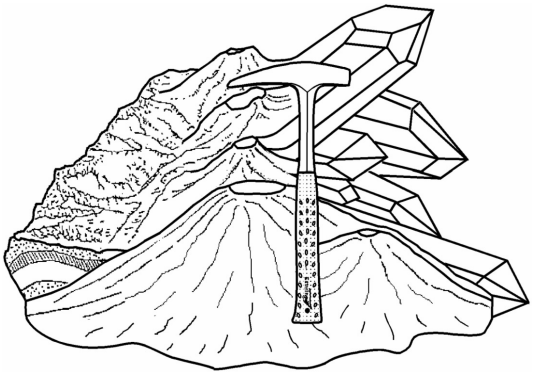


Geocene

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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.

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CORNWALLIS FORMATION BLOCKS IN WAITOMOKIA TUFF RING DEPOSITS, MANGERE

Bruce W. Hayward

In July 2005, a group of fifteen Geoclubbers walked along the newly restored foreshore exposures of Waitomokia tuff ring and discovered numerous large blocks (up to 1 m across) of unusual Waitemata Group rocks enclosed in the lapilli tuff deposits. For 45 years this section of coastline had been hidden and inaccessible as it was the edge of one of the Mangere sewage oxidation ponds that had been created out of the former intertidal flats between Puketutu Island and the Mangere lowlands. In the early 2000s, the sewage plant was switched to onland treatment and the oxidation ponds removed and returned to their former intertidal state.

Alongside the Watercare walkway at around high tide level, there is near continuous 200 m long exposure of part of the Waitomokia tuff ring deposits (Figs. 1–2). The exposure is along strike and mostly comprises ~1 m thick bed of basaltic lapilli-tuff containing numerous pebble, cobble and boulder-sized exogeneous blocks (up to 1 m across; mostly 0.1–0.5 m).



Fig. 1. Location of Waitomokia tuff ring shoreline exposures.



Fig. 2. View southwest along the high tide exposure of Waitomokia tuff.

Rock types in the blocks

These blocks range in shape from rounded (softer lithologies) to angular (harder lithologies) (Figs. 3–4).

The majority of the blocks are derived from the lower Miocene Waitemata Group and consist of a range of lithofacies:

a. Common blocks of fine pebble conglomerate in a volcaniclastic coarse sand matrix grading up into medium sandstone (Figs. 3, 5–6). The pebbles are angular to rounded and composed of a wide variety of rock types, particularly fresh grey andesite, oxidised red andesite, cream-grey mudstone (from Northland Allochthon);
b. Common thick, massive to graded, volcaniclastic, medium-coarse sandstone (Figs. 7–8), sometimes with concretions (cemented around mudstone rip-up clasts);
c. Minor massive grey mudstone.

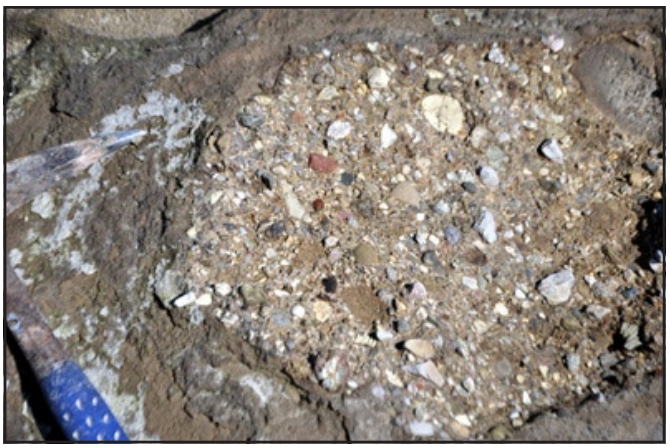


Fig. 3. Subrounded block of massive conglomerate (Cornwallis Formation) with pebbles of a mix of sedimentary and volcanic rock types.



Fig. 4. 20 cm clump of angular blocks of indurated cream, fine sandstone (Waitemata Group) that appears to have broken into several pieces on impact.



Fig. 5. 50 cm block of bedded pebble conglomerate and sandstone typical of Cornwallis Formation.



Fig. 6. 30 cm block of fine pebbly volcaniclastic grit of probable Cornwallis Formation.



Fig. 7. 30 cm subrounded block of massive volcaniclastic medium sandstone.



Fig. 8. 30 cm block of cross-bedded fine-medium sandstone (Waitemata Group).

Age of the blocks

One sandstone (lithofacies b.) was calcareous and when processed, contained a rich foraminiferal fauna with >80% planktic foraminifera indicative of deposition beneath open oceanic water at bathyal or abyssal depths. Age-diagnostic species present (*Globoquadrina dehiscens*, Ld–Tt; *Catapsydrax dissimilis*, L–Po; *Globigerina woodi*, late Lw-W) give an early Miocene (late Lw–Po) age placing the rocks clearly in the Waitemata Group.

Correlation of the block rock types

Lithofacies a. conglomerate does not occur in the Waitemata Group of central and Auckland area (East Coast Bays, Pakiri, Paremoremo, Blockhouse Bays Formation). The closest match within the above formations are heterolithologic pebble conglomerates around Albany (Bartrum, 1920) but these also contain well-rounded diorite, basalt and argillite pebbles. The best match of the Waitomokia conglomerate blocks is with the younger (still Otaian, Po, in age) Cornwallis Formation (Jones and Martin, 1965) which outcrops through the eastern foothills of the Waitakere Range and on the northern coastline of the Manukau Harbour around Cornwallis (Fig. 9) (Hayward, 1976; Kermode, 1992). Cornwallis Formation has also been tentatively identified outcropping on the southern shores of Manukau Harbour at Glenbrook Beach, near Waiuku (Hayward, 1976) (Fig. 9).

Implications for Mangere Lowland geology

Augustin-Flores *et al*. (2014) showed that nearby Maungataketake volcano's explosive activity mostly occurred at shallow depths within the ~60 m of Pliocene-Pleistocene shelly sand and silt (Kaawa Formation) and rhyolitic sediment (Tauranga Group) that overlies the more consolidated Waitemata Group. Both Maungataketake and nearby Puketutu (Fig. 9) have well-exposed tuff ring deposits containing similar-sized blocks of Waitemata Group lithologies to those at Waitomokia (Augustin-Flores *et al*., 2014; Hayward, 2009), but neither have blocks akin to Cornwallis Formation (pers. obs.). It is likely that these Waitemata blocks were derived from the upper parts of the Waitemata sequence beneath each volcano and therefore that Cornwallis Formation lies at shallow depth beneath Waitomokia and not beneath the other two. There is believed to be about 800-1000 m of Waitemata Group beneath the Cornwallis Formation (Raza *et al*., 1999) and thus I infer that Mesozoic

basement is at this depth beneath Waitomokia and it is shallower to the west and south beneath Puketutu and Maungataketake. Maybe Waitomokia is sited within a narrow graben striking NE–SW like many of the faults of the Manukau-Franklin lowlands to the south (Kenny *et al*., 2012).

The inferred depth (800–1000 m) of basement rocks beneath Waitomokia is in contrast to its depth encountered in drillholes to the north at Mt Roskill (600 m) (Edbrooke *et al*., 1998) and to the west at Grahams Beach, Awhitu (390 m) (Waterhouse, 1989). This illustrates the inferred structural complexity that likely occurs within the Waitemata Group and older rocks beneath the Manukau Harbour (e.g., Kenny *et al*, 2012), which today just looks like a simple low-lying depression.

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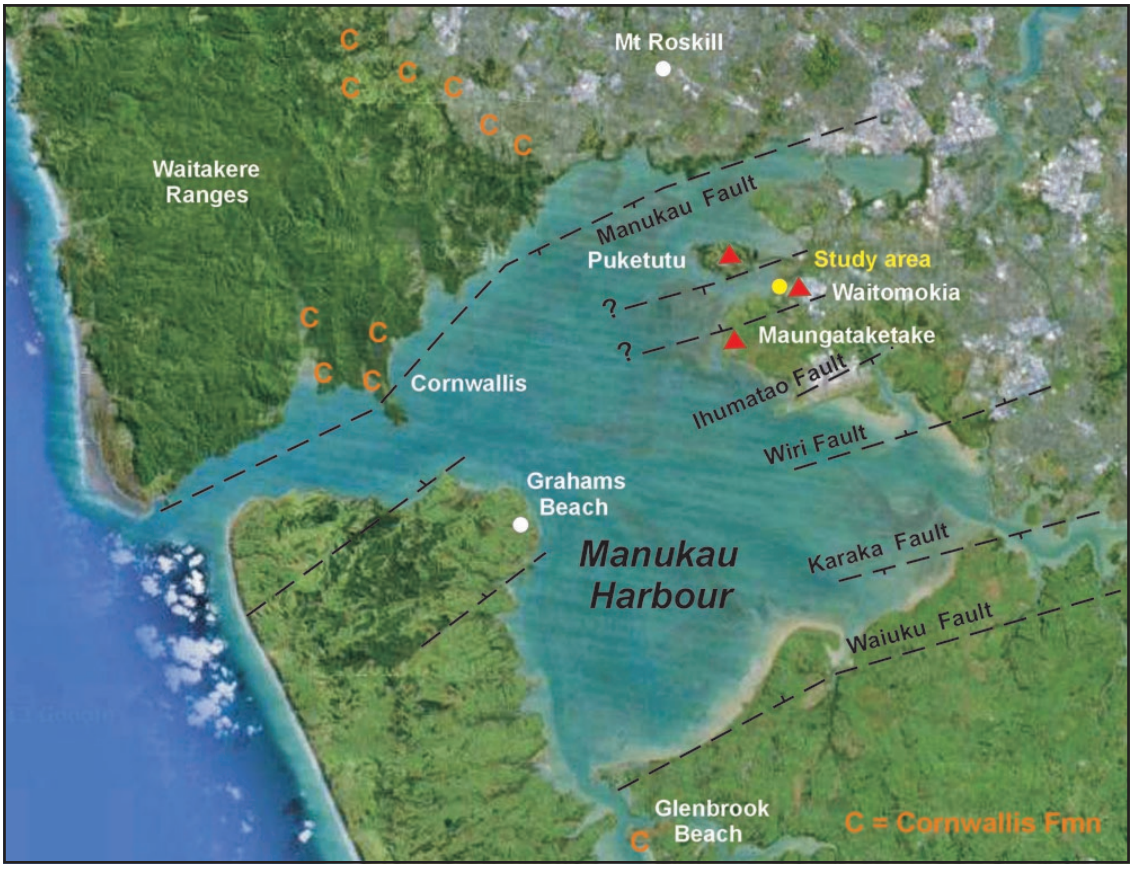


Fig. 9. Locations mentioned in the text and the nearest surface outcrops of Cornwallis Formation. Named faults are from Kenny *et al*. (2012) and questioned faults are possible to explain the presence of Cornwallis Formation blocks in Waitomokia tuff.

JUST 600 YEARS OF EROSION ON RANGITOTO'S COAST

Peter Daymond-King and Bruce W. Hayward

In June 2014, 25 Geoclubbers took advantage of the closure of Rangitoto wharf (for replacement) and visited the east end of Rangitoto from the Islington Bay wharf landing. For most, it was their first trip along the less-civilised track across the lava flows to Wreck Bay (Boulder Bay) on the north coast.

Most visitors to Rangitoto only see the coastline on the sheltered southern or western sides, where erosion has been minimal (Figs 1–2) and many surface features of the lava flows are still exposed (e.g. Hayward, 2012). In the most sheltered embayments on the south side, marine mud has accumulated intertidally and mangroves are growing.

The scene along the northern coast is quite different however. Most of the coastline consists of subvertical cliffs, rising 5–8 m above MSL (mid tide), eroded into Rangitoto's basalt lava flows (Figs 3–4) with occasional pocket bays backed by pebble, cobble and boulder beaches (Fig. 5). Sitting having lunch at Wreck Bay, we reflected on the fact that what we were seeing was the work of marine erosion over just 600 years since Rangitoto was formed (Lindsay *et al*., 2011). Our trigonometric calculations based on cliff height and average flow slope of about 10° suggests that in this short time the northern coast has been eroded back by 20–40 m. This is 3–6 m per 100 years, which is as fast as, or even faster than, the rate at which the softer early Miocene Waitemata Sandstone cliffs are retreating just across the water at Takapuna. Why might the harder basalt rock be eroding at a faster rate than the sandstone in a similar exposed setting?



Fig. 1. Part of the un-eroded, sheltered southern coastline of 600-year-old Rangitoto Island.



Fig. 2. Lava flow lobes and other surface features are well-preserved on the un-eroded southern coastline of Rangitoto Island. Photo: Near Rangitoto wharf.



Fig. 3. The basalt lava flows along the more exposed northern coastline of 600-year-old Rangitoto Island have been eroded back into 4–8 m high cliffs.



Fig. 4. Part of the eroding northern coastline of Rangitoto Island with caves and arches having been picked out by wave attack on loose rubbly breccia and along cooling joints within the basalt.



Fig. 5. Most of the northern coastline is steep eroding cliffs but in a few places these are interrupted by pocket beaches of rounded cobble and boulder gravels.

The sandstone cliffs are mostly retreating because of fretting of the sand and mud as it is alternately wet and dried, especially in the lower parts of the cliffs just above high tide level and the scree that accumulates is carried away by the tides. Yes there is also some mechanical erosion, where the waves get in along fractures and the compressed air and water open up the fractures and the pounding waves and sand grains abrade the shore line. On Rangitoto, the lava flows are almost as fresh and hard today as when they were erupted. There has been little weathering and yet the coastal erosion rate is high. This is clearly a result of the cooling joints/fractures that cut through the solidified lava at irregular spacings of ~0.1–1 m. In some places within and between flows there are loosely cemented breccias of basalt rubble and scoria. Physical erosion by the waves has eroded out many of these breccia lenses and layers and worked its way along the fractures, creating intertidal crevices, caves and overhangs (Fig. 4). The pounding waves open up the fractures and periodically, especially during storms, blocks of basalt lava fall out of the cliff to be tossed around in the intertidal and subtidal zones above wave base.

The day we visited Wreck Bay the sea was almost flat calm offshore and for most of the time this shore is subject to only mild wave activity with waves less than 0.5 m high. Rangitoto is well inside the shelter of the Hauraki Gulf, but periodically during large storms or tropical cyclones the northern coastline can be subjected to strong northerly or northeasterly waves (up to 3–4 m high). We hypothesise that the majority of the physical erosion on this coast of Rangitoto occurs during these large storms.

Perhaps the most eye-opening aspect of the erosion on Rangitoto's north coast was the size and degree of rounding on some of the boulders thrown up high on the beach in Wreck Bay (Fig. 6). At and above high tide there was a large storm beach deposit of rounded to subrounded cobbles and boulders of basalt (many 1 m or so in diameter). The rounding of these boulders could only have occurred when the waves were strong enough to jostle and move them about or at least throw the cobbles against them. Some of the larger boulders in the high tide beach would be well over 1 tonne in weight and yet storms within just the last 600 years have eroded them from the lava flows, bounced them around like balls, sufficient to shape them into giant rounded masses with polished sides.

So how big would a wave have to be to move a cubic metre of basalt? Within waves, there is little water transport in open water but it is significant near the shore. The effect is larger where there is a steep rise from deeper water to the shoreline, as on the northern coast of Rangitoto. The density of basalt is about 3 times that of water, so that a cubic metre of basalt weighing 3 tonnes would be equivalent in weight to a wave containing a 1 metre squared cross section of water 3 metres long. Any wave higher and longer than this could potentially move the basalt. Since the corners of a large block of basalt would easily be abraded by smaller cobbles thrown at it by wave action, it is only



Fig. 6. Garry Carr inspects the high tide storm beach deposits of rounded basalt boulders and cobbles at Wreck Bay (Boulder Bay) on the north coast of 600-year-old Rangitoto Island.

necessary for the block to be moved and overturned very occasionally for significant rounding to occur. Moreover, a succession of large waves does not appear necessary in order to overturn the block.

A 1.5 metre wave (typically with a wave length of about 33 metres and speed of 6 metres per second) could potentially move a cubic metre of basalt situated at the level of the wave trough. Given that the boulders observed were up to several metres above mean sea level, a wave of 3 to 4 metres in height should turn over a cubic metre boulder of basalt without difficulty. Wave height records for this particular area do not seem to be available.

Key factors in determining wave height are wind speed and fetch - the uninterrupted distance of open water over which the wind blows without significant change in direction. A wave height of 4 metres could be created by a wind of 56 kph and fetch of 518 km. It would travel at approximately 9 metres per second. It is clear that there is insufficient fetch to the city side of Rangitoto for such waves to form but is it possible that such waves would be created from the north to the east of Rangitoto?

Records from Rakino and Whangaparaoa extracted from data held by NIWA show the following number of days with wind gusts of >61 kph and >95 kph which could create waves of between 3 and 4 metres in height:

Table 1. Number of days with wind gusts of >61 kph and >95 kph. Source: NIWA, 2014.

Rakino			Whangaparaoa		
	>61 kph	>95 kph		>61 kph	>95 kph
1987	74	4	2012	73	5
1988	110	10	2013	60	6
1989 (2 mths)	15	1	2014 (7 mths)	50	1

Winds from between north and east of Rangitoto will have the longest fetch and thus create the largest waves. Wind direction is available only for some maximum monthly gusts in the region.

Table 2. Proportion of maximum monthly wind gusts from the northeast quadrant. Source: NIWA, 2014.

Station	Years	No. of Observations	North–East	Percent
Leigh	1973–2014	417	203	49%
Whangaparaoa	2012–2014	27	15	56%
Mechanics Bay	1955–1961	82	35	43%
Auckland City	1972–1990	225	64	28%
Whenuapai	1972–1993	251	49	20%

If maximum monthly wind gusts are used as a proxy for storm conditions, then it is clear that about 50% of them strike Rangitoto from the north east quadrant. (Topography appears to significantly modify wind direction and speed in the inland and city areas). Available wind and calculated wave data thus readily explain the erosion and rounding observed since the eruption of Rangitoto.

In a report to the Auckland City Council on coastal inundation and storm tides prepared, NIWA (2013) calculated the frequency with which storms with waves of between 3.15 metres and 4.27 metres would strike the coast of Rangitoto. Their estimates suggest that over 530 storms with waves of greater than 3.15 metres would strike in a period of 600 years which is in general agreement with the calculations above.

Sometimes the speed of geological processes can be a lot faster than one would imagine!

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QUIZZES

Know your volcanoes. Match photos 1 – 5 with volcano names A – E.
(Answers on last page)

1.



2.



3.



4.



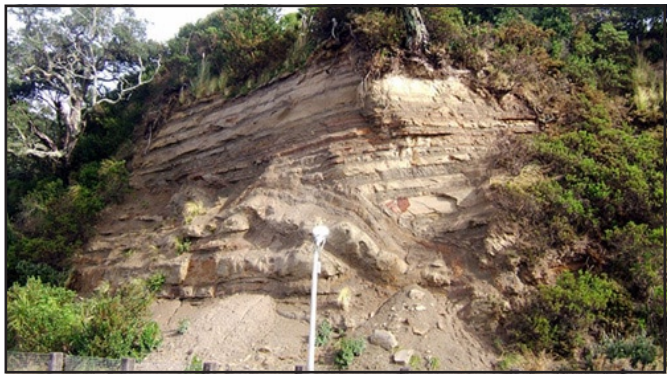
5.



Possibilities to choose from:-

A Green Mount
B Mt Albert
C Mt Roskill
D Mt Victoria
E Mt Wellington

Where is this Waitemata Group cliff?
(Answer on last page)



Possibilities to choose from:-

a Emu Point, Motutapu Island
b Mission Bay / Bastion Point
c Long Bay, southern end
d Cape Horn, north coast Manukau Harbour
e Whangaparaoa Head

FOSSIL FOREST EMERGES FROM BENEATH TAKAPUNA BEACH

Bruce W. Hayward

In May 2014, the sands near low tide at the middle of Takapuna Beach shifted and exposed the long buried remains of an ancient forest. Many long-time locals say they have never seen it before, although some of the soft sticky mud that it is buried in has been uncovered in other parts of the beach on odd occasions in the past. Locals met on the beach variously speculated that this was the remains of an old scow that was washed up on the beach decades ago or another example of the forest that was killed and buried by volcanic ash from Pupuke Volcano.

Examination of the site, showed that this fossil forest consists of many small tree stumps in growth position in an ancient soil (Figs 1–3). The trees colonised the surface of a thick white rhyolitic ash deposit, and in turn have been buried and preserved by another thick creamy-white volcanic ash bed. The fossil forest consists of in-situ tree stumps, mostly less than 15 cm diameter, but at least one close to 1 m in diameter. Also present in the 10–15 cm black, organic-rich paleosol are the black carbonised remains of fallen branches, twigs and roots and several 5–10 cm lumps of kauri gum. In places the volcanic ash has weathered to clays and is soft and sticky, but in other places it has been hardened by remineralisation and some of these rocks stick up 30 cm above the present beach level.

A similar sequence of white volcanic ash and peat occurs in Shoal Bay and was exposed a few years ago by earthworks when the Esmonde Rd interchange for the northern motorway was being enlarged. Other thick rhyolitic ash and ignimbrite deposits with interbedded peat and in-situ fossil forests also occur in a number of low-lying parts of Auckland, such as Pakuranga, Takanini and Waiuku. Elsewhere they have been dated at close to 1 million years old and the caldera eruptions traced back to a buried caldera volcano near Mangakino in the centre of the North Island (Alloway *et al*., 2004).

History tells us that it will not be too long before the sands shift back and once again bury Takapuna Beach's hidden secret - the oldest fossil forest on the North Shore.

Reference

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Figs 1–3. In-situ trunks of small trees stick out of the black paleosol between two rhyolitic ash deposits near low tide, off the end of Park Ave, in the middle of Takapuna Beach, May 2014.

HELVETIA VOLCANO – A NEWLY RECOGNISED TUFF RING AND MAAR IN THE SOUTH AUCKLAND VOLCANIC FIELD

Bruce W. Hayward

The South Auckland Volcanic Field has received far less attention from geologists than its younger, better preserved and more accessible cousin in Auckland. Hochstetter (1864, in Fleming, 1959, p. 87–90) was the first to comment on the general nature of the geology of this area. He believed the volcanic field was mostly composed of basaltic conglomerate and breccia, because numerous rounded boulders lay around on the surface as they still do today. Where erosion was deeper he noted the presence of massive basalt lava flows but did not realise that the surface boulders were a result of deep spheroidal weathering along fracture planes in the original lava flows. He noted the absence of scoria cones in the Pukekohe area and commented on the exceedingly fertile soil in the vicinity of Tuakau (and Pukekohe). He noted that the basaltic rocks overlay Quaternary lignite and rhyolitic sediment and were therefore also of Quaternary age (younger than 2.6 million years), but from the depth of weathering and erosion he concluded they were much older than Auckland's volcanoes. These observations still hold true.

The first geologist to start identifying the volcanoes in the central Pukekohe part of the South Auckland field seems to have been Day (1948) in his unpublished MSc thesis at University of Auckland. Schofield (1958) published the first moderately comprehensive map of the field showing the centres of each of the volcanoes he recognised. Around Pukekohe he recognised Pukekohe Hill cone, a "flat dome" at Puni Domain, a cone north of Paerata, and three explosion craters east of Pukekohe.

In another Auckland University MSc thesis, Rafferty (1977) produced a map of the extent of all the lava flows and centres he recognised in the field and this has formed the basis for many of the subsequent published maps (e.g. Cameron *et al*., 1997; Cox and Hayward, 1999; Hayward *et al*., 2011; Nemeth *et al*., 2012), although there have been some modifications and additions by Roger Briggs and Adrian Pittari as a result of their own work and that of some of their students at Waikato University (e.g. Rosenberg, 1991; Cook, 2002; Ilanko, 2010; Gibson, 2011; Taylor, 2012). Rafferty (1977) recognised 82 volcanic centres (volcanoes) in the South Auckland Volcanic Field and these were documented with names in the New Zealand Geopreservation Inventory (Kermode *et al*., 1992). With the more recent work at Waikato University, a few of the names have been changed or modified and these appear in Nemeth *et al*. (2012)'s map. K-Ar (potassium-argon) dates of the basalt rocks have been obtained from 43 of the volcanic centres and these were presented in Briggs *et al*. (1994) and indicate that the field was active between 1.6 and 0.5 million years ago.

South Auckland Volcanic Field

This field (also sometimes known as the Franklin Volcanic Field) extends from Papakura in the north to Pukekawa in the south (south of the Waikato River) and from Waiuku in the west to Hunua Falls in the east. It is a field of over 80 relatively small monogenetic volcanoes (or volcanic vents). Monogenetic means that each volcano erupted in a single relatively short episode and never erupted again.

Because they are much older, the South Auckland volcanoes are more weathered, more eroded and not as well preserved as those in the younger Auckland field. Unlike the younger Auckland volcanoes, those in the South Auckland Volcanic Field have been draped in thick rhyolitic and rarer andesitic volcanic ash, up to 5 m thick (Lowe, 2010). This Hamilton Ash was mostly erupted between 300,000 and 500,000 years ago from centres in the Taupo Volcanic Zone. Much of this ash has been washed off the more undulating and higher parts of the field, like the tuff rings and the Hunua Ranges, but many of the gently sloping lava flow fields of the shield volcanoes are still deeply buried by this ash cover. Weathering of this thick ash, where it is preserved on the gentler shield volcano slopes beneath a dense native forest cover, has produced thick, red-brown volcanic soils that the Pukekohe-Bombay area is famous for. These soils are widely used for the growing of horticultural crops wherever they occur.

The South Auckland Volcanic Field can be divided into three geographic areas. The eastern third of the field occurs in the western parts of the Hunua Ranges. Here it consists of numerous eroded remnants of lava flows and scoria cones (mostly older than 1 myrs) that erupted from a number of vents, commonly along major fault lines that cut through or form the margin of the uplifted greywacke basement rocks. The second area is the southern part of the South Auckland Volcanic Field located in the uplands to the south of the Waikato River. Many of the volcanoes in this area erupted in the latter part of the field's history and the volcanic landforms, including a number of scoria cones, are the best preserved in the field. The third, and largest area of the South Auckland Volcanic Field forms most of the relatively low-lying land between the Waikato River in the south and Manukau Harbour in the north, and between the Manukau sand dune barrier in the west (Waiuku) and uplifted Hunua Ranges in the east (Bombay). This lowland area is underlain by younger sedimentary rocks, some of which (like the Pliocene Kaawa Shellbeds) are major groundwater aquifers. Magma coming up through this wet ground appears to have always started erupting as wet explosive eruptions producing maar craters surrounded by tuff rings. In a number of instances the voluminous rising magma

then switched to the outpouring of lava flows that built extensive gently sloping, overlapping shield volcanoes that are only just recognisable in the landscape. The newly recognised Helvetia Volcano is within this third area of the field, just north of Pukekohe.

Helvetia Volcano

This previously unrecognised volcano lies 2 km northwest of the centre of Pukekohe, north of the three shield volcano centres of Pukekohe Hill, Puni Domain and Pollock Rd, and west of the maar craters and tuff rings of North Pukekohe and Rooseville North (Fig. 1). Six knolls and low arcuate ridges of tuff define a 2 km-long, 1.3 km-wide, oval-shaped ring (Fig. 2) that encircles a flat-floored "crater" (Fig. 3). The three eroded ridge remnants lie between Hart and Heights Rd and, at 73–85 m above sea level, define the north side of this indistinct crater (Fig. 2). A shorter NW–SE-oriented ridge (81 m above sea level) is crossed by Hart Rd where tuff is exposed in a road cutting. It defines the western edge of the crater. The most prominent tuff ring remnants are two steep-sided NE–SW-oriented knolls (95 and 102 m above sea level) that lie between Kauri and Rifle Range roads (Fig. 4). They rise 30 and 40 m above the flat floor of the crater to the north and have steeper slopes on their northern sides, inside the crater (Figs. 5–6). Bedded tuff is exposed on the northern side of these knolls.

Between the eroded tuff knolls and ridges on the western side of the tuff ring, the topography is uneven (Fig. 2) and appears to be composed of basalt lava flows from Pukekohe Hill or Pollock Rd shield volcanoes that have flowed through two gaps in the tuff ring and into the western end of the crater. The western quarter of the crater floor is uneven and sloping gently eastwards into the crater (Fig. 2) and is presumably directly underlain by weathered basalt flows. The remainder of the crater floor is almost perfectly flat but slopes very gently to the west to the outflow stream channel at the toe of the lava flows in the northwest. This gently sloping flat is composed of, or at least capped by, alluvium and peaty soil that has filled up the originally deeper crater, which undoubtedly also contains 3 m+ of Hamilton Ash.

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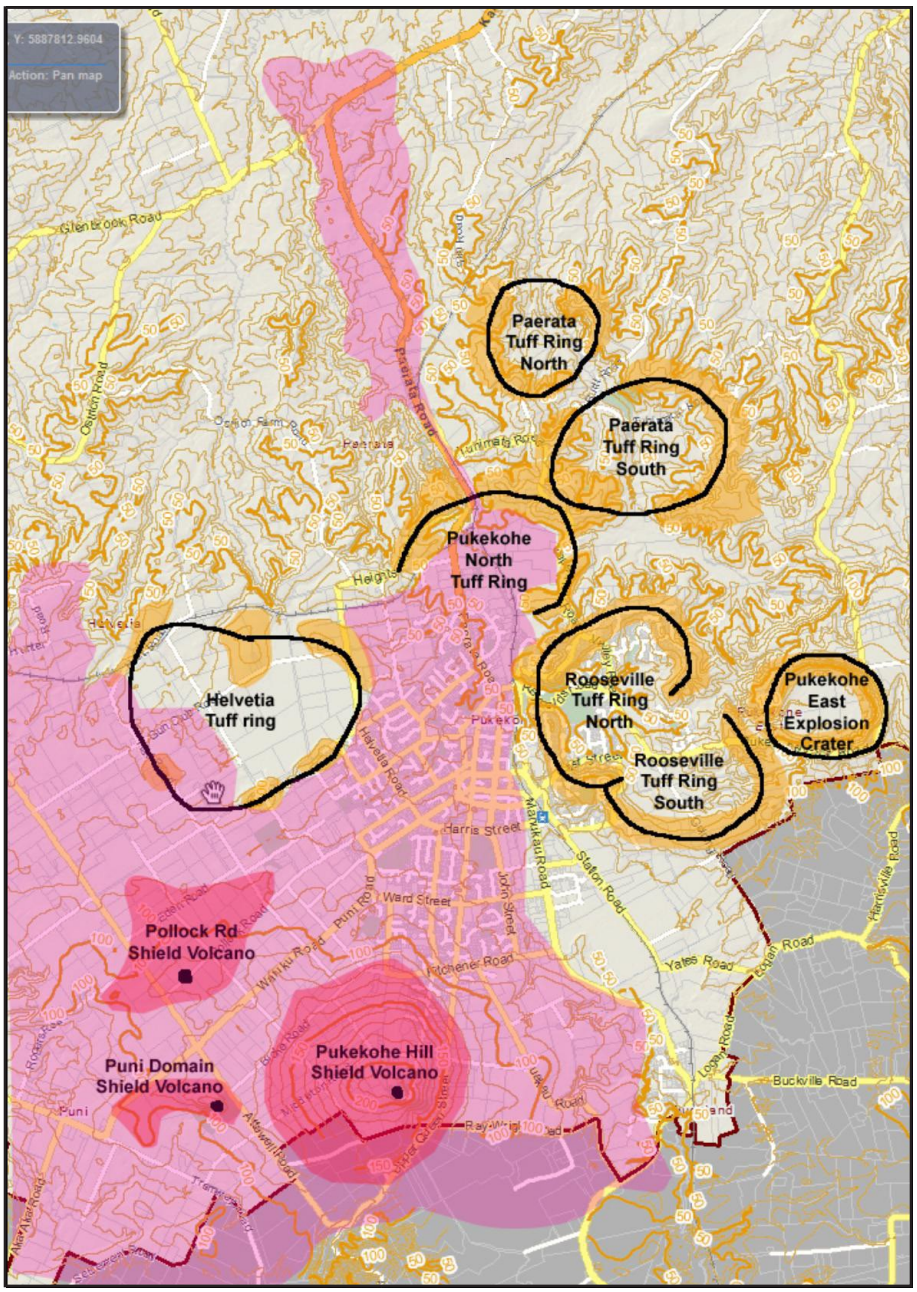


Fig. 1. Map of the Pukekohe portion of the South Auckland Volcanic Field showing the location of tuff rings/craters (orange), shield volcanoes (red) and the full extent of their lava flows (pink). Newly-recognised Helvetia Volcano (tuff ring) lies north of Pukekohe Hill shield volcano.

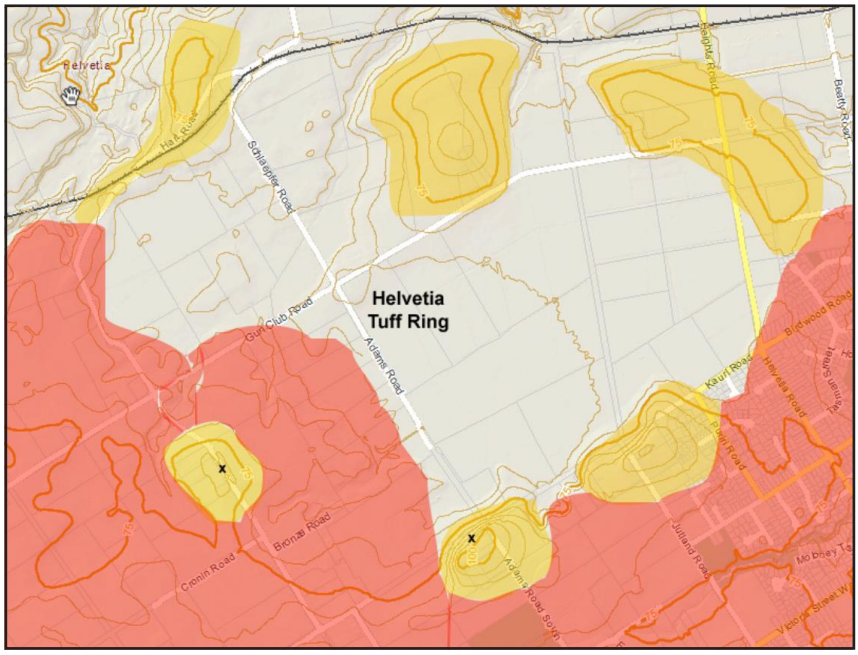


Fig. 2. Map showing the circular distribution of tuff ring remnants (yellow) that outline the Helvetia Tuff Ring. Pukekohe Hill lava flows (dark orange) appear to have entered the crater from the southwest side. Exposures of tuff are shown with crosses.



Fig. 3. View west and north from Helvetia Rd across the flat floor of Helvetia Crater.



Fig. 4. View south from Gun Club Rd across Helvetia crater to the tuff ring remnant on the southern side.



Fig. 5. View from Adams Rd across the floor of the crater to one of the tuff ring remnants on the south side of Helvetia Tuff Ring.



Fig. 6. View east to the Adams Rd tuff ring remnant on the south side of Helvetia Tuff Ring. Note the steeper slope (left under the trees) on the inner northern side of the tuff ring hill.

MOVING MAUNGA

Malcolm S. Simpson

On the 10th May 1844 the European inhabitants of the fledgling town of Auckland witnessed a gathering of some 3000 – 4000 Maori from tribes in central and northern New Zealand. The gathering was hosted by the prestigious Waikato chief Te Wherowhero and chief Wetere Te Kauae. It was called a Paremata - a feast given in return for favours - but probably the principal reason was the enhancement of the mana of the powerful Waikato tribes and a display of their power to both local Maori and the European settlement. Governor Fitzroy was well aware of the presence of a contingent of armed Maori far in excess of the European population of 2,500 including 60 soldiers. He was suitably impressed and in despatches to the British Colonial Secretary suggested an increase in the military. In the event, relations between Maori and the settlers at the gathering were cordial.

The Daily Southern Cross, in an article titled "Native Feast", contained the following description:

"The preparations for the feast were enormous. A wall of potatoes in baskets extended nearly for a quarter of a mile, covered on top with several thousand dried sharks and dogfishes. Opposite to this potato wall was a shade of the same length, covered with blankets which were intended as presents to their guests…The day and the scene were peculiarly delightful.
"The natives fixed upon one of the most lovely spots of the town for the scene of their festivity. The tents and huts occupied a level plain, surrounded by three gently rising hills, from the tops of which the proceedings on the plain could be seen with much advantage."

Governor Fitzroy, visiting the Feast with his staff, described the scene taking place in a "natural amphitheatre" and an eye witness ascended Mt St John from which he obtained a view of the whole scene. Also observing the happening was artist Joseph Merrett. He made a water-colour sketch, later filling in with pen finer detail to produce a panoramic view 840mm wide. During the year following, the sketch was transferred to a lithograph, which, while retaining the general layout as shown in the original sketch incorporated some embellishments and a series of numbered points of interest annotated at the base of the picture. Of significance were the hills numbered Mt Hobson-1, Mt Eden-2, and Three Kings-21. These annotations were to provide a conundrum the solution of which is still unclear.

We now jump forward some forty-five years when the "Auckland Star" newspaper produced Bretts 1890 Almanac (Brett was the proprietor of the Star) with an insert of the 1845 lithograph enhanced with two tints and named "Maori Feast at Remuera" (Fig. 1). It is likely that the circulation of this lithograph stimulated an interest as to where in Remuera the scene took place. Given the elapse in time from 1844, there would have been very few of the eye witnesses still alive in 1890 to assist in resolving the question.

Sometime before 1908, Dr Hocken of Dunedin, a prominent art collector, bibliographer and researcher, acquired the original water colour sketch and a copy of the 1845 lithograph. His collection of art, manuscripts, etc., were bequeathed to Otago University following his death in 1910 and are now known as the Hocken Collection - a large and important archive. As part of the Collection record relating to the two pictures is the following in ink



Fig. 1. Brett's Almanac 1890 enhanced lithograph of the Feast (detail) showing prominent hill, named Mt Hobson, with Mt Eden in rear right.

and in Dr Hocken's hand:

"... the artist of this primitive watercolour was Joseph Merrett, [1816? –1854] *a former resident of NSW and interpreter. It was lithographed at home with some alterations which are an improvement on the original. Judging from its rarity, this lithograph must have made a scanty sale….N.B. The site of the Feast being quite forgotten & frequent inquiry failing to locate it, I devoted some time in 1908, aided by Mr Allom of Auckland to its discovery. The hill in the foreground of the picture is the foot of Little Rangitoto* [Maunga Rahiri] *now reserved for quarry purposes. Mountain Road* [now named Upland Rd] *runs through it thus forming an additional landmark. This gives a sufficient key to the position…"*

This assertion as to locality was based upon the relative positions of Mt Hobson and Mt Eden in the lithograph and Dr Hocken (and others) used these geographical positions to postulate the site of the observer (artist). Hence the site of the Feast lay between Little Rangitoto and the eastern slopes of Mt Hobson two kilometres away crossing two deep gullies. Hardly the natural "amphitheatre" described by Fitzroy.

Consideration has to be given to the possibility that the identification of Mt Hobson in the lithograph is incorrect. If we assume the prominent cone in the middle of the lithograph is *Mt St John*, which follows that the artist was viewing the scene of the Feast from the lower slopes of Mt Hobson, we then have a better approximation of the relative position of Mt Eden and the view of the "amphitheatre" stretching just over 500 metres to Mt St John (Fig.2). Unfortunately, what appears to be a nice solution to the enigma is compromised by the position of the Three Kings in the lithograph, shown as two distant hills to the far west. From Mt Hobson the Three Kings lie to the south west. Furthermore, from Mt Hobson the view of the Three Kings is blocked out by the bulk of Mt St John.

So there does not appear to be any realistic explanation of the artist's placement of the three mountains. Was the picture a composite, the background of the cones just added to give verisimilitude to the view? Art historian, Leonard Bell, has drawn attention to the differences between the watercolour and the lithograph as far as the grouping of the Maori and Governor Fitzroy are concerned, moving from a spectacle of force by the Maori in the watercolour to a more benign view in the lithograph "downplaying the sense of animation of the Maori figures in favour of a more orderly and calmer scene, in which attention is directed towards Fitzroy, as if he was presiding over the event". Thus the lithograph becomes a political statement.

Whatever the motivations of the artist, the recording of the Feast is an important and interesting part of early Auckland history, even if his geographical placements are perplexing. Fitzroy moved very quickly to make both Mt Hobson and Mt St John reserves, despite opposition from early landowners, an act which can only be applauded. Unfortunately, Little Rangitoto has completely disappeared and Three Kings largely quarried away.

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Stone "From Tamaki Makau Rau to Auckland" (2001)



Fig. 2. Map from Google Maps of the relative positions of volcanic cones mentioned in the text. Red X marks the location of the Feast.

UNDERSTANDING MAUNGAKIEKIE / ONE TREE HILL VOLCANO – SOURCE OF ITS LAVA FLOWS

Bruce W. Hayward

Summary

The availability of a high precision LiDAR contour map of the topography of One Tree Hill volcano has made it possible to prepare a more accurate map of this volcano's scoria cone complex and the elevational distribution of extruded viscous lava flow terraces with steep flow fronts located most of the way around the lower outer slopes of the cone. This mapping allows the recognition of two levels of viscous lava flow expulsion - one at approximately 110 m above sea level and the other at about 130 m. I argue that the recognition of these two levels at many places around the cone and within the craters is not pure coincidence but relates to the last two phases of lava expulsion, after the majority of lava fountaining from the craters had ceased. During each of these two phases I infer that the molten magma in the near-surface plumbing was linked throughout the volcano's plumbing so that the lava levels in all feeders was approximately the same at any time.

I propose a simple model for the eruption sequence of One Tree Hill. Most of the sequence was a result of high rates of magma rise with rapid eruption of both frothy and highly fluid hot lava. Late in the volcano's life, magma rise and eruption rates are inferred to have slowed as the rising magma cooled, became gas-poor and progressively more viscous.

The scoria cone was built by fountaining of frothy lava from just the three craters. The single summit was a result of a late stage wind-blown fountain of scoria largely landing in one area on the northeast crest. I infer that the two southern craters were breached by out-flowing fluid lava fairly early during the scoria cone construction and that their conduits remained closely linked and their lava levels and breached lip elevations remaining in concert throughout their lives. I also infer that vast quantities of hot fluid lava pushed its way through the base of the scoria cone to pour from vents or rifts around most of the lower slopes of the scoria cone complex. Over time these vents migrated up the slopes, as the surrounding lava flow levels built up.

The fluid lava from the base of slope vents and from the breached craters escaped into several steeply incised south-flowing branches of the Onehunga tributary of the Manukau River system. Eventually these branch valleys were completely filled with solidified lava flows forming quite steep lava flow slopes down to the Manukau lowlands on the east and south sides. On the northern side of the cone the fluid lava first filled the dammed upper portions of these south-flowing valleys, creating a flat lava flow field extending beneath the showgrounds before it spilled over the crest of the main sandstone divide and may have flowed off down as far as Newmarket and under parts of Mt Eden's lava flow field.

As the supply of magma slowed late in the eruption sequence, the amount of gas coming out of solution in the magma is inferred to have decreased and frothy scoria fountaining waned. The erupting lava slowed, cooled and became more viscous with the penultimate phase of expulsion producing terraces and steep flow fronts from magma squeezed out on all sides of the cone and from the two breached craters at an elevation of about 110 m. Following a short stage of cooling that blocked some of the near surface plumbing within the volcano, the final phase of viscous lava expulsion was from new higher vents at about 130 m elevation on the north and south slopes and from a small area on the east side.

Introduction

In 2010 a group of 16 Geoclubbers visited Maungakiekie/ One Tree Hill volcano but never climbed to the summit as we usually would. Instead we spent 3 hours circling the lower slopes and fields inside Cornwall Park and One Tree Domain examining the relationship between the scoria cone and the lava flows that were extruded from around its base. These contacts do not appear to have been examined in great detail in the past, possibly because the rocky rubbly original surface of most of One Tree Hill's lava flows have been blanketed and buried by 3–5 m thickness of fine scoriaceous volcanic ash erupted from neighbouring Three Kings volcano, 28,500 years ago (Kermode, 1992; Lindsay *et al*., 2011). Although this thickness of ash would have been deposited over all of Maungakiekie volcano, most of it appears to have washed off the steeper slopes of the scoria cones and lava flow fronts. The gentler slopes of the lava flow field has, however, been converted into smooth fields within the park, except for a few scattered clumps of high-standing basalt lava flow blocks sticking up through the ash cover. The best place to see a section through the Three Kings ash overlying One Tree Hill scoria is in a small disused quarry on the south side of the southwest breached crater.

Previous work

Mapping by Hochstetter (1864), Searle (1962) and Kermode (1992) has shown that One Tree Hill extruded the second largest quantity of magma in the Auckland Volcanic Field and that the resulting lava flow field extends as far as Newmarket, Ellerslie, Penrose, the Onehunga foreshore of Manukau Harbour and west beneath most of the suburbs of Royal Oak and Epsom. Their studies, summarised by Kermode in Kermode *et al*. (1992) indicated that One Tree Hill was probably older than all its nearest neighbouring volcanoes (Fig. 1). One Tree Hill lava flows are clearly overlain by the younger ash from Three Kings, Te Hopua and Mangere volcanoes, and by the lava flows from the younger Mt Eden, Mt Wellington and Mt Smart volcanoes. Kermode also suggested that One Tree Hill lava flows underlay flows from Mt Hobson and scoria from Mt St John, but I suggest that this relationship is not so certainly established. Nevertheless, it is quite clear that when One Tree Hill began erupting on the Auckland Isthmus (maybe 50–100,000 year ago) it erupted over a rolling countryside of small valleys and ridges cut into the underlying Waitemata Sandstone, covered in forest and largely unmodified by the volcanic products from other even earlier Auckland volcanoes. The location of One Tree Hill was just southeast of the

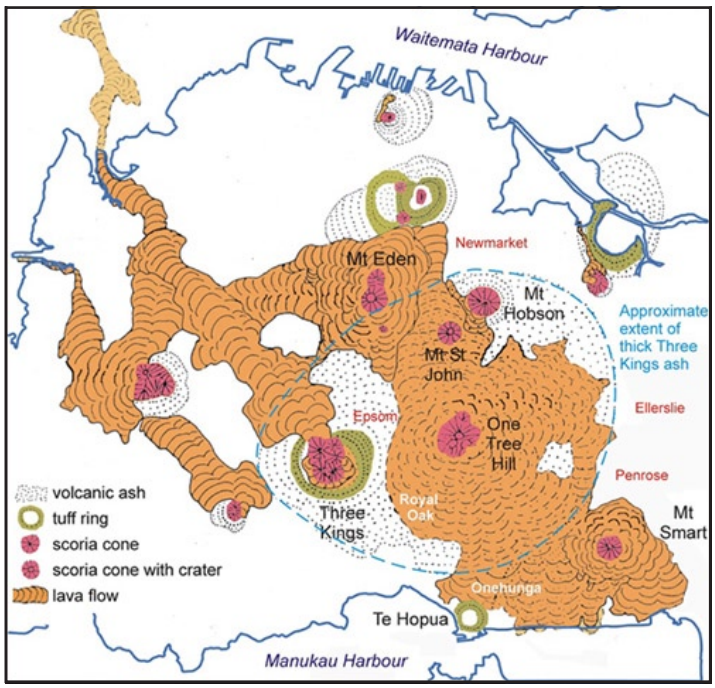


Fig. 1. Map of the volcanoes of central Auckland (from Hayward *et al*., 2011).

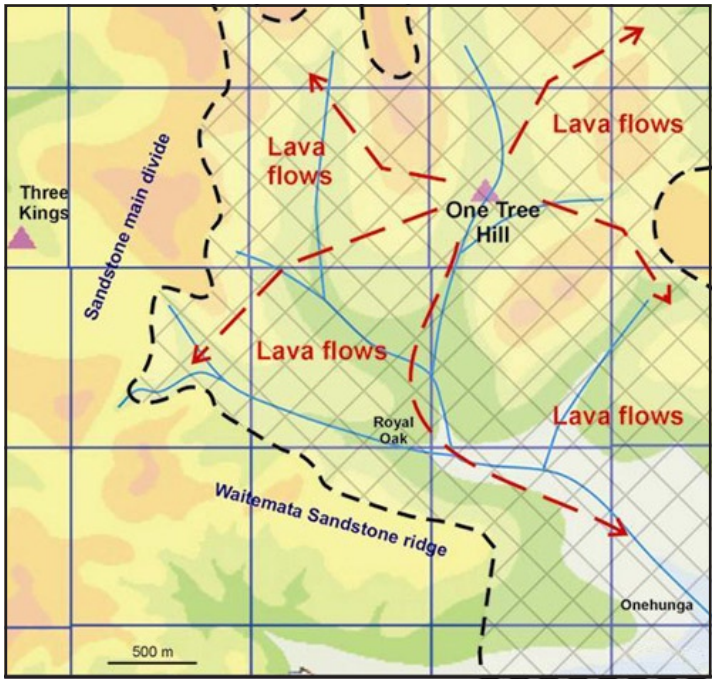


Fig. 2. Shaded contour map of the inferred pre-volcanic topography of valleys and ridges eroded into the underlying Waitemata Sandstone rocks in the vicinity of One Tree Hill volcano (from Kenny *et al*., 2012). The map indicates how the initial fluid lava from One Tree Hill flowed south down the tributaries of the Onehunga branch of the Manukau River system. On the north side of One Tree Hill the fluid lava flows were was ponded in the upper reaches of these tributaries before they overtopped the main divide in the vicinity of present day St Cuthberts College.

main water-catchment divide between the Waitemata Valley in the north and Manukau Valley to the south (Fig. 2).

Hochstetter (1864) noted that One Tree Hill scoria cone appeared to overlie a gently sloping tuff ring on its northern side. As pointed out by Searle (1962) we can now see that this area is underlain by lava flows and the tuff he saw was the blanket of ash from Three Kings on the surface. Searle (1962, 1964) noted that One Tree Hill's scoria cones sit "above a broad lava field that forms a steep pedestal at the foot of the cone." Searle (1962, p.215) seems to have been the only one to previously make observations on the geology of the lower slopes of One Tree Hill's cone(s) and infer an eruptive sequence: "Two important areas of emission are marked by breached craters on the southwest and southeast flanks of the scoria mound, but much lava also originated from lower levels in the same area, as is shown by lava mounds at the base of the scoria cone. Outflow to the north at a high level formed a marked buttress of solid rock the surface of which falls steeply in the direction of outflow into a fan of lava now covered by ash. Early activity in both these sectors appears to have been predominantly effusive, with lava gushing from a number of vents to produce massive flows. During late phases, eruption became more explosive, and cone-building was completed."

Geological map

With the recent availability from Auckland Council of the LiDAR contour map of Auckland, with contours as precise as 0.5 m apart, it is now possible to produce a far more accurate map of the scoria cones and lava flows within One Tree Hill Domain and Cornwall Park (Fig. 3). The roughly circular scoria cone has three craters, two breached (southwest and southeast) and one intact in the north. The 182 m high summit is a peak on the east rim of the main crater rising 15–20 m higher than the rest of the circular rim (Fig. 4). The two breached craters have smooth, gently outwardly sloping crater floors (mantled by thick ash) with their mouths both at the same elevation of 112±1 m.

About three quarters of the basal perimeter of the scoria cone complex is surrounded by steep lava flow fronts (10–20 m high). The only portions of the scoria cone with no apparent lava flow terrace and steep front are inside the craters and in two places on the western side. There are two steep lava flow fronts in the south. The lowest of these two fronts (Sth 1) has its crest at 105–108 m, which is slightly lower than the crests of the western front (112 m, in private property) and eastern front (110–112 m). These three lower fronts form the outer edges of flat to gently-sloping ash-covered terraces that are up to 200 m wide in the south (Sth 1) and 100 m wide elsewhere (East and West) (Fig. 5). The other two lava flow fronts (Nth, Sth 2) have their crests 15–20 m higher at 125–135 m. They also have narrower (30–80 m wide) terraces above. The small north terrace (to the west of



Fig. 3. New geological map of Maungakiekie/One Tree Hill volcano within the Domain and Cornwall Park.



Fig. 4. Oblique aerial view from the south over One Tree Hill scoria cone complex showing the summit peak with intact northern crater to the left and two breached craters to the left and right in the centre. The south 2 flow front and terrace has extruded through the southern outer slopes of the scoria cone between the mouths of the two breached craters.



Fig. 5. The steep lava flow front east, seen here in 1899, was extruded as viscous lava forming an extensive terrace at about 110–115 m on the lower eastern slopes of the One Tree Hill scoria cone. Photo by Hugh Boscowan, Auckland Museum collection.

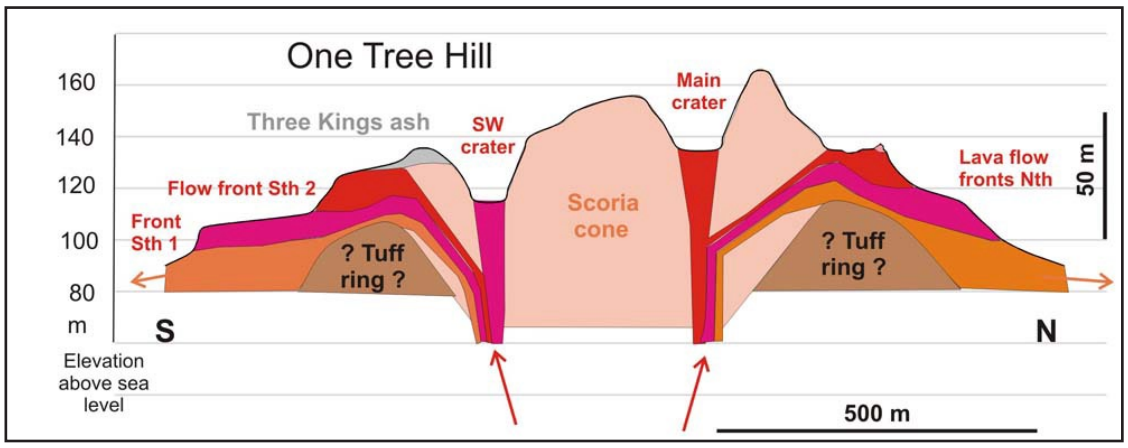


Fig. 6. North–south cross-section through Maungakiekie scoria cone and lava flow terraces with inferred simplistic internal structure.

the Cornwall Park kiosk) is more complex than others with a spur of lava extending northwards from the base of the higher front (current road level) and having its own front with a crest at 115 m. The higher northern terrace has a rounded knoll 3 m above the rest that could be some ash-mantled rafted scoria, but there is no exposure to test this hypothesis. The southern terrace (Figs 4, 6) is deeply buried by Three Kings ash, as seen in the disused quarry face (Fig. 7), and the lava forming it, appears to have been extruded to an elevation of 130 m, just 10 m below the crest of the scoria rim of the southwest crater. There is also a small exposure of extruded lava at 130 m elevation on the scoria slopes just outside the mouth of the southeast crater, on its northern side.

The contours on the ash-buried lower lava flows beyond the base of the scoria cone complex give indications of the flow directions of some of the more fluid flows, as shown by the black arrows on the map (Fig. 3). The ridge beneath Sorrento Restaurant in the southwest has a slightly higher knoll composed of a rubbly basalt lava flow, inferred to be produced by lava flow processes and



Fig. 7. 3–5 m of thinly bedded wind-blown, scoriaceous ash, erupted from nearby Three Kings volcano 28,500 years ago, mantles all the lava flows and flatter surfaces of One Tree Hill volcano but has washed off the steeper slopes and lava flow fronts. It is best seen in the old quarry face on the south side of the southwest crater.

probably does not mark an additional vent where lava may have been extruded, although this possibility cannot be ruled out. Perhaps the most prominent ash-mantled lava flow (here named Kiosk lava flow, Fig. 3) extends from the gap between the north and east flow fronts, in the vicinity of the kiosk, and slopes gently away down to the northeast fanning out as it goes. The main Cornwall Park access road from the roundabout to the kiosk ascends the surface of this prominent flow.

Inferred eruption sequence

Less speculative conclusions

There is no evidence to suggest whether One Tree Hill's eruptions began with a wet explosive phase and produced a tuff ring and explosion crater or not. If it did, all trace is now buried (Fig. 6). As with the majority (if not all) of Auckland's dry basalt eruptions, the initial phase was likely fountaining of frothy scoria as gas came out of solution in the magma with the pressure reduction as it reached the surface. Soon after this phase started, hot fluid lava probably started flowing out from around the base of the growing scoria cone. The initial direction and spread of these highly mobile flows would have been determined by the underlying valleys that it flowed down (Fig. 2). Fluid lava that flowed out to the north was ponded in the upper reaches of several small branches of the Onehunga tributary of the Manukau River system (Fig. 2), creating a fairly flat lava flow apron (underneath the present day showgrounds-Alexandra Park and surrounding area) before some flows overtopped the divide and spilled downhill towards Mt St John, Newmarket and Mt Eden areas. To the east, west and particularly the south, the lower stretches of these and other branch valleys of the Onehunga tributary stream were steeper and deeper (Kenny *et al*., 2012) and the hot fluid lava would have raced off down these to the Manukau Lowlands where they came to a halt in the vicinity of the now flooded Mangere Arm of the Manukau Harbour. The voluminous fluid lava that spilled out in these directions in a series of flows cooled and congealed, filling up the valleys to create an extensive, moderately-sloping lava flow field that now lies beneath the suburbs of Greenlane, Penrose, Oranga, Onehunga, Royal Oak and Epsom. All these flows must have been

relatively fluid and thus were still extremely hot when extruded from around the base of the growing scoria cone and probably also from the breached mouths of the southwest and southeast craters. This contrasts with the flows that congealed and solidified with steep flow fronts (Figs 3, 6) around the lower slopes of the scoria cone. Their steep cooling fronts and short distances that they have flowed out away from the base of the cone tell us that they were slow-moving and highly viscous and therefore cooler than their highly fluid cousins that flowed like rivers down the valleys.

I infer that the three craters were the only significant vents that erupted fountains of frothy lava that built the scoria cone complex. Unlike Searle (1962), who thought the high summit mound was produced by unidirectional fountaining from one of the vents, I infer that a strong westerly wind during the final phases of fountaining caused most of fountaining froth to land on the eastern side of the intact crater rim.

Significant questions

1. Was the viscous lava that form the terraces with steep flow fronts that surround the scoria cone erupted early, during or towards the end of the eruptive sequence? Were they erupted before, after or interspersed with the hotter more fluid flows that appear to have come out from the same or lower elevations around the base of the cone complex?

Searle (1962) believed that these viscous lava flows that form the steep flow fronts on the lower slopes of the scoria cones were erupted early in the eruptive sequence, possibly at the same time or interspersed with the more fluid flows. I suggest that this is unlikely and that a more logical model would be that the hot fluid lava was erupted first with a high outflow rate bringing magma to the surface rapidly with voluminous fluid outpourings from the lower base of the growing scoria cone and breached craters. As the supply of magma from below dropped off, the rate of extrusion slowed and the lava became progressively cooler, more degassed and more viscous. With this model the extrusion of the viscous flows would have been among the last events in the eruption sequence. Unfortunately, I know of only one place where we see a contact between this viscous lava and the scoria cone. It is in a small bluff (former quarry face, Fig. 8) on the north side of the mouth of the southeast breached crater at 130 m elevation. Here at least 2 m of basalt lava overlies 1 m+ of scoria and clearly was extruded after this part of the scoria cone had been completely formed. This supports the hypothesis that the extrusion of the viscous lava occurred at the end of the eruptive sequence.

2. Is there some significance in the coincidence of elevation of the overflow lips of the two breached craters, as well as the tops of the east, west and south 1 flow fronts (at 105–112 m)?

I think the approximate coincidence in elevation of all these five areas of late phase lava expulsion is more than fortuitous. It is probably telling us that lava was expelled at all these five places at approximately the same time and that all the pipes or fissures carrying magma to the surface (in the two breached craters and on the lower eastern, western and southern slopes) were connected at shallow depth and contained sufficiently fluid magma that its upper level was approximately the same in all feeders. If the lower lips of any of these vents built up with congealing lava, the flow would stop there until the lip levels built up in all places.

It is interesting to contemplate the history of the two breached carters if we assume that their magma conduits were closely connected. There is no visible evidence of any scoria mounds that might have been rafted away downslope when each of these two craters was breached. Small mounds and more thinly spread rafted scoria could be hidden beneath the blanket of Three Kings ash, however. Thus we have no evidence as to when each of the craters was breached. There is no suggestion in the crater shapes and slopes that the breaching occurred late in the eruption sequence. I think we can safely infer that the breaching was fairly early on and that some of the fountaining frothy scoria from each vent landed on outflowing lava and was rafted away in small amounts as it landed. The breachings may have occurred at about the same time and conceivably could have involved initial thermal erosion into lower parts of the scoria cone and resulted in a lowering of the lips of one or both. If only one lip was lower than the other, the outflow may have temporarily stopped from the higher one. As there is no scoria built up in the breached mouths, I infer that most of the outflow was of surface flows and not through lava tubes inside flows with solidified roofs and that there was little fountaining in the final phases of the eruption sequence when the viscous lava was being expelled.



Fig. 8. Quarrying on the northern wall of the southeast crater in 1899, showing blocks of lava at 130 m above sea level in cutting at right end of face (below right hand tree on skyline). This face is still exposed today and shows the lava flow overlying scoria, proving that the lava was extruded after the scoria cone was fully formed. Photo by Hugh Boscowan, Auckland Museum collection.

The contour map (Fig. 3) suggests that towards the end of the period of expulsion of more fluid, hotter flows, the level of extrusion had risen to about 110 m and the last two of these more fluid flows flowed due east from the southeast crater and came out from the northern slopes as the Kiosk lava flow. From then on the magma became progressively more viscous, with lava extruded at about 110 m elevation from a number of vents along the lower eastern, western and south slopes. Similar viscous lava coming through the breached mouths of the two craters coalesced with that from vents on the western and southern sides to form the west and south1 flow fronts. The narrow lower toe of the north flow front (Fig. 6) may also have been extruded at this time.

3. Is there any significance in the coincidence in the elevation of tops of the south 2 and north flow fronts and the southern end of the east front (130–135 m) and also the floor of the intact crater (135 m) (Fig. 6)? Were these higher elevation viscous flows extruded before or after the craters were breached?

The exposure of lava over scoria at 130 m (Fig. 7, mentioned above) clearly shows that this higher level lava was expelled after the cones had been built and therefore well after the breaching of the craters. This is quite contrary to my initial thoughts, which were that I could not see how lava could be extruded adjacent to both sides of the southeast crater mouth yet well above the level of its breached lip, unless the breaching had yet to occur. If, as I now infer, the lava was expelled later, why was none expelled at similar altitudes on the inner slopes of the crater itself?

At this stage I offer the following possible scenario to explain the observed facts about the extrusion of viscous lava that formed the narrower high level terraces with lava flow fronts on the southern and northern sides of the cone. After the last extrusions of viscous lava at the 110 m level, the upward migration of magma in the main supply conduit may have come to a standstill of sufficient duration for the still molten viscous magma to cool and solidify within most of the pipes through the lower parts of the scoria cone and also in the upper parts of the conduits feeding the southeast and southwest craters. Before all the plumbing within and beneath the lower parts of the scoria cone was fully blocked, there may have been a renewed last surge of viscous magma from beneath. This was unable to force its way through to the surface up the completely blocked necks of the two southern craters but did come up inside the northern crater and scoria cone ramparts to about 130 m, 5 m below the present ash-filled level of the intact crater floor. Quite possibly a new high level pipe intruded through the northern scoria ramparts from the main crater neck and extruded the high level northern terrace of viscous lava at ~130–133 m elevation. A small amount of this last batch of viscous lava seems to have found its way to the surface, possibly up through incompletely clogged plumbing and extruded at the higher level at the southern end of the eastern terrace.

Within the southern ramparts of the scoria cone, the last batch of viscous magma also seems to have been able to find its way up through, or alongside, some of the older plumbing and finally found its way to the surface at two or more points (see arrows, Fig. 3) at similar elevations of about 130 m (when the ash-cover is accounted for). Here the greatest quantity of this last phase lava was extruded forming a 200 x 70 m lava terrace surrounded on its southern side by the 15 m-high, steep, rocky slopes of the south 2 lava flow front. I infer that this last phase of viscous lava flow extrusion was unaccompanied by any significant gas release or fountaining and marks the end of eruptions at One Tree Hill Volcano.

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TO AORAKI / MT COOK

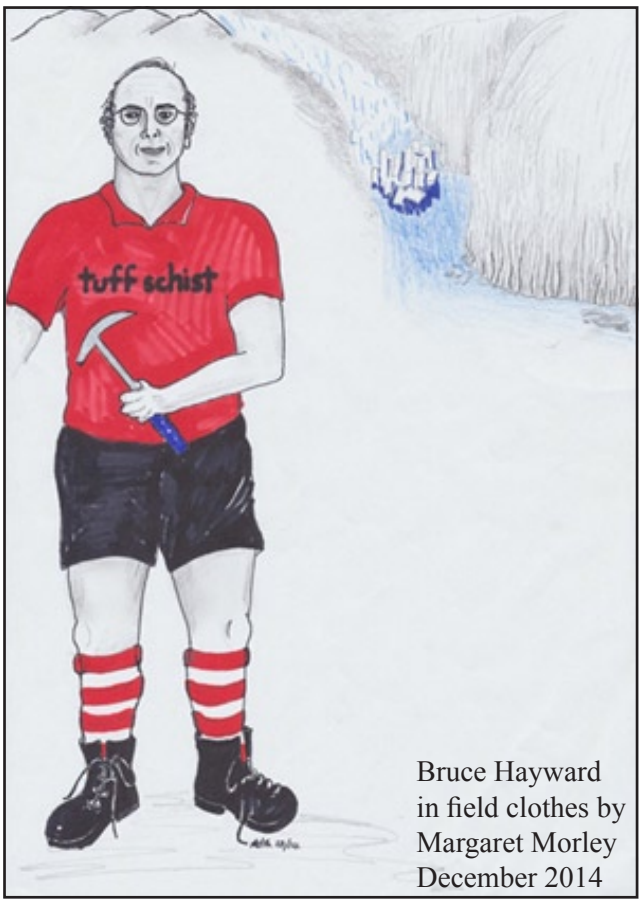
Not a gleam of snow,
just thick grey cloud.
Sorry mountain, I missed you fifty years ago
and didn't see you this time round.

Since last I came you lost your head,
I heard, insulted by the elements though
respect, of course, is a human art,
and I guess there's none in nature. So:

Your Most High Uninviting Mightiness,
sulk all you want, I have lost heart.
I don't even dare to step on your slopes.
You can deign to weep in the rain.

Beautiful above, no doubt you are, I can't look;
one can't hover over Aoraki/Mount Cook.
But hail to your watery burden of mist.
The trip leader wears a tee-shirt, Tuff Schist.

Julie Daymond-King
December 2014



Bruce Hayward
in field clothes by
Margaret Morley
December 2014



Storm enveloping Aoraki / Mt Cook and Lake Pukaki - from Editor's photo collection.

QUIZ ANSWERS

Know your volcanoes.

1 = C, Mt Roskill, viewed from the west
2 = E, Mt Wellington, from Pakuranga
3 = D, Mt Victoria, from North Head
4 = A, Green Mt, East Tamaki. Quarrying has started. Harris Rd crosses the top of the photo and includes the intersections with Crooks Road (top centre left) and Neales Road (top right).
5 = B, Mt Albert, before decapitation. Western Springs in the foreground.

Where is this Waitemata Group cliff?

b Mission Bay / Bastion Point (easily seen disrupted strata at the first corner of Tamaki Drive, heading towards the city)