised for work as a civil engineer and surveyor (New Zealand Herald 1871) and with his knowledge of London's water works, and as projector for a proposed Auckland Water Company, advanced an idea to pump water from the Auckland Domain (Daily Southern Cross 1871). Over the next few years Frederick wrote letters to the editor about water supply issues, had arguments about the veracity of supply from the Waitakere Ranges or the Waikato River versus more local (volcanic) aquifers (e.g. Daily Southern Cross 1872a&b), reported to the City Council about the Western Springs as a water supply (Auckland Star 1873a) and wrote on the suitability of Nihotupu as a supply (New Zealand Herald, 1873a&b). Peppercorne apparently exhibited designs for the new Auckland Provincial Hospital at the Fine Arts and Industrial Exhibition held at the Mechanics Institute in 1873 (Auckland Star 1873b, Platts 1980). He wrote three times on detailed proposals for a new "hydraulic lift graving dock" for the Port of Auckland in June 1873 (e.g. New Zealand Herald 1873c).

In 1874, Peppercorne was quoted as "formerly of Auckland" in a report about his writing to Napier papers regarding the use of concrete rather than kauri for construction in Napier (Auckland Star 1874). He estimated that with the then rate of consumption that the supply of kauri from the Auckland Province would end by 1899. By 1875, he is reported to be the Municipal Engineer and working on the water supply for Napier (e.g. New Zealand Times 1875). It should remembered that Napier was a very different place prior to the 1931 earthquake, with Scinde Island pretty much being just that. Frederick appears to have been very busy as Municipal Engineer from 1875–1880.

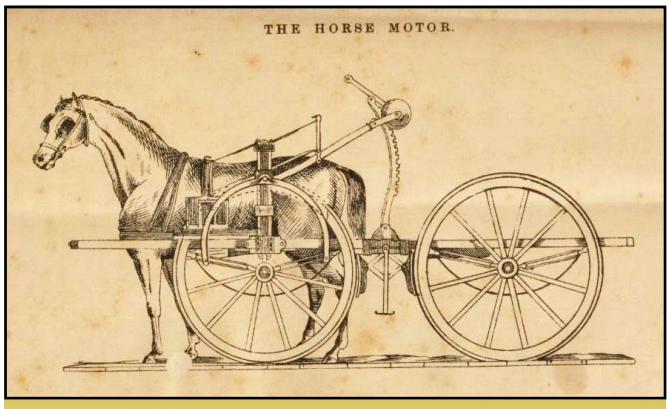


Fig.3: Illustration from "The Economy of railways, considered chiefly with reference to the Australasian colonies". Peppercorne (1870).

He was a member of the Hawkes Bay Philosopical Institute and continued to publish on various topics including Australian meteorology and hydrology, bar harbours, irrigation and on climate change (Peppercorne 1879a–d). His Royal Society of New Zealand paper on deforestation and climate change (Peppercorne 1879c) is considered one of the earliest on the topic (Knight 2011). In 1879, he published a booklet on "Irrigation and Canalisation Works (Ancient and Modern)" (Peppercorne 1879d). Late in 1879, he appears to have been unwell and reported to be better after a trip to the South Island (Hawkes Bay Herald 1879). In September 1880, Frederick resigned as Municipal Engineer (effective 31 December 1880) and his letter of resignation, which detailed his service, was published (Hawkes Bay Herald 1880).

The death of his brother, William H., in Sydney on 31 December 1879, and matters relating to his own health, may have been the personal reasons for resigning his appointment in September 1880 and quitting New Zealand. He noted in his letters of resignation that in his six years' service to the borough, some great improvements had been made under his supervision, notably the: cost-effective design and construction of an efficient water works with its ample supply of pure water; Browning Street storm water sewer; implementation of Bell's system of drainage and sewerage; raising of levels to reduce flooding, formation of streets where a fetid swamp had existed; and reclamation of the inner swamp (Hawkes Bay Herald 1879, Hawkes Bay Herald 1880, Hawkes Bay Herald 1881a).

Councillor George Swan noted that - "In spite of whatever might have been said against him, the feeling he had was that of heartfelt regret at Mr Peppercorne having relinquished the position of engineer to the borough. A more upright, well-meaning man, or one possessed of better ability for the office, could scarcely be found. From what had come under his (Cr. Swan's) notice he could say that Mr Peppercorne was a gentleman of strict integrity, thoroughly trustworthy, and a most efficient servant to the Corporation. It was with extreme regret that he now wished him good-bye, and he was quite certain that the sentiment was shared by the other members of the Council." (Hawkes Bay Herald, 1881a).

In February 1881, he left Napier on the 'Arawata' (Hawkes Bay Herald 1881b) and arrived in Sydney on the 14 February 1881 (NSW Legislative Council 1894, p. 42). His publications on rainfall, water conservation and irrigation in New South Wales (Peppercorne 1881, 1882a–c) were seemingly his last.

Frederick Peppercorne was clearly an educated, thinking man of many talents who had an interesting life Down Under. He died aged 68 on 3 May 1882 at his residence *Terrara*, 328 Victoria Street, Darlinghurst, Sydney. He was survived by his daughter Henrietta Blanton of Parkville, Melbourne (The Leader 1882).

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Return to contents page

IMPROVED EXPOSURES ALONGSIDE NORTHCOTE ROAD PROVIDE GREATER INSIGHT INTO PUPUKE VOLCANO ERUPTIONS

Bruce W. Hayward

Introduction

Many groups, including Auckland Geology Club, visit the road and quarry cuttings alongside the northern (lake) end of Northcote Road, Takapuna (Fig. 1). This sequence provides the most extensive insights into the later eruption sequence of Auckland's oldest volcano, Pupuke Moana. This end of Northcote Road provides access to the south shore of Lake Pupuke and the North Shore Canoe Club headquarters. The road runs down between two old quarries that extracted basalt lava and scoria during the mid-late 20th century (Fig. 2). Smales Quarry on the east side of the road was the earliest and cut down through scoria and into a thick lava flow. The quarry on the west side of the road excavated into the basalt lava well below the present lake level in the 1960s–70s. As a result, Northcote Road between the two quarries was also lowered and a road cutting created on its eastern side. It is the sequence of volcanic rocks in this road cutting that provides the best insights into Pupuke's eruption sequence (Allen *et al*. 1996; Hayward *et al*. 2011; Hayward 2019).

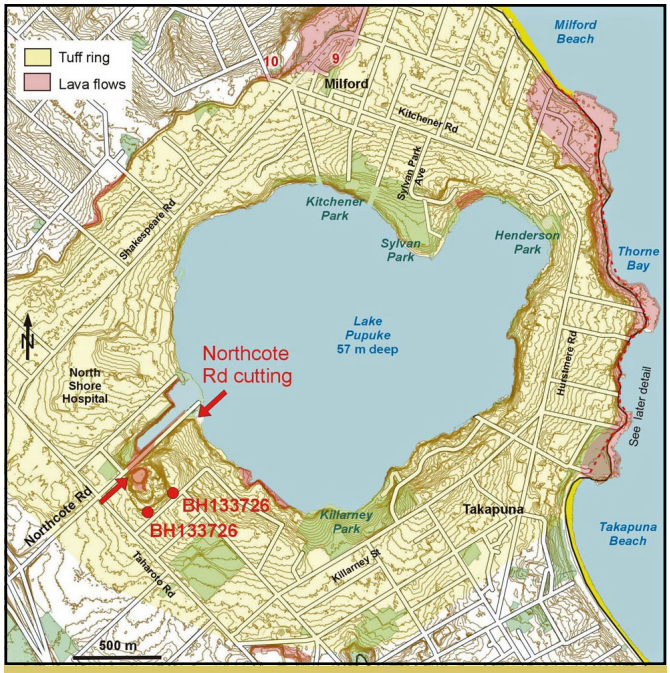


Fig. 1. Map of Pupuke Volcano showing the location of the Northcote Rd cutting study site (arrowed). The location of two boreholes (prefixed by BH) are indicated.



Fig. 2. Oblique aerial looking north over the study area in 2009 with Northcote Road running up the photo near the centre. The deep hole in Smales Quarry is partly full of water. The elongate arm of Lake Pupuke to the west of Northcote Road is a flooded former quarry. The road cutting is arrowed.

Up until the 1990s, the road and quarry cuttings were relatively clear of vegetation, but weathered. In the last 30 years, pohutukawa trees have been planted along the roadside in front of the cutting and gorse and scrub grew over the exposures in the uphill half. In early 2023, the owners of the long-disused Smales Quarry cleared the scrub and began earthworks above and in the excavated quarry hole as the first stage of development of the site. As a result, the rock sequence in the cutting was the best exposed it has been for many years (Fig. 3) and allowed a re-examination of the relationships of the various rock units.

Previous work

Allen *et al*. (1996) inferred five stages in the eruption of Pupuke volcano. Initial short-lived phreatomagmatic eruptions were followed by dry eruptions of lava flows, forming a wide, gently-dipping shield, possibly with a central scoria cone above the vent. This was followed by localised strombolian activity "in the west", producing an 8 m-thick black and red scoria deposit (seen in Northcote Road cutting) overlain by phreatomagmatic deposits that formed a tuff ring around the whole Lake Pupuke crater. They recognised inner and outer tuff ring sequences based on the Northcote Road cutting, partly

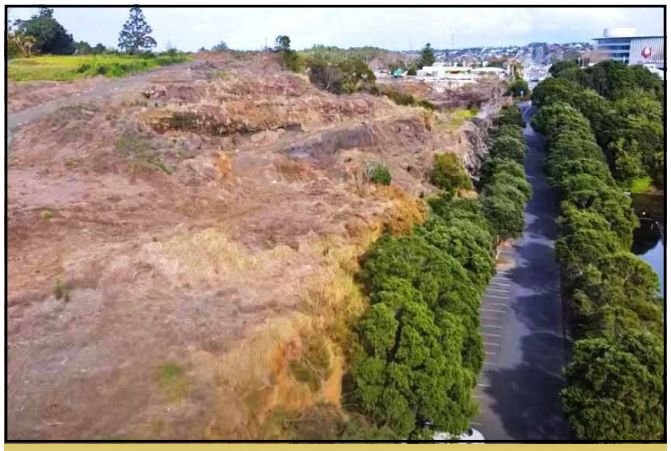


Fig. 3. Oblique aerial looking south over the north end of Northcote Rd in 2023 showing the recent vegetation clearance of the road cutting and the quarry faces and land above. Photo by Julian Thompson.



Fig. 4. View eastwards across to the Northcote Road cutting in 2023 showing the lower section that until recently was separated from the upper section (far right) by vegetation cover.

because vegetation already obscured the relationship between the sequences at the lower and upper ends of the cutting (Fig. 4). As the Northcote Road cutting was starting to become hidden by vegetation, Allen *et al*. (1996, figure 8) undertook bed-by-bed detailed logging of the sequence in two places (in their inner and outer tuff rings). Within the pyroclastic sequence above the lava flows, they recognised in both columns an upwards shift from dominantly dry, through alternating wet and dry, to dominantly wet eruption products.

Allen *et al*. (1996) observed that the Pupuke sequence was unique in the Auckland field, where all other eruptions show a trend from wet to dry style, and not the reverse that is seen at Pupuke. They infer there may have been a time break to allow water to accumulate in the vent (although they saw no evidence for this) or the vent location moved. Hayward (2019) has suggested that the increasing wet style might have been due to the Wairau Stream becoming dammed by Tank Farm and Pupuke volcanoes, and water then being diverted into the Pupuke vent.

Hayward (2009) described a heap of basalt spatter enclosed by a lava flow at the upper end of the cutting. It was inferred to be a small hornito that erupted through a hole in the roof of a flow before being surrounded and buried by a later flow. Hayward *et al.* (2011, p. 110) and Hayward (2019, p. 75) provided a schematic sketch of the Northcote Road cutting with text that inferred that the near-vertical-sided scoria mound was part of a former scoria cone that had been rafted away on top of the lava flow it overlies, before being buried by the later tuff. The apparent northwards dip on top of the flow suggested the scoria cone may have been located a few hundred metres to the south.

In an alternative interpretation, Nemeth *et al*. (2012) inferred that the thick lava in Smales Quarry (at that time partly filled with water) was a basalt plug overlain by locally-sourced scoria deposits with some scoria being rafted away to the north. Hayward (2020) visited the site when the quarry was pumped dry and was told of drillholes that showed that the lava was a flow underlain by Pleistocene sediment. Nemeth *et al.* (2012) also noted that the bedding characteristics of the phreatomagmatic tuff sequence at Northcote Road suggest that they were deposited in the medial to distal parts of the tuff ring and thus there has been considerable post-eruption enlargement of the Pupuke maar crater.

Hayward (2020) described pods of porcellanite (baked Pleistocene rhyolitic sediment) that appeared to occur within the top of a flow or in between flows. He inferred that these “rafts” of sediment were either ripped from the wall of the throat of the volcano by the ascending lava or picked up as the lava flow passed over the ground surface.

The sequence

Two cored boreholes (NZGD BH133726-7 in the New Zealand Geotechnical Database, 2023) located at 28.5–32.5 m above MSL on the crest of the tuff ring at the top of Smales Quarry site (Fig. 1) intersected the base of the Pupuke lava flow sequence sitting on Pleistocene sediment (no basal tuff) at 0–2.5 m below MSL. The lava flow unit is 15–18 m thick overlain by 14–18 m of pyroclastic sediment (New Zealand Geotechnical database).

In the road cutting, the sequence consists of a 6 m+-thick basalt flow (base not seen, but presumably 5–8 m above base of volcanic sequence) overlain with an undulating rubbly contact by two, 1–2 m-thick lava flows (seen in the upper part of the cutting, Hayward 2020). The top flow is then overlain by 8 m of weakly stratified, flat-lying, fresh black, poorly vesicular scoria/basalt lapillistone (Fig. 5), which in places has been oxidised by weathering to an orange rusty colour (especially in a 5-m-high, steep-

sided mound of this material that occurs in the lower section of the cutting; Fig. 6). The base of the mound sequence overlies 30 cm+ of blocky basalt breccia (Fig. 7), presumably sitting directly on the top of the lava flows (which are exposed just across the road).

This black, scoriaceous deposit contains several 0.1–0.2 m-thick beds of laminated, pinch and swell, irregularly cross-bedded, light-coloured ash (surge deposits) in its upper 4 m (Fig. 8). It passes gradationally upwards (with decreasing proportion of dryer deposits of lapillistone) into ~6–10 m of well-bedded, dominantly fine-grained tuff (Fig. 9) that is inferred to be phreatomagmatic surge deposits. This is the dry to wet sequence of Allen *et al.* (1996).

The recently cleared vegetation over the whole length of the Northcote Road cutting now shows the relationship between the upper and lower parts of the sequence (Allen's inner and outer tuff ring), where before there was a hidden section (Fig. 10). There is a north-dipping (lakeward) normal fault cutting the section and displacing the lava flows and black lapillistone sequence by ~6 m vertically (Fig. 11). Rather than the sequence dipping down towards the lake, as previously inferred, it is downfaulted (Fig. 12). The fault scarp is then mantled and buried by the phreatomagmatic tuff ring deposits. This shows that the fault displacement occurred close to the time of onset of the wet explosive eruptions and probably represents a slumping of the lakeward part of the lava flow-lapillistone sequence into the Pupuke



Fig. 5. Weakly stratified, fresh black basaltic lapillistone unit in the quarry cutting above Northcote Road.



Fig. 6. Orange oxidised (weathered) lapillistone in the steep-sided mound in the lower section of Northcote Road cutting.



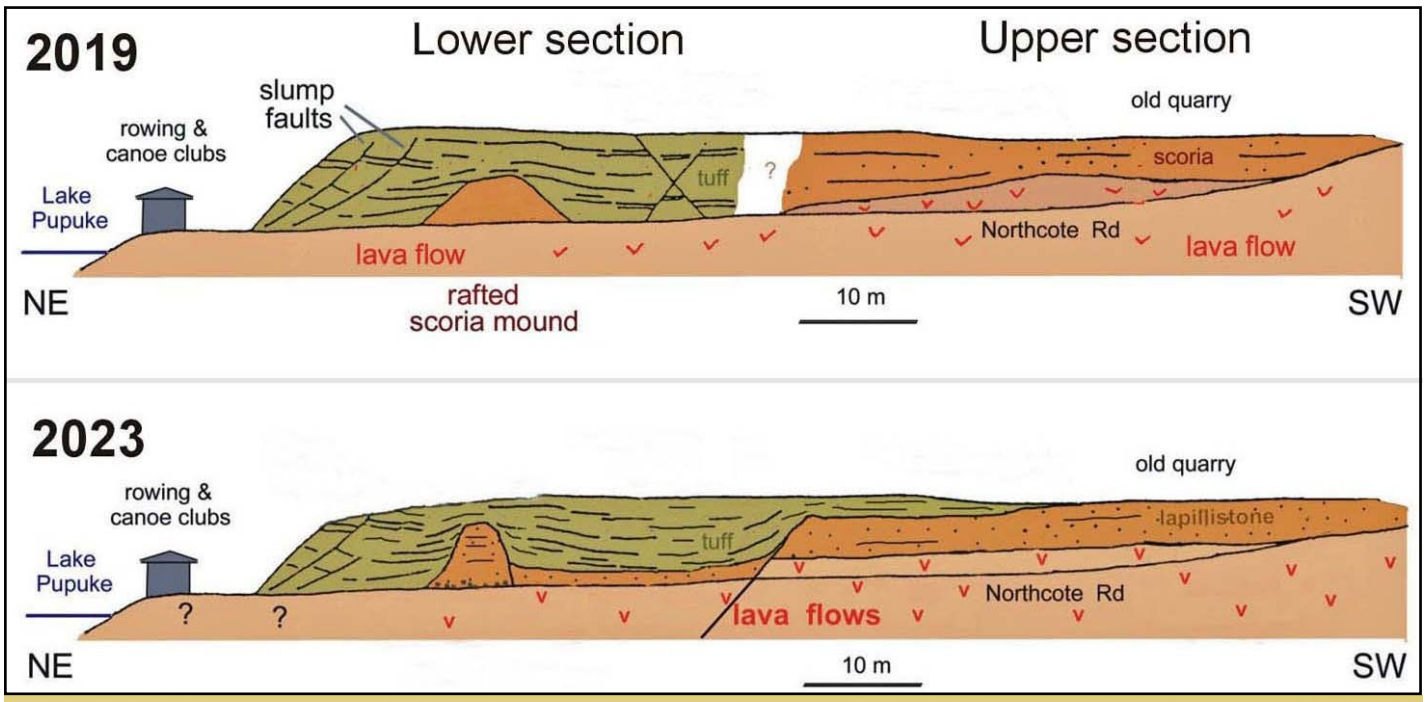
Fig. 7. Blocky basalt breccia at the base of weathered lapillistone in the mound, Northcote Road.



Fig. 8. Pinch and swell of light-coloured ash inferred to be wet base surge deposits within the dry strombolian lapillistone, Smales Quarry exposure.



Fig. 9. Thin-bedded tuff in the upper part of the Northcote Road section inferred to have been ejected by wet phreatomagmatic eruptions.



Fig, 10. Simplified sketches of the Northcote Road section comparing that inferred from the partly vegetation-covered exposures by Hayward (2019) and in this study in 2023 after vegetation clearance.



Fig. 11. The newly-recognised north-dipping (to left) fault that was formerly hidden by vegetation between the upper and lower sections of the Northcote Road cutting. This fault appears to have been formed by crater ward collapse and slumping of the northern portion of the section as the first phreatomagmatic eruptions were initiated.

crater/vent as it was being voided by the large eruptions. This was also the time when the steep-sided mound of lapillistone (Fig. 13) was created. Both visible sides of this mound are smooth, joint planes where blocks of lapillistone have slid off (Fig. 13), presumably as the section slumped into the crater. Possibly the loose material has been partly swept away by a mini-tsunami of water that may have come out of the crater during the collapse. In the foot of the lower section of the road cutting, there appears to be a continuous exposure of lapillistone linking the mound southwards to the fault and thence to the upper section of the cutting.

Further observations and interpretation of the rafted baked Pleistocene sediment

The much-improved exposures now clearly show that the baked pods of rhyolitic sediment (Hayward 2020) occur within the top of, and on top of, the second-youngest basalt flow and nowhere else in the sequence (Fig. 14).

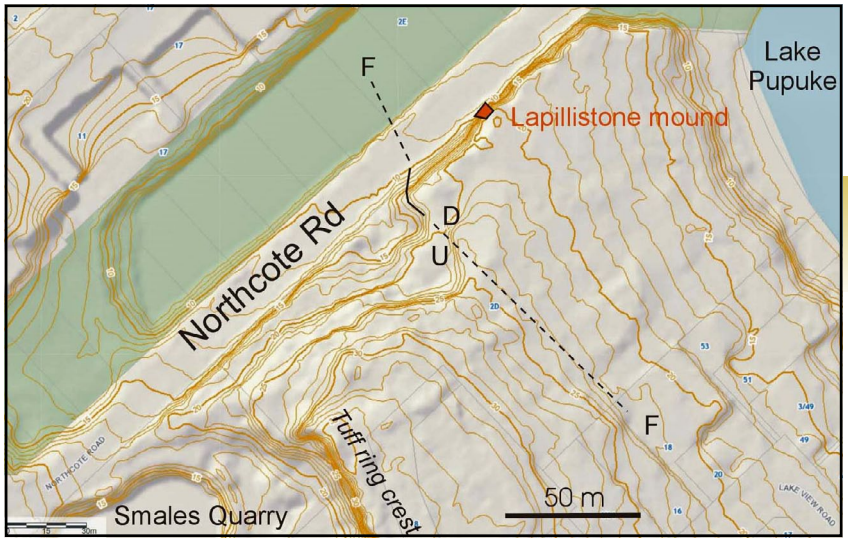


Fig. 12. Contour plan (1 m contours) of study site beside Northcote Road showing the location of the newly recognised fault separating the upper and lower sections of the cutting. Locations of photos in this note are also shown.



Fig. 13. Steep-sided mound/ridge of orange-weathered lapillistone buried by thin-bedded tuff. Note the smooth joint-controlled sides of the mound where material has slid away before being buried. Photo taken 1994. Width of photo 8 m.



Fig. 14. Pod of baked rhyolitic sediment within the top of a basalt flow and buried beneath the next in the upper section of the Northcote Road cutting, 2023. Photo by Julian Thompson.

A recent drillhole through the Pupuke tuff ring on the north side of the lake penetrated 15 m of tuff and basalt lava overlying Pleistocene rhyolitic sediment at ~MSL. Between 10 and 16 m below MSL, a unit of basalt lava has intruded along the unconformable contact between the Pleistocene and underlying Waitemata Sandstones. In places, this rhyolitic sediment was recorded as being exceptionally hard (baked porcellanite). This record of intrusional basalt and hard baked porcellanite suggests an alternative interpretation (to that of Hayward 2020) for the Northcote Road pods that occur in and at the contact between two flows. It seems more plausible that this particular Northcote Road flow started by being intruded as a sill through the soft wet rhyolitic sediment before pushing up to the surface to become a flow carrying along pods of the overlying baked sediment.

Summary of revised interpretation of the sequence

No borehole logs from the New Zealand Geotechnical database (2023) record tuff beneath the Pupuke lava flows, thus an initial phreatomagmatic phase of eruption, if it did occur, was small. The first major phase of eruption was the dry eruption of lava flows producing a low shield, possibly with a small scoria cone around the vent (near centre of present crater). This was followed by wind-blown air fall deposition ~1 km from the vent, of relatively dense basaltic lapillistone. Allen *et al.* (1996) suggest this low vesicularity was a result of degassing of stagnant magma in the volcano's throat before it was ejected by a superheated steam-driven strombolian/fountaining eruption through it. Soon after this second phase of eruption, a significant portion of the southern side of the volcano slumped into and widened the crater. A possible small tsunami associated with this collapse could have helped erode some of the lapillistone, leaving behind a steep-sided mound/ridge.

The re-activation of the stagnant magma might have resulted from the first water (from dammed Wairau Valley) infiltrating the vent. The lapillistone fall eruptions were followed by a sequence with increasing components of wet phreatomagmatic phases interspersed with the dryer strombolian, as more and more freshwater flowed into the vent. The final phases of the eruption, before magma supply ceased, was entirely phreatomagmatic and built the uppermost 5–10 m of tuff ring crest.

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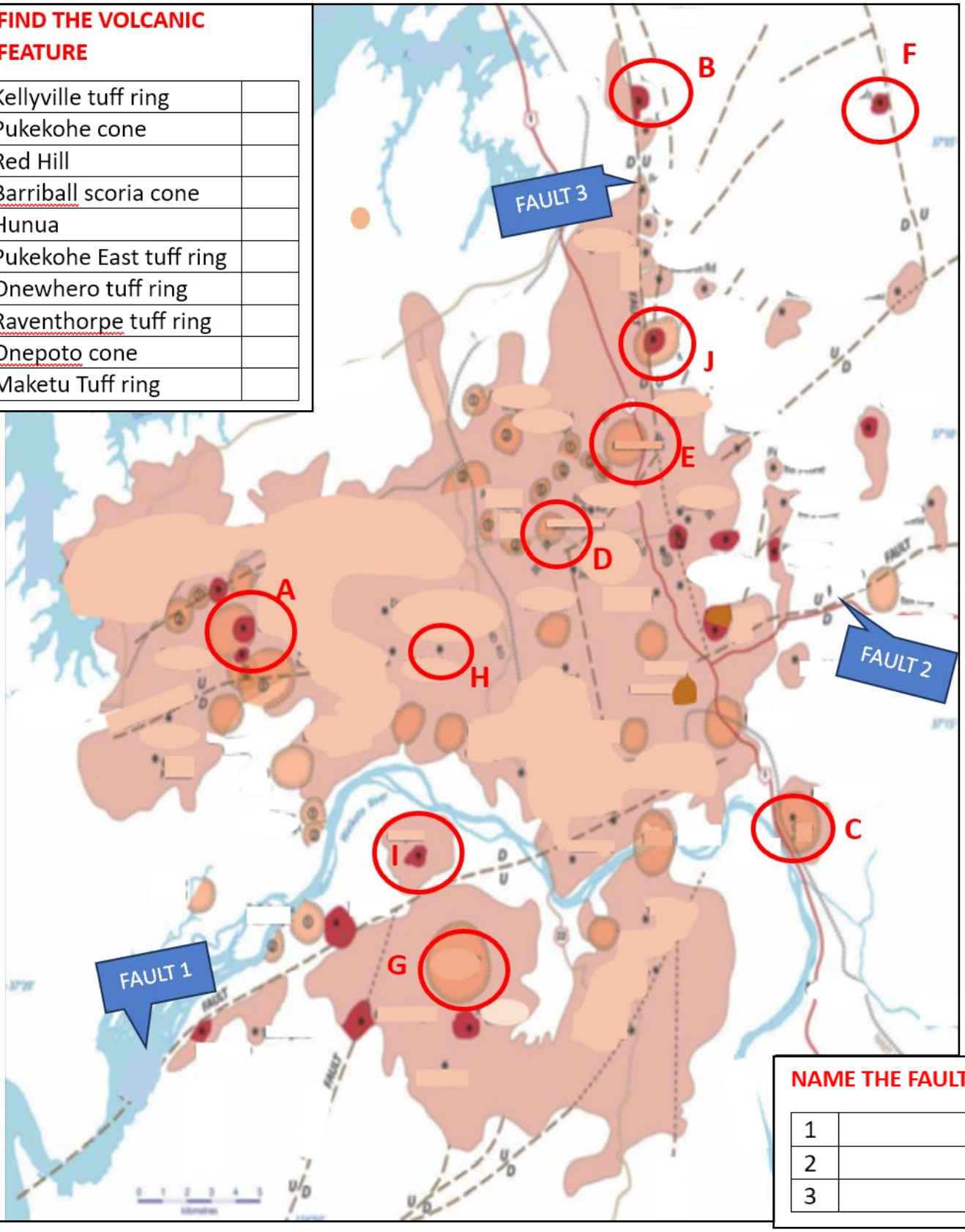
Return to contents page

SOUTH AUCKLAND VOLCANO QUIZ

Wendy Goad

FIND THE VOLCANIC FEATURE

Kellyville tuff ring	
Pukekohe cone	
Red Hill	
Barriball scoria cone	
Hunua	
Pukekohe East tuff ring	
Onewhero tuff ring	
Raventhorpe tuff ring	
Onepoto cone	
Maketu Tuff ring	



NAME THE FAULT

1	
2	
3	

Answers

Volcanic feature
A. Barriball scoria cone
B. Red Hill
C. Kellyville tuff ring
D. Pukekohe East tuff ring
E. Raventhorpe tuff ring
F. Hunua
G. Onewhero tuff ring
H. Pukekohe Cone
I. Onepoto Cone
J. Maketu tuff ring

Fault
1. Waikato
2. Pokeno
3. Drury

Return to contents page

GEOLOGY TRIVIA QUESTIONS

Wendy Goad

28 Geology Trivia Questions Ranked Easiest to Hardest

1. What variety of quartz, with chemical formula SiO2, is pink and seems to be named after a red flower with prickly stems?

2. Normal, reverse, strike-slip, and oblique are the four types of what things found in the Earth's crust?

3. Mostly found shifting around under its water, what ocean is the namesake of Earth's largest tectonic plate?

4. More commonly known as Louwala-Clough to the Klickitat Native American tribe, what stratovolcano erupted on May 18, 1980, causing over $1 billion in damage in Washington according to the International Trade Commission?

5. Sometimes called the "fire of the desert," what is the national gemstone of Australia?

6. Common on the surface of Mars, what is the name of the extrusive igneous rock formed from the rapid cooling of lava that is rich in magnesium and iron?

7. What is the name of this dark igneous rock, nicknamed "nature's glass", that forms when molten lava cools at a rapid speed?

8. Composite and shield volcanoes are the larger varieties and what third type is the smallest volcano that is typically composed of small fragments of ejected material?

9. Usually, dark grey to black in colour, what fine-grained volcanic rock forms the columns of the famous Giant's Causeway in Northern Ireland?

10. In geology, what eight-letter word means a deposit of clay, silt, sand, and gravel left by flowing streams in a river valley or delta?

11. Yellowstone and Lake Taupo are examples of what geological feature, which forms after a collapse of land following a volcanic eruption?

12. Travertine, tufa, coquina, and chalk are all forms of what type of sedimentary rock?

13. What 18th century Scottish scientist, noting the physical transformations of the terrain of the Scottish Lowlands, is considered the founding father of modern geology?

14. In 2021, a geological study of what planet, named for the roman goddess of love, discovered that parts of its rocky surface move in patterns similar to ocean pack ice on Earth?

15. An accumulation of sediments shaped like a shallow cone, such as a narrow canyon emerging from an escarpment, is an alluvial _____.

16. What metamorphic rock is formed when silicious sandstone is subjected to heat and pressure?

17. Petrology is also known as the study of the history, origin, structure, and chemical composition of what objects?

18. As is commonly known, diamonds are made entirely of Carbon. Name either of the two elements that make up rubies.

19. What word to a geologist means the movement of water through rock and to a barista means the movement of water through coffee grounds?

20. What is the name for an underground layer of liquid-bearing permeable rock?

21. Known as a mining “powerhouse”, what country is frequently the world’s top annual producer of chrome, manganese, platinum, and vanadium?

22. Where would you find all of the following officially-named rocks? Adirondack, Barnacle Bill, Bathurst Inlet, Big Joe.

23. What is the term for the rigid, outer shell of a planet or natural satellite? The crust and a portion of the upper mantle on Earth form this layer.

24. What Greek philosopher of the 4th century BC created one of the first evidence-based systems of geology, theorising that the Earth changes over time in ways one individual cannot see? He is known for being a student of Plato, and for writing such books as “Poetics.”

25. Take the number of rocky planets in our solar system plus the number of teaspoons in a tablespoon. What’s the sum?

26. The Greek philosopher Theophrastus analysed a variety of minerals, gems and ores, such as marble, pumice and limestone, in his treatise “On S ”. Complete the name of his treatise word “S” blank, defined as hard, solid, and non-metallic?

27. The Asteroid Belt famously separates the inner rocky planets from the gas giants that begin with Jupiter. What is the name of the astronomical entity beyond Neptune’s orbit that also houses the three officially recognised dwarf planets: Pluto, Haumea, and Makemake?

28. Which geological time period that began 358.9 million years ago, during which large coal deposits formed, has a name derived from the Latin for “coal-bearing?”

Answers

Return to contents page

1. Rose quartz
2. Faults
3. Pacific Ocean
4. Mt St Helens
5. Opal
6. Basalt
7. Obsidian
8. Scoria cones
9. Basalt
10. Alluvium
11. Caldera
12. Limestone
13. James Hutton
14. Venus
15. Alluvial fan
16. Quartzite
17. Rocks
18. Aluminium and oxygen
19. Percolation
20. Aquifer
21. South Africa
22. Mars
23. Lithosphere
24. Aristotle
25. Seven
26. Stones
27. Kuiper Belt
28. Carboniferous

THE ORIGIN OF UNUSUAL BEACH DEPOSITS AT ACHILLES POINT, MUSICK POINT AND OTATA ISLAND, AUCKLAND

Ian Simpson and Bruce W. Hayward

Introduction

This paper discusses the origin of the unusual matrix of breccia/conglomerate deposits first described by Hayward (2012) after an Auckland Geoclub trip around Musick Point in March 2012. That paper also mentioned ostensibly similar cemented beach rock 100–200 m south of Achilles Point (Gentlemen's Beach). Subsequently, Hayward (unpub.) has also noted similar beach deposits on Otata Island in the Noises Island Group (Fig 1). The origin of these black- and brown-stained breccia matrices has been the subject of much discussion. One possibility was that the black matrix was airfall ash from the Rangitoto eruption or from Motukorea basaltic beach rock sand that had been redistributed on these beach sites. Another was that the matrix was degraded pitch or tar.

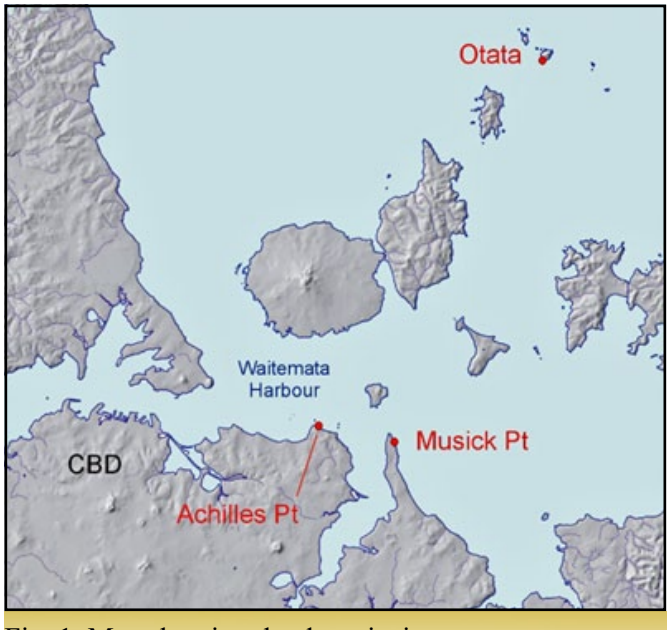


Fig. 1. Map showing the deposit sites.

Description of the Deposits

The deposits are all between mid and high tide levels and are at the foot of the sea cliffs. The Musick and Achilles Point deposits consist of Waitemata Group lithologies with mostly mudstone and sandstone clasts embedded in a fine black or brown-stained matrix containing sand. Most of the clasts are pebbles or cobbles, although some are much larger. Some of the pebbles are rounded, suggesting they have been subject to water and wave movement. The Musick point deposits are welded, hard, and brown stained from limonite (Figs 2 & 3), while the other deposits have a softer matrix. At Achilles Point, the deposits in one area form part of the wave platform, while in other areas they appear to be plastered onto cliff sandstone (Figs 4 & 5). The exposure at this site varies with sand movement and is sometimes almost completely obscured by beach sand. The Otata deposit is a shell and sand deposit stuck in a crack in the greywacke rocks by a black cementing material.



Fig. 2. Musick Point eroded remnant of a deposit plastered onto the high tide platform at the base of the sea cliff.



Fig. 3. Closer view of cemented, brown-stained deposit at Musick Point.



Fig. 4. Deposit forming part of the wave platform at Gentlemens Bay east of Achilles Point.

Table 1. AMS radiocarbon ages for shells at Achilles Pt (Ach 1) and Otata I. (Ota 1). Dates have been calibrated (2 sigma) using the MARINE20 calibration curve and ΔR for the Auckland region of 156±34 yr. Radiocarbon dating supplied by Waikato University Radiocarbon Laboratory (prefix Wk) and GNS Science Rafter Radiocarbon Laboratory (prefix NZA).

Sample no.	Lab. no.	Dated material	Radiocarbon age (yr BP)	Calibrated age (AD) 2 sigma
Ach 1	NZA73454	single *Austrovenus* shell	778±25	1714–1953+
Ota 1	Wk54425	single *Tucetona* shell	616±21	1802–1953+

An attempt at geochemical fingerprinting of the Achilles Point matrix, to test the hypothesis that this was of volcanic ash origin, was unsuccessful as the material was said to be too degraded.

Mollusc Bivalve Shell Radiocarbon Dating of Matrices at Achilles Point and Otata

The matrix at Archilles Point and Otata contained embedded shells (*Austrovenus stuchburyi* and *Tucetona laticostata* respectively) that were suitable for radiocarbon dating. The shells were not orientated in a life position and were incorporated in the matrix (Figs 6 & 7). The radiocarbon dates are shown in Table 1. The calibrated ages show that the shells became incorporated in the matrix relatively recently, presumably from beach and wave platform shell debris of greater age than the matrix itself. These dates are outside the eruption time for Rangitoto calculated to be 600–620 years ago from carbon^{14}, and geochemical fingerprinting. Shells from Musick Point have not been dated and could be of a different age.



Fig. 5. Breccia at Achilles Point (Gentlemens Bay) plastered against a sea cliff turbidite.



Fig. 6. Otata deposit with incorporated shells in a crack in the greywacke country rock.

Heavy Fuel Oil (Bunker oil) spills from shipping in the Hauraki Gulf

After the first world war, ship fuel moved from coal to fuel oils. Heavy fuel oil, also called Bunker Oil, is the residual fuel after the distillation of crude oil. It is highly viscous and contains contaminants of sulphur and heavy metals. On degradation from sun, oxidation and sea water, there is loss of volatiles, causing increased viscosity and solidification, leading to tar and finally asphalt. Petroleum asphalts are made up of resins, asphaltenes, aromatic hydrocarbons with multiple carbon rings and long chain saturated hydrocarbons. Asphalt chemicals are all very resistant to further breakdown. Elemental carbon makes up 86% of asphalt (Chen *et al*. 2022, Wang *et al*. 2020). When specimens of the matrices at Archilles Point and Musick Point were heated with a propane gas torch, the only residue was sand and a very small amount of ash.



Fig. 7. Shells incorporated in matrix at Achilles Point.

Oil seeps are not known in the Hauraki Gulf, but spills of heavy fuel oil were recognised as a problem in New Zealand waters in the 1920s. The "Oil in Territorial Waters" Act was passed in 1926 and imposed a fine of not exceeding 500 pounds for discharge of oil into territorial waters. In 1927, the Niagara captain was fined for two charges of discharging oil. In 1935, the Auckland Harbour Board reported that during the past seven years there had been "a large number of instances of oil escaping from ships into the harbour, but only 18 had been definitely traced to particular ships and prosecutions had followed." (New Zealand Herald 1935). It was noted that a considerable amount of damage had been done to pleasure craft in the harbour, and some of the bathing beaches had been affected. Several other prosecutions were reported in the New Zealand Herald, including one in 1945 where an estimate of 1000 gallons was spilled and escaped into the harbour and was dispersed by the tide before the oil could be cleaned up (New Zealand Herald 1945).

It seems most likely that the black tar-like deposits at Achilles Point and Otata were the product of heavy fuel oil spills, probably 80 or more years ago, which were concentrated by wind and wave action and subsequently incorporated cobbles, pebbles, sand, and seashells. After many years, the deposits so formed appear geological rather than organic.

The harder cemented matrix at Musick Point may be older with a longer time for the mineralisation, or alternatively could require another explanation.

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Return to contents page

The perils of ChatGPT - artificial intelligence that answers your questions. Or does it?

Request from Peter Crossley, Geoclub Member and expert on Auckland's lava caves:
"Tell me about the Ruapotaka Shaft, Mt Wellington."

ChatGPT answer: The Ruapotaka Shaft is an historic mining feature located on the slopes of Mount Wellington in Auckland, New Zealand. It is part of the wider history of mining activities in the Auckland region, which was particularly active during the late 19th and early 20th centuries when gold mining was a significant industry in New Zealand. Here are some key points about the Ruapotaka Shaft and its historical context:

1. **Location:** The Ruapotaka Shaft is situated on the southeastern side of Mount Wellington, which is an extinct volcanic cone and one of Auckland's iconic landmarks.
2. **Mining History:** The Ruapotaka Shaft was used for gold mining, which was carried out in various parts of the Auckland region in the late 1800s. Gold was discovered in the area in the mid-1800s, leading to a gold rush and the establishment of numerous mining operations.
3. **Underground Mining:** Like many gold mines of that era, the Ruapotaka Shaft would have been used for underground mining. Miners would have descended into the shaft to access gold-bearing quartz veins deep underground.
4. **Abandoned Facility:** The Ruapotaka Shaft, like many historic mining operations, was eventually abandoned as the gold resources became economically unviable to extract. It is now a remnant of Auckland's gold mining heritage.
5. **Heritage Significance:** The Ruapotaka Shaft and other mining relics in the Auckland region hold historical and cultural significance. They serve as a reminder of the region's mining past and the challenges faced by early miners.
6. **Access:** While the Ruapotaka Shaft is a part of Auckland's history, access to the site may be restricted, and it's important to respect any barriers or safety measures in place. Visitors interested in exploring the area should check with local authorities or historical preservation organizations for more information.

Overall, the Ruapotaka Shaft on Mount Wellington is a part of Auckland's mining history and the significant role that mining played in the development of the region . . .

The rest of the article was not copied to me. - Ed.

This stuff needs to be outed and ridiculed.
*Ruapotaka Shaft is a **LAVA CAVE** on the **WESTERN** side of Mt Wellington. Be afraid, readers. Be very afraid! - Ed.*

A LATE CRETACEOUS SHELL FRAGMENT WITH EARLY MIOCENE BRYOZOA FROM THE WAITIITI FORMATION, HOKIANGA, REVEALS A COMPLEX HISTORY AND PALEOECOLOGY

Seabourne Rust

In the South Hokianga area of Northland, New Zealand, early Miocene sedimentary rocks of the Otaua Group overlie the Northland Allochthon, from which they are largely derived. We have been studying the Early Miocene Otaian Stage (21.7–19.0 Ma) Waitiiti Formation in an effort to record macrofossil distribution and diversity (Rust 2019 2020 2022, Rust & Yanakopulos 2011 2012), with results recorded on the New Zealand Fossil Record File (FR site # O06/f0121).

In the banks of the present-day Taita Stream near Waimamaku, the marine-deposited mudstone and sandstones of the Waitiiti Formation outcrop as a shallowing-up, north-dipping section, largely obscured and deformed by recent slumping and mass movement, adjacent to a ~10 x 5 km uplifted block of Tangihua Complex rocks known as the Waima Range (Wakefield 1977, Evans 1994).

The Waitiiti Formation in the Taita Stream consists of poorly-bedded, grey mudstone with scattered small molluscs, passing upward into layered mudstone and fine sandstone, with some coarser lenses or channel-fill deposits of larger lithic fragments and occasional worn macrofossils including ahermatypic corals, photosymbiotic large foraminifera and coralline algae/rhodoliths. Locally, the lithic fragments frequently show signs of bioerosion and encrustation. The majority of these rocks are reworked Northland Allochthon sandstones and mudstones of probable Cretaceous - Paleocene age. Some spherical concretions up to 1.5 m across contain fossil remains of a large marine inoceramid bivalve, possibly *Inoceramus australis* (Fig. 1), indicating they are likely sourced from Late Cretaceous Piripauan stage (~83 Ma) Punakitere Sandstone.



Fig 1. Part of a reworked Late Cretaceous Punakitere Sandstone concretion containing pieces of the bivalve *Inoceramus* shell, exposed in section. Collected from the Taita Stream Waitiiti Formation locality, Waimamaku.

These older rocks might represent part of the 'bedrock' of an Early Miocene shallow shoal or perhaps euphotic-mesophotic zone reef - a rocky seafloor that formed a significant hardground upon which a diverse epifauna could develop. This habitat once existed on the western fringes of proto-Northland, covering an area being progressively uplifted, to eventually form the Waima Range.

Here we note the occurrence within the Waitiiti Formation of a 5 x 6 cm piece of reworked *Inoceramus* valve (Fig. 2), indicated by the prismatic shell structure when viewed in cross section, which is ~5 mm thick (Fig. 3). This Cretaceous shell fragment reveals a long and interesting history as it has been exposed on the sea floor during the Otaian and encrusted by a diverse assemblage of bryozoan colonies (Fig. 4) and was bored through at

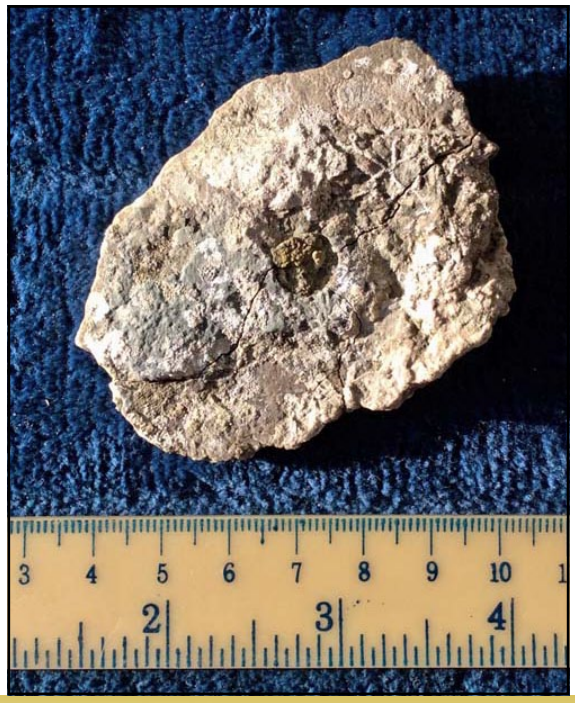


Fig 2. Encrusted piece of inoceramid bivalve shell from the Waitiiti Formation, Taita Stream, Waimamaku.



Fig 3. Encrusted inoceramid shell in section showing characteristic fibrous/prismatic calcite.

some stage (circular borehole at centre), probably by a pholad bivalve (Rust 2022).

Encrusting bryozoan taxa on this specimen include a minimum count of two cyclostomes: *Tubulipora* sp. and *Desmediaperoecia* sp., and ten cheilostomes: *Aimulosia* sp., *Celleporina* sp., *Crassimarginatella* sp., *Hippomenella* sp., *Inversiula* sp., *Micropora* sp., *Phonicosia* sp., *Puellina* sp., *Smittina* sp. and *Smittoidea* sp. Other colonies were difficult to identify due to preservation.

Minimum bathymetric ranges recorded for comparable modern taxa of encrusting bryozoans from the New Zealand area (e.g., Gordon 1984 1989), reveal the depth ranges of most of these genera are typically (although not restricted to) shallow shelf habitats, with an overlap of the overall Waitiiti Formation encrusting taxa also consistent with deposition at approximately 20–50 m depth. Hence we can consider the ‘‘proto-Waima Range” area to have been uplifted at least to shallow shelf depths at some stage by the late Otaian.

Local sedimentation must have been low over long periods on the stable shallow shoal/reef edge site to favour bryozoan larval settlement and growth, and avoid burial. Most of the reef-derived lithic and biogenic material from the Waitiiti Formation at the Taita section exhibit ample evidence of bioerosion and diverse epibiont encrustation. Despite undergoing regional uplift, local habitats may have been relatively stable for years to decades. But occasional overturning of some smaller pebble- and cobble-sized clasts and rhodoliths, probably during storm events, is suggested by the concentric growth of coralline algae and a covering of encrusters on all surfaces.

The Taita Stream section of the upper Waitiiti Formation assemblage as a whole suggests some mixing of shallow

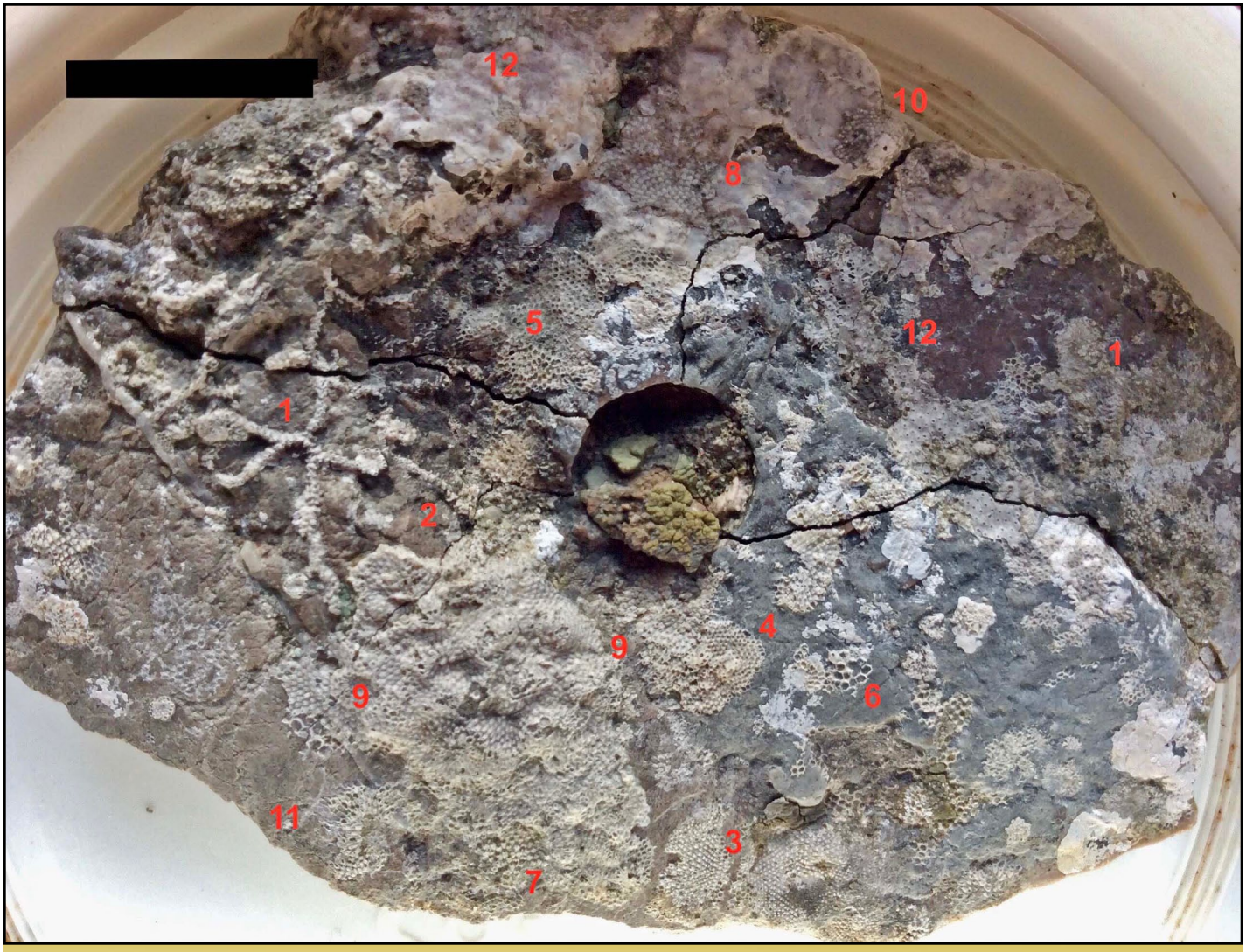


Fig 4. Diverse bryozoan colonies encrusting inoceramid shell, with circular boring at centre, Waitiiti Formation, Taita Stream, Waimamaku. Width of view = 50 mm. Key to bryozoan colonies: 1. *Desmediaperoecia* sp., 2. *Tubulipora* sp., 3. *Aimulosia* sp., 4. *Celleporina* sp., 5. *Crassimarginatella* sp., 6. *Hippomenella* sp., 7. *Inversiula* sp., 8. *Micropora* sp., 9. *Phonicosia* sp., 10. *Puellina* sp., 11. *Smittina* sp. and 12. *Smittoidea* sp.
Black scale bar (top left) is 10 mm long.

and deeper water faunal elements. The encrusted *Inoceramus* shell fragment, along with the displaced macrofossil components of shallow water to mesophotic-derived reef corals, rhodoliths, mollusc shells and bryozoan-encrusted lithic clasts, were eroded, moved downslope and subsequently redeposited in a slightly deeper water marine setting, perhaps nearing mid-shelf depth, as indicated by microfossils (Hayward, in Evans 1994). Hence the deposit can be interpreted as a 'displaced thanatocoenesis', a number of which are found in other comparable Miocene basin-filling strata of northern New Zealand (cf. Hayward & Triggs 2016). Some twenty million years later, this fossil-bearing sequence is now finally exposed once again, this time on land, after the Waitiiti Formation rocks were uplifted as part of the Waimamaku Anticline and subsequently eroded by the Taita Stream, flowing down from the Waima Range.

So to conclude, this ~80+ million year old piece of shell, encrusted by ~20 million year old bryozoans, gives us evidence of several chapters in a fascinating and complex local history.

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Return to contents page

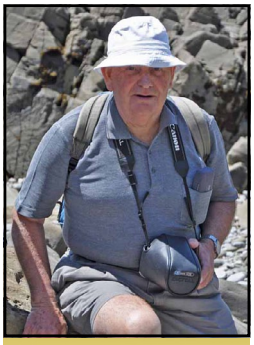
MEMORIES OF WARREN SPENCE, GEOCLUBBER EXTRAORDINAIRE 1992–2019

Bruce W. Hayward & Hugh R. Grenfell

Warren Spence was a staunch member of Auckland Geology Club for 26 years. Although never a formal committee member, his never-ending support earned him the title of a de-facto member for all those years. He heard of the proposal for the establishment of a geology club in 1992 through his attendance at a series of geology-themed lectures run by Auckland Institute and Museum. He signed up as one of the foundation members at the first meeting.



Warren Spence, Okura Walkway, 1998



Warren with camera as always, Mangawhai Heads, 2012

Although he lived out at Manurewa with his brother, Warren would drive in and attend almost all of our monthly meetings, initially held at the Museum, then later at the University and in more recent years at Epsom Community Centre. He also attended the majority of our field trips, half day, full day and multi-day, often providing lifts for participants in his trusty Nissan Maxima. He was very generous with his time, and on many occasions would go out of his way to pick up George Wingate from the nearest station or from his home in Mt Albert. At meetings Warren was often one of the first to arrive and last to leave, and invariably helped ready the room and tidy up afterwards.



Warren (right), Murray Baker and Alan Nelson, Runaruna mud volcano, 2003.



From left: Warren, Malcolm Simpson, Peter Daymond-King and Helen Holzer, downtown Auckland's old sea cliffs, 2007.

Warren had a quiet and relatively shy personality, but would chat away to members when approached. As a result, he invariably sat near the back of the lecture room and was never heard to ask a question, yet his understanding of what was said was remarkable. On field trips he was often at the back of the circle and taking pictures with his large SLR camera. Despite encouragement, he never brought any of his photos in to the club to share with us on member's evening or other occasions. In earlier times he would always offer to carry the rather large first aid kit in the field and became our regular "tail-end-Charlie", who could be relied on to stay at the back of the party in the field and make sure we did not leave anybody behind as we moved off from stops.

Because he was quiet, we seldom heard from him about his past career and life. Occasionally, he would speak of his work as an engineer for Air New Zealand, servicing their airplanes at Auckland's Mangere Airport. We also knew of his love and skill as a glider pilot and instructor for Auckland Gliding Club at Appleby Road, Drury. He must have had some amazing aerial photographs. A search of the web shows that he was awarded Gliding New Zealand's premier award, the Friendship Cup, in 1994 for "outstanding contribution to the gliding movement in NZ". Another historic mention of Warren's skills as a younger man is recorded on the web, for June 1960:

> "The Marlborough Gliding and Soaring Club's height record was broken yesterday morning by Mr Warren Spence, Woodbourne, who achieved 16,000ft in a 110-minute flight. The previous record was 12,000ft set by Mr Spence and Mr Bruce Hargraves, formerly of Woodbourne. Yesterday's flight was limited in height by lack of oxygen and the extreme cold - minus 12 degrees Centigrade. Mr Spence was towed to 5,000ft and released over the Wairau Bridge. He gained his elevation in a wave lift parallel with the hills."



Warren Spence in his glider after breaking Marlborough gliding altitude records in 1960.

Warren was deceptively fit, having recovered completely after heart surgery in Germany in 1996. Many of us have our own memories of club events involving Warren and his wry smile. Among the more memorable were his unplanned swim in Lake Wakatipu in 2009 (something he did more than once trying to get the perfect photograph – the camera was always fine but Warren wet); his badly damaging his thumb with his hammer while collecting fossils at Whakapirau Road in 2001, and getting lost in 2017 on the northern motorway with George while trying to drive to Army Bay, Whangaparaoa and catching us up 2 hours late at lunch time at the end of the peninsula.



Warren with Jurassic fossils and smashed thumb, Whakapirau Road, 2001.

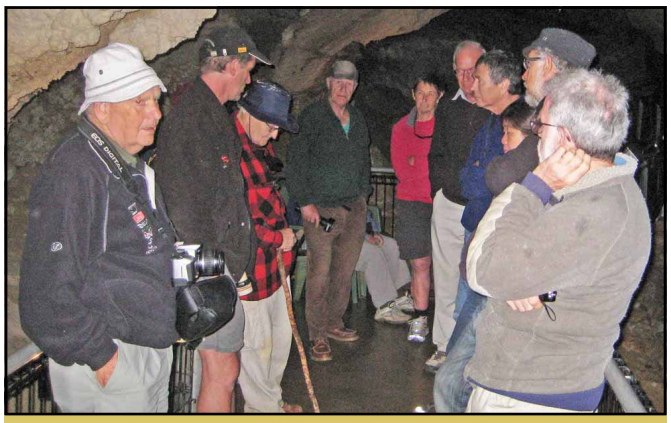
All of us who knew Warren still miss his presence and helpful nature at Geoclub activities. He passed away after a short illness in December 2019, aged 82.



From left: George Wingate, Warren, Peter Scott and Peter Daymond-King, Klondyke Road, Port Waikato, 2011.



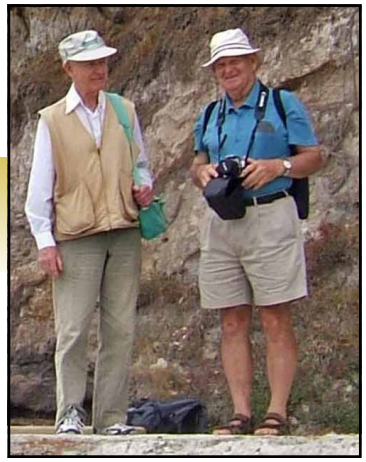
From left: Peter Crossley, Peter Daymond-King and Warren crossing Waitakere River mouth, Te Henga, 2016.



From left: Warren, unknown, Peter Stewart, Peter Daymond-King, Helen Holzer, unknown, Trevor Goldschmidt, Peter Crossley and George Wingate, Ruakuri Cave, Waitomo, 2010.



Betty Headford and Warren, Conway Coast, north Canterbury, 2011.



Warren (right) and Keith Eyre, St Kentigern cliffs, 2007.



Warren (left) and Geoclub party, Lake Pukaki, 2014.

Return to contents page

HYPERLINK INSTRUCTIONS

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

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

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

Return to contents page

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