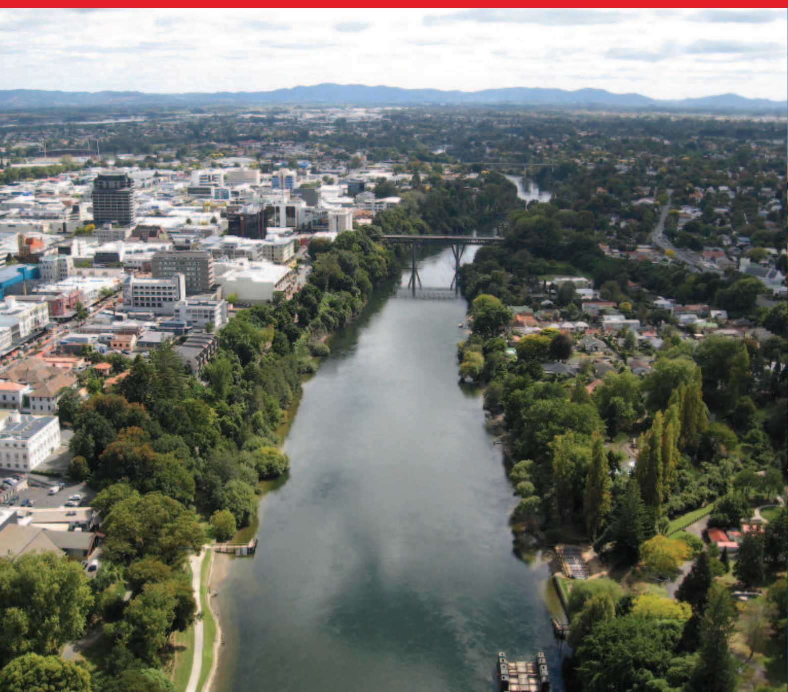
GEOSCIENCES 2012
Hamilton November 25-28

Geoscience Society of New Zealand 2012 Conference

FIELD TRIP GUIDES



HAMILTON 25 - 28 November 2012

Geoscience Society of New Zealand

Geosciences 2012

HOST Sponsor

The University of Waikato
Te Whare Wānanga o Waikato

Department of Earth and Ocean Sciences

Faculty of Science and Engineering

Broad Memorial Fund

GOLD Sponsors

GNS Science
Te Pū Ao

Ministry of Economic Development
Manatū Ōhanga
NZ Petroleum & Minerals

Waikato Regional Council
Te Kaunihera ā Rohe o Waikato

BRONZE Sponsors

the Royal Society of New Zealand
Te Apārangi

NIWA
Taihoro Nukurangi

EQC
Earthquake Commission
Kōmihana Rūwhenua

Holcim

NZJGG BBQ Sponsor

Taylor & Francis
Taylor & Francis Group

TEA BREAK Sponsor

aurecon

DINNER PRIZES

absolutely ORGANISED

EXHIBITORS

AusIMM
The Minerals Institute
New Zealand Branch

Geoscience Society of New Zealand

GEOSCIENCES 2012
Hamilton November 25-28

Annual Conference of the Geoscience Society of New Zealand

Field Trip Guides

Conference Convenor
Adrian Pittari (University of Waikato)

Organising Committee
Roger Briggs, Rochelle Hansen, Chris Hendy, Steve Hood, Peter Kamp, David Lowe, Cam Nelson, Sydney Wright (University of Waikato)

Administration
Janet George (Absolutely Organised Ltd)

Symposium Convenors
Peter Almond, Greg Bignall, Carolyn Boulton, Karin Bryan, Hamish Campbell, Martin Crundwell, Jennifer Eccles, Susan Ellis, David Hamilton, Peter Kamp, Gert Lube, David Lowe, Vicki Moon, Nick Mortimer, Adam Munro, Rewi Newnham, Adrian Pittari, Mark Quigley, Andrew Rae, Catherine Reid, Martin Reyners, Glenn Vallender, Russ Van Dissen, Jenny Webster-Brown

Field Trip Leaders
Roger Briggs, Mike Hall, Chris Hendy, Peter Kamp, Kerri Lanigan, David Lowe, Vicki Moon, Cam Nelson, David Palmer, Adrian Pittari, Andrew Rae

Photographs on front cover: Maria Lowe (top), Wendy Peel (bottom left)

The bibliographic reference for each field trip guide is:

Author, A.N. (2012). Title of Field Trip Guide. In: Pittari, A. (compiler). Field Trip Guides, Geosciences 2012 Conference, Hamilton, New Zealand. Geoscience Society of New Zealand Miscellaneous Publication 134B. p. x.

ISBN 978-1-877480-26-3
ISSN (print) 2230-4487
ISSN (online) 2230-4495

Geosciences 2012

Annual Conference of the Geoscience Society of New Zealand, Hamilton

Field Trip 4

Thursday 29 November 2012

Where Subduction Meets Intraplate Activity

Leaders: Roger Briggs and Adrian Pittari

University of Waikato

Bibliographic reference:

Briggs, R.M., Pittari, A. (2012) Where Subduction Meets Intraplate Activity. *In*: Pittari, A. (compiler). Field Trip Guides, Geosciences 2012 Conference, Hamilton, New Zealand. Geoscience Society of New Zealand Miscellaneous Publication 134B. 14 p.

ISBN : 978-1-877480-26-3

ISSN (print) : 2230-4487

ISSN (online) : 2230-4487

HEALTH AND SAFETY

PLEASE READ!

Certain hazards will be encountered on this field trip. At all times, participants must heed and observe the warnings and directions of the leaders.

Participants should carry their own sunscreen and any personal medications for allergic reactions (e.g. insect stings, pollen, food allergies).

We expect the weather to be warm and sunny, but participants also need to be prepared for cold, wet and windy conditions on the west coast. Sturdy, enclosed, boot-like footwear and eye protection (e.g. glasses or sunglasses) are required. A sunhat, sunscreen, and waterproof and windproof jacket are recommended. Please do not underestimate the potential to get sunburnt.

A good level of fitness and mobility is required for this trip. Participants must be surefooted enough to walk several hundred metres along uneven terrain, and be able to scramble up and down steep tracks. The climb out of Te Toto gorge involves about a 200 m ascent. Underfoot conditions will include slippery tracks, slippery large boulders and hard angular rocks along the coast, and grassy overgrown slopes.

Caution should be exercised when examining rocks at the base of cliffs and quarry faces, due to the risk of rock fall from above. If you hammer rocks, wear eye protection and pay special heed to the safety of other participants.

At Kirikiripu Quarry which is disused and very overgrown, we will not be going anywhere near the quarry face, but we will confine our route to the floor of the quarry near the water tank. The floor of the quarry is overgrown and swampy, and is covered in unstable boulders. Boots and eye protection are your responsibility.

Route and itinerary

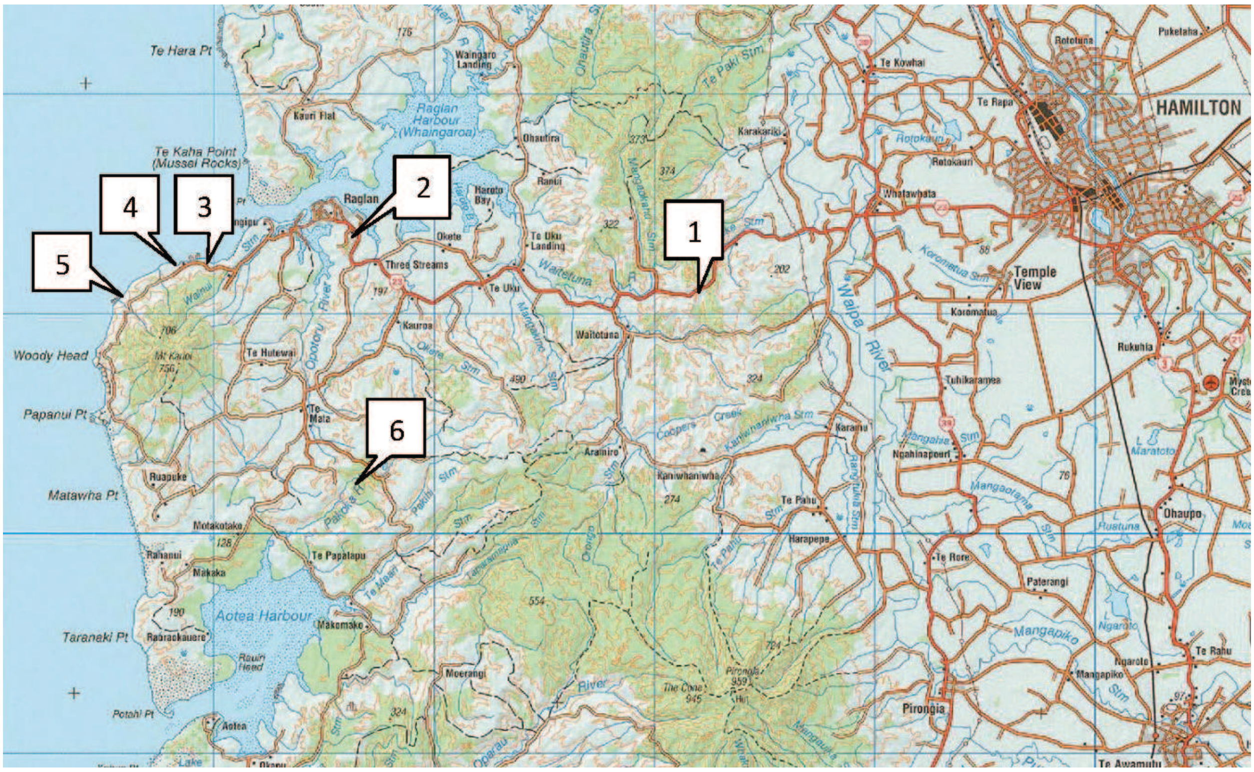


Figure 1 Route map

This is an all-day scenic excursion to look at some of the basaltic volcanic rocks of western North Island. We will spend most of our time at Te Toto gorge on the northwestern coast of Karioi volcano, and then circle Karioi via the Whaanga Road to Bridal Veil Falls, and then return to Hamilton by about 5.30 pm.

Depart Hamilton 8.00 am

Stop 1 Raglan saddle. Traffic hazard at this stop. Take care when crossing road.

Stop 2 Kirikiripu Quarry on the eastern outskirts of Raglan. Wear eye protection if hammering rock. Do not go anywhere near the quarry face and keep to designated track.

Stop 3 Manu Bay and view of Wainui Beach (toilets available). Brief stop and view only. We will not go on to the rocks.

Stop 4 Whale Bay. Wear eye protection if hammering rock. Uneven ground over lava flows.

Stop 5 Te Toto gorge (lunch stop). A good level of fitness and mobility is required if you choose to walk down into the gorge. Be careful of slippery tracks and uneven ground. There is a 200 m ascent to climb out of the gorge up a steep and slippery track.

Stop 6 Bridal Veil Falls (toilets available). Wear eye protection if hammering rock. Keep strictly to designated track and stairway.

Return to Hamilton by about 5.30 pm.

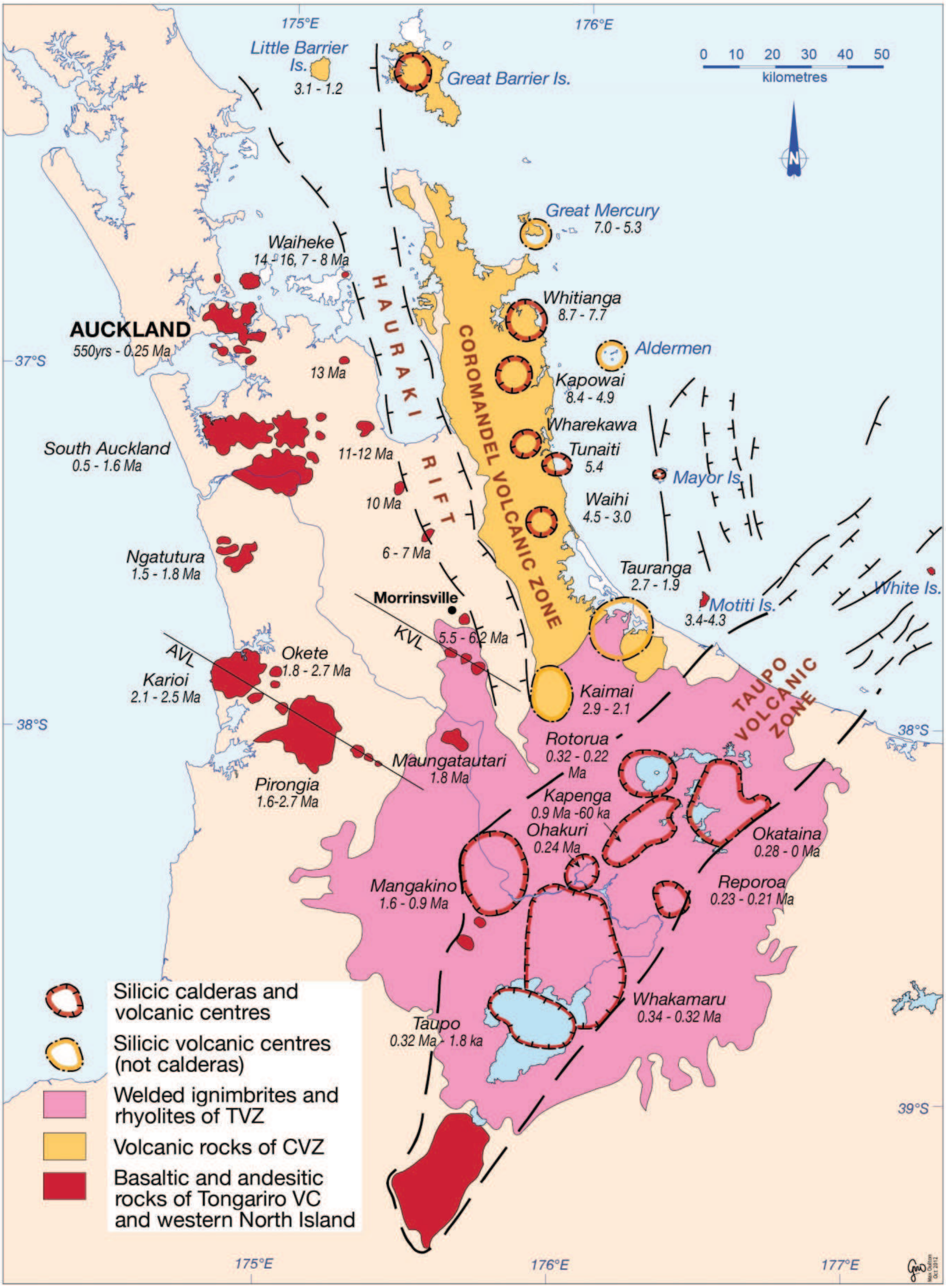


Figure 2 Map of volcanic rocks of the central North Island showing their distribution and age, and the orientation of the Alexandra Volcanic Lineament (AVL) with respect to the Taupo Volcanic Zone.

Introduction

The oldest rocks in the Raglan area of western North Island are Late Triassic to Late Jurassic sedimentary rocks of the Murihiku terrane, which have been broadly folded into the Kawhia Regional Syncline (Waterhouse and White 1994; Edbrooke2005). These rocks are unconformably overlain by the Oligocene – Early Miocene calcareous siltstones and sandstones, and limestones of the Te Kuiti Group. At the base of Te Toto gorge and just a few metres above present sea-level, the Kaawa shallow marine and estuarine sandstones (Kaawa Formation ; Kear 1957) are overlain by non-marine Ohuka carbonaceous sandstones. On the west coast, these rocks are in turn unconformably overlain by Late Pliocene and Quaternary coastal sands of the Awhitu and Karioitahi groups, and dominantly terrestrial alluvium of the Tauranga Group (Edbrooke 2005). The sedimentary sequences are overlain by the basalts of the Alexandra and Okete volcanics which are the focus of this field trip. Quaternary caldera-forming eruptions from the Taupo Volcanic Zone (mainly Mangakino and Whakamaru volcanic centres, Fig. 2) have blanketed western North Island with rhyolitic ignimbrites and tephras (Kauroa Ash and Hamilton Ash beds, Horrocks 2000, Lowe et al. 2001).

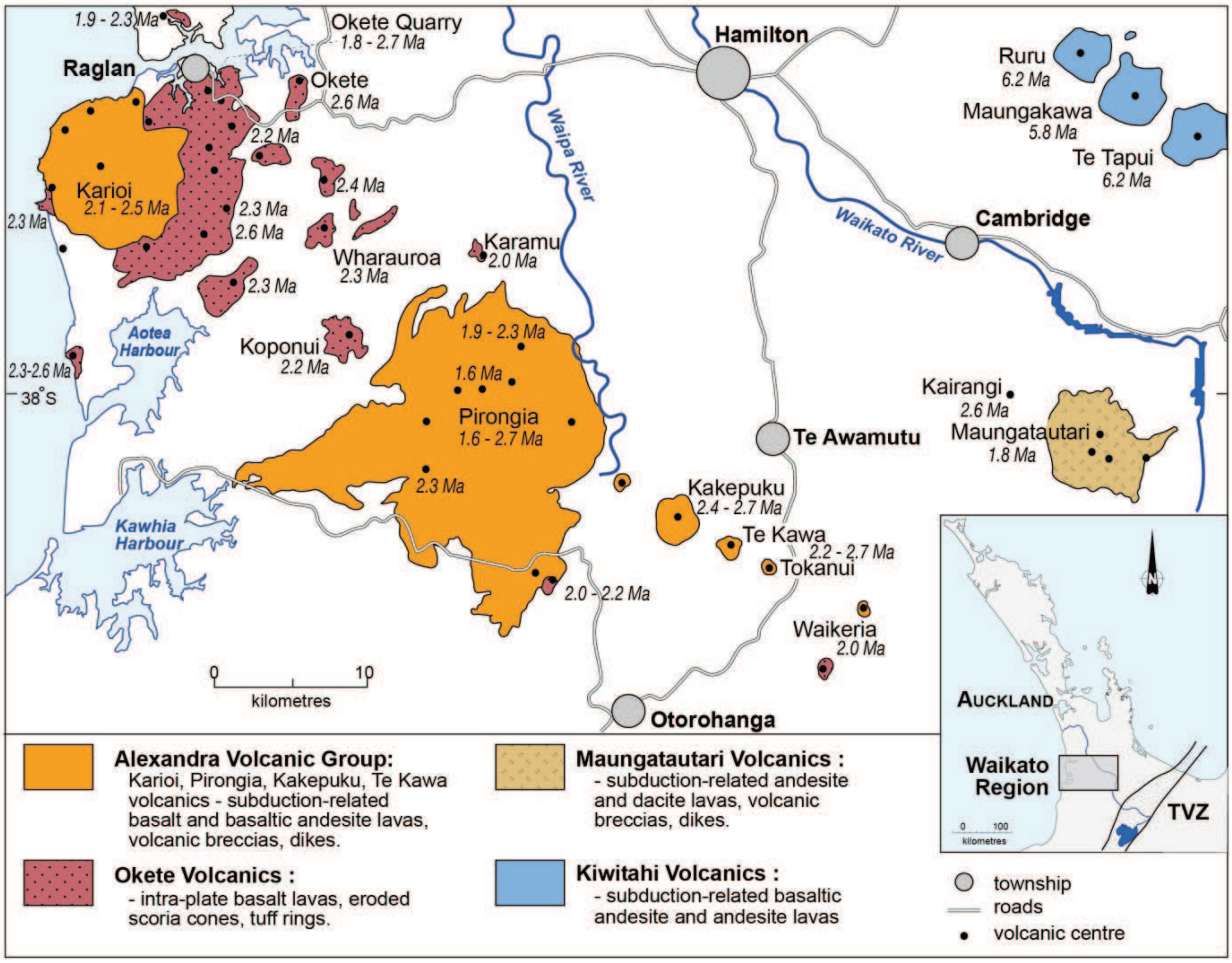


Figure 3 Distribution and age of the volcanic rocks of the Waikato region.

Geological background

The Alexandra Volcanic Group in western North Island consists of two contrasting basalt magma series: a subduction-derived series, and an alkalic intraplate series (Fig. 3). They are both spatially and temporally associated, and at Karioi volcano on the west coast south of Raglan, the two series of lavas are stratigraphically intercalated. This one day post-conference field trip offers an overview of the subduction-derived low-angle composite cone of Karioi, and the alkalic intraplate small volume monogenetic volcanic field of the Okete Volcanics.

The Alexandra Volcanic Group consists of two large low-angle composite cones, Karioi (756 m) and Pirongia (959 m), and five smaller volcanoes including Kakepuku (440 m), Te Kawa (214 m), Tokanui , Waikeria (and an un-named volcano between Pirongia and Kakepuku), all of which form a 65-km long volcanic chain with a marked NW-SE alignment at 300°. This volcanic chain is named the Alexandra Volcanic Lineament (AVL) and has a structural orientation orthogonal to the strike of the Taupo Volcanic Zone (Fig. 2). The Alexandra Volcanics have erupted approximately 55 km^3 of basaltic material covering an area of about 450 km^2. They were erupted over a short time period from 1.60 to 2.74 Ma (Early Quaternary to Late Pliocene) and there is no progressive younging direction along the AVL (Fig. 3). There are no major surface faults in this region of western North Island which have a NW strike, and there is no geophysical evidence for any displacement or tear in the subducted slab, but the AVL may be a response to deep-seated stresses imposed on the Australian Plate by the oblique subduction at the Hikurangi Margin. The main AVL volcanoes of Karioi, Pirongia, Kakepuku and Te Kawa are predominantly basalt lavas with minor volcanic breccias, dikes, lapilli tuffs and tuffs. The basaltic rocks are low SiO_2 ankaramites (augite-rich basalts), olivine basalts and high-Al basalts, and there are several late-stage absarokites with shoshonitic affinities and medium to high-K basaltic andesites which form capping lavas on the summits of some Pirongia peaks. All the primitive lavas of Karioi, Pirongia, Kakepuku and Te Kawa have geochemical compositions typical of subduction-derived continental margin magmas and show no evidence for crustal contamination, i.e., they have high LIL/LREE and LIL/HFS element ratios, and Sr, Nd, and Pb isotopic compositions derived from a source with three components, a source similar to MORB, a component from subducted oceanic lithosphere, and a minor component from subducted sediments (Briggs and McDonough 1990).

The alkalic intraplate suite of the Alexandra Volcanic Group, named the Okete Volcanic Formation by Briggs (1983), comprises a monogenetic volcanic field of at least 27 centres that form mainly eroded scoria cones and basalt lavas, and include at least 5 tuff rings or maars from explosive phreatomagmatic eruptions (Fig. 3). Significantly, none of these centres are aligned along the Alexandra Volcanic Lineament but are widely scattered, mainly in the area surrounding Karioi. However, many of the Okete volcanic centres are aligned along N- striking and NE- or ENE-striking regional surface faults, especially observed in coastal exposures. Okete lavas and tuffs are basanites, alkali olivine basalts and hawaiites, and have geochemical compositions typical of other intraplate alkalic basalt volcanic fields in western and northern North Island, i.e., steep REE patterns indicating derivation from a garnet peridotite source, low LIL/HFS element ratios, and Sr, Nd and Pb isotopic compositions with a HIMU-OIB signature. The Okete Volcanics were erupted over an age range of 1.80 to 2.69 Ma (Briggs et al. 1989), i.e., similar to the other Alexandra Volcanics. The four intraplate volcanic fields of the Auckland Volcanic Province of Okete, Ngatutura (1.8 – 1.5 Ma; 16 centres), South Auckland (1.6 – 0.5 Ma; 82 centres) and Auckland (0.26 Ma – 550 years; 53 centres) are spaced at 35 – 40 km intervals and progressively young to the north. Ultramafic upper mantle and mafic lower crustal xenoliths occur in some Okete basanite and alkali olivine basalt lavas, and will be examined at Stop 1 at Kirikiripu Quarry.

Stop 1 Raglan saddle

We will stop here briefly for an overview of western North Island geology and views of Pirongia, Karioi, and the Te Uku wind farm on the Wharauroa and Te Uku plateaux. The nearby hills and roadcuts are sandstones and siltstones of the Early Jurassic Newcastle Group of the Murihiku terrane.

Stop 2 Kirikiripu Quarry

Turn off the Raglan – Hamilton highway (SH23) on to Hills Road and then left on Cornwall Road to visit the Kirikiripu Quarry. Kirikiripu is one of the volcanic centres of the Okete Volcanics and is deeply eroded (Fig. 4). It consists of an early tuff ring overlain by a later scoria cone and three lava flows (Keane 1985). The northern lava flow has been exposed in the quarry, which has long been disused and is largely overgrown. Take care with the footing in the quarry, and we will not approach the quarry face because it is weathered and partly unstable. We will examine boulders of basalt on the floor of the quarry. However, the interesting feature of the basalt in the quarry is the large amount of ultramafic xenoliths, some of which reach 15 cm across, and constitute a large volume of the rock (up to 20% of the basalt lava in some instances). The xenoliths consist of dunites, lherzolites, harzburgites, wehrlites and clinopyroxenites (Fig. 5), and have been described by Brothers and Rodgers (1969), Rodgers et al. (1975), and Sanders (1994). Most of the xenoliths are considered to represent undepleted mantle or refractory residue, but the diverse compositions suggest a large degree of heterogeneity of the upper mantle beneath western North Island. None of the ultramafic xenoliths contain garnet.

We will then drive through Raglan and along Wainui Road to Manu Bay.

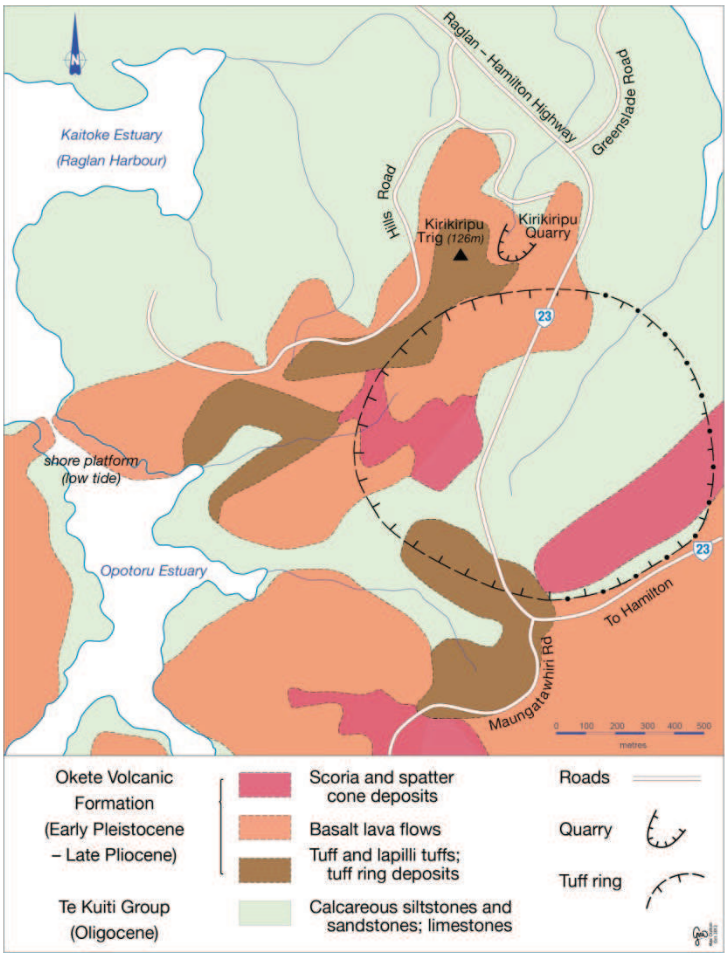


Figure 4 Geological map of Kirikiripu volcanic centre near Raglan (modified from Keane 1985).

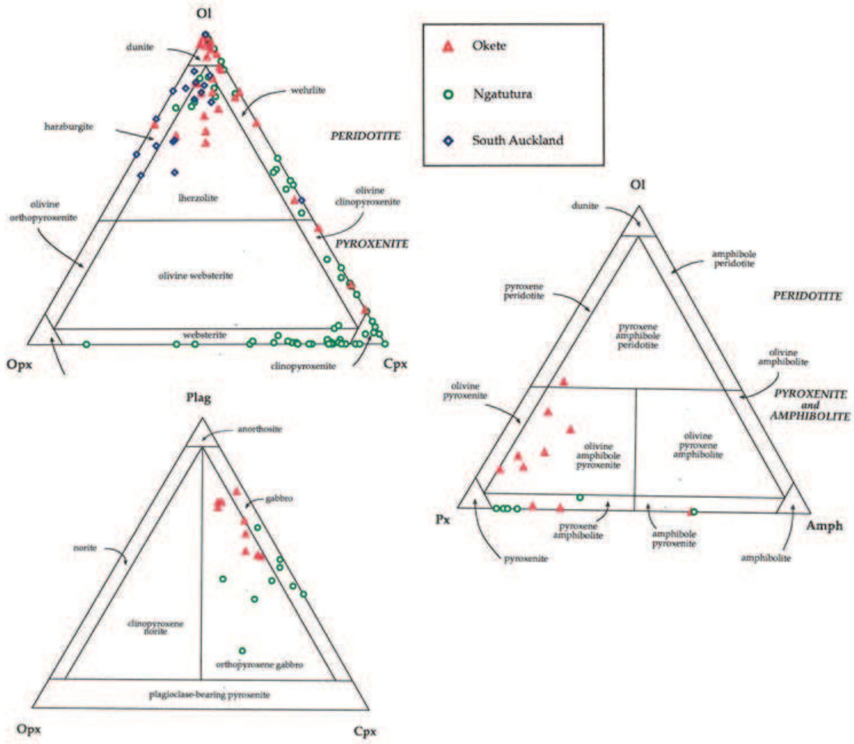


Figure 5 Classification and nomenclature of (a) ultramafic peridotite and pyroxenite xenoliths, (b) amphibole-bearing ultramafic xenoliths, and (c) plagioclase-bearing gabbroic mafic xenoliths from the Okete (Okete Quarry, Kirikiripu Quarry, Te Toto gorge, Bridal Veil Falls), Ngatutura, and South Auckland volcanic fields (Sanders 1994).

Stop 3   Manu Bay

We will stop briefly at Manu Bay, a mecca of the surfing world, and a view of Wainui Beach, the Raglan bar, and the coastline north of Raglan Harbour to Carters and Gibson beaches. (Toilets available).

Stop 4   Whale Bay

We will then continue a short 5-minute drive further along the Whaanga Road to Whale Bay on the northwestern slopes of Karioi volcano. At Whale Bay there are coastal exposures of Karioi subduction-derived low-SiO_2 ankaramite lavas with unusual spheroidal weathering developed from widely spaced joints. The basaltic ankaramites contain abundant large (up to 10 mm) euhedral black augite phenocrysts with minor olivine and plagioclase phenocrysts. 15 minute drive on Whaanga Road to Te Toto gorge.

Stop 5   Te Toto gorge

At Te Toto gorge we will walk from the carpark to the viewing platform, and then take our lunch and walk down into the gorge. Take care on slippery track.

The Te Toto amphitheatre is one of many scallop-shaped landslides around the Karioi coast (Fig. 6). It probably formed by coastal erosion of the toe of the landslide which is composed of soft, incompetent Kaawa sandstones and Ohuka carbonaceous sandstones, and rotational sliding to expose cliff sections of the early stages in the history and construction of Karioi volcano. Such exposures of the early stages in the growth of Late Pliocene- Quaternary composite cones or shields are not often found.

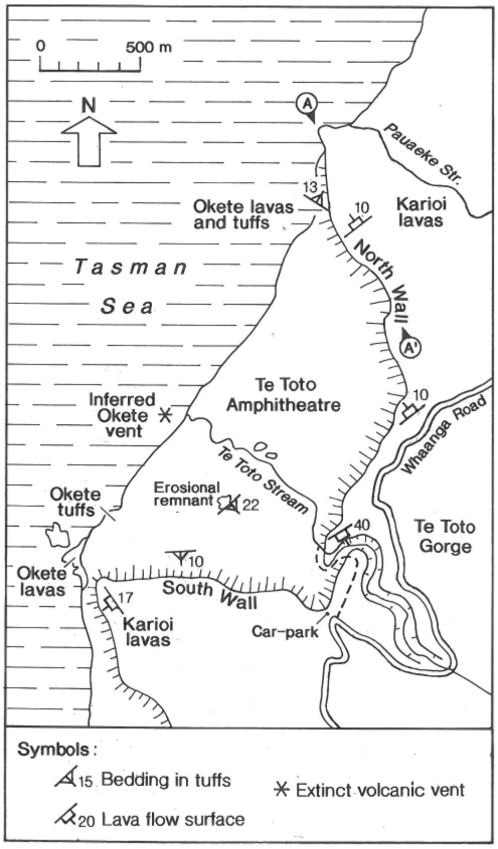


Figure 6   Map of Te Toto amphitheatre on the northwestern coast of Karioi volcano (from Goles et al. 1996).

The stratigraphy of the edifice of Karioi volcano is complex but can be subdivided into four main units (Goles et al. 1996). The three older units are shown in the north wall cliff section of the Te Toto amphitheatre (Fig.7), and all four units are shown in the composite stratigraphic column in Fig.8. Paleomagnetic polarity data and unpublished K-Ar ages (Itaya pers.comm) suggest that the lower part of the stratigraphic succession from the Pauaeke Member to the Te Toto Member crosses the Gauss (Normal)- Matuyama (Reverse) chron boundary at about 2.48 Ma (Mankinen and Dalrymple 1979). Representative geochemical compositions are given in Table 1 (Goles and Briggs, unpublished data), and stratigraphic variations in geochemical composition are shown in Fig. 9. Sr and Nd isotopic compositions are shown in Fig.10. Postulated sources and depths of the different magma types are schematically shown in Fig. 11.

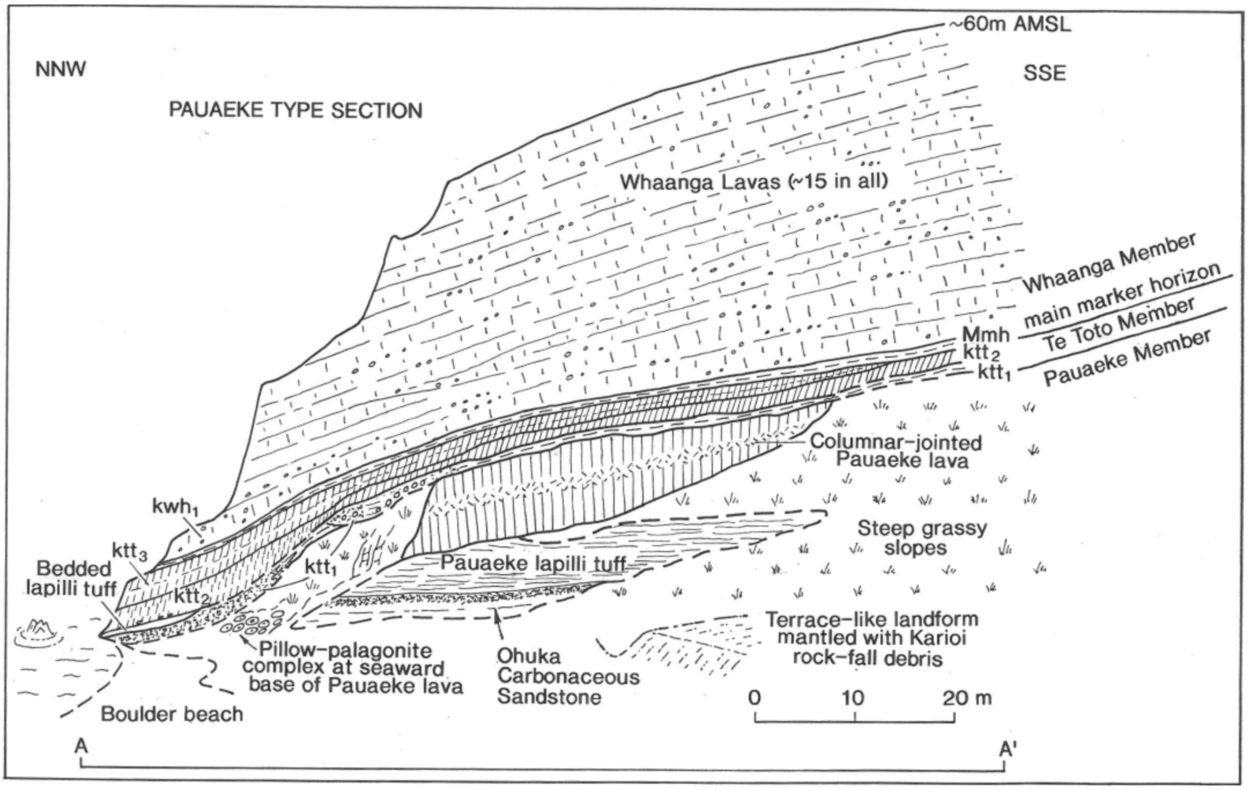


Figure 7 Sketch of the North wall section of the Te Toto amphitheatre (from Goles et al. 1996).

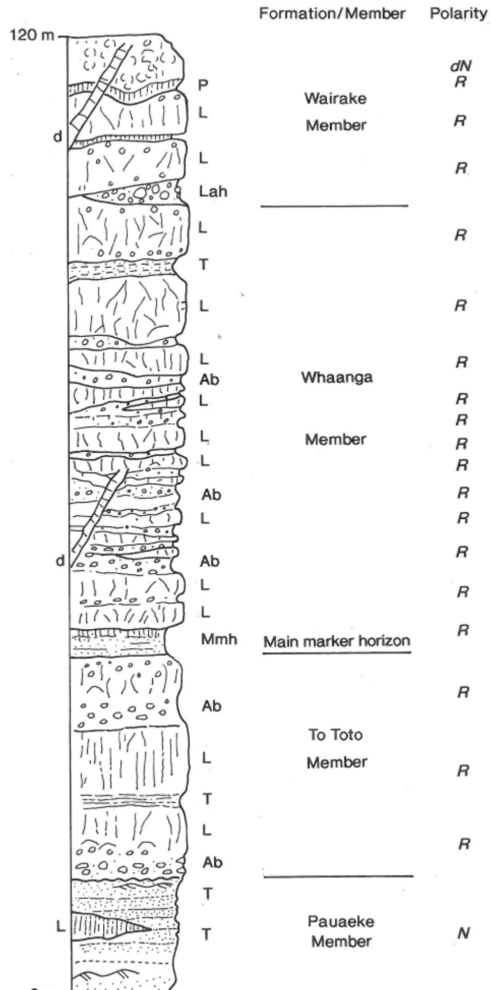


Figure 8 Composite stratigraphic column through the Okete and Karioi units exposed in the South wall of the Te Toto amphitheatre and the upper sections of Te Toto gorge. L, lava flow; Ab, autoclastic breccias; T, tuff and lapilli tuff; d, dike; Lah, laharic deposit; Mmh, main marker horizon; P, paleosol (Goles et al. !996).

(1) The oldest unit making up the Karioi edifice is the Pauaeke Member. This unit consists of tuffs and lapilli tuffs formed from initial explosive phreatomagmatic eruptions and occasional lava flows which have been pillowed in some cases near the coast. The tuffs cover much of the lower floor of the amphitheatre. The Pauaeke Member is the oldest member of the Okete Volcanics, and the tuffs and lavas have an alkalic intraplate composition. Some of the tuffs contain lherzolites, wehrlites and clinopyroxenites, mafic dark-brown amphibole-bearing pyroxenites and amphibolites, and plagioclase-bearing gabbros, representing upper mantle and lower crustal xenoliths (Fig. 5).

(2) The Pauaeke Member is overlain by the Te Toto Member which forms at least three lava flows with interbedded tuffs exposed on the north (Fig. 7), east and south wall of the amphitheatre. The Te Toto Member is part of the Karioi Formation and all lava flows have a subduction-derived continental margin geochemical composition. The upper contact of the Te Toto Member is an erosion surface and is capped by a conspicuous, widespread red basaltic tuff and weathered tachylite horizon which reaches up to 2 m thick. It is referred to as the main marker horizon and labelled in Figs. 7 and 8 as Mmh. The Mmh is sufficiently weathered to be considered as an inceptisol and contains quartz. The quartz could have been derived from local beach sands, or from rhyolitic tephras from TVZ, or from tropospheric aerosolic dust (Stewart et al. 1986).

(3) The Te Toto Member is overlain by the Whaanga Member which is represented by at least 15 lava flows overlying the Mmh, and forms most of the upper cliff sections exposed in the Te Toto amphitheatre (Fig. 7). Whaanga flows are quite distinct from Te Toto lavas and consist of thin (commonly 1-2 m thick but up to 5 m thick) laterally discontinuous sheet flows. Rubbly scoriaceous autoclastic breccias 1-2 m thick occur above and below each lava flow. Goles et al. (1996) considered the Whaanga Member to be part of the Karioi Formation but it has all the geochemical and isotopic signatures of the alkalic intraplate Okete Volcanics. However, all of the other Okete volcanic centres are monogenetic and consist of an initial tuff ring and a later scoria cone associated with two or three lava flows, and do not construct polygenetic shields like the Whaanga Member. Nevertheless, as shown by Rangitoto in the Auckland volcanic field and Holcim's Quarry in Bombay in the South Auckland volcanic field, intraplate basaltic volcanic fields are not always monogenetic. In this context, we now consider the shield of the Whaanga Member to be part of the Okete Volcanics.

(4) The Wairake Member is the youngest unit of the Karioi Formation and represents the late cone-building stage of the volcano. It consists of late-stage valley-filling basalt, basaltic andesite and andesite lava flows, laharic deposits on the flanks, basaltic and andesitic dikes, and intrusive volcanic breccias. The Wairake Member has constructed a cone, now deeply eroded, overlying all the previous units. The stratigraphic position of each of the Wairake Member units is mainly unknown, and no stratigraphic position is implied for Wairake rocks in Fig. 9. Most of the Wairake Member lavas and dikes have compositions similar to those of the Te Toto Member, i.e., typical of subduction-derived continental margin magmas, but others are complex and have compositions which are transitional, and possibly represent mixing of Okete (intraplate) and Te Toto (continental margin) type magmas (Figs. 9, 10, 11).

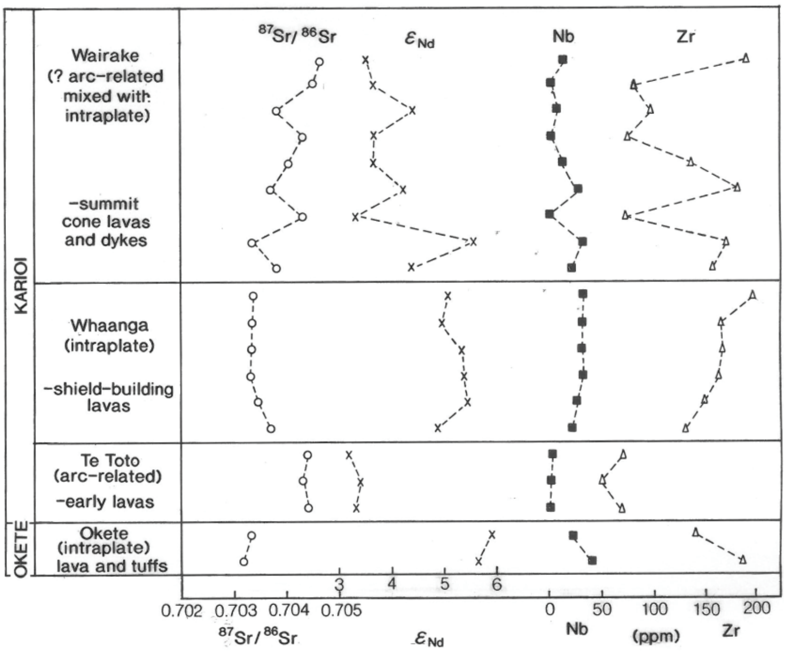


Figure 9 Stratigraphic variations in geochemical compositon from basal Okete lavas to uppermost Wairake summit cone lavas and dikes of the Karioi edifice (Goles and Briggs, unpublished data).

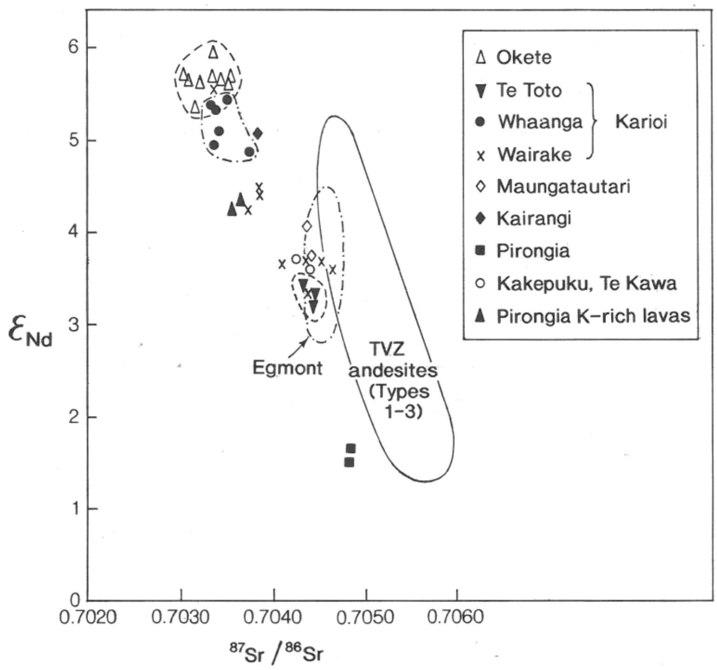


Figure 10 Sr and Nd isotopic compositions of Okete and Karioi volcanic rocks (Goles and Briggs unpublished data). Data for Egmont from Price et al. (1992, 1999), and for Taupo Volcanic Zone andesites from Graham et al. (1992, 1995).

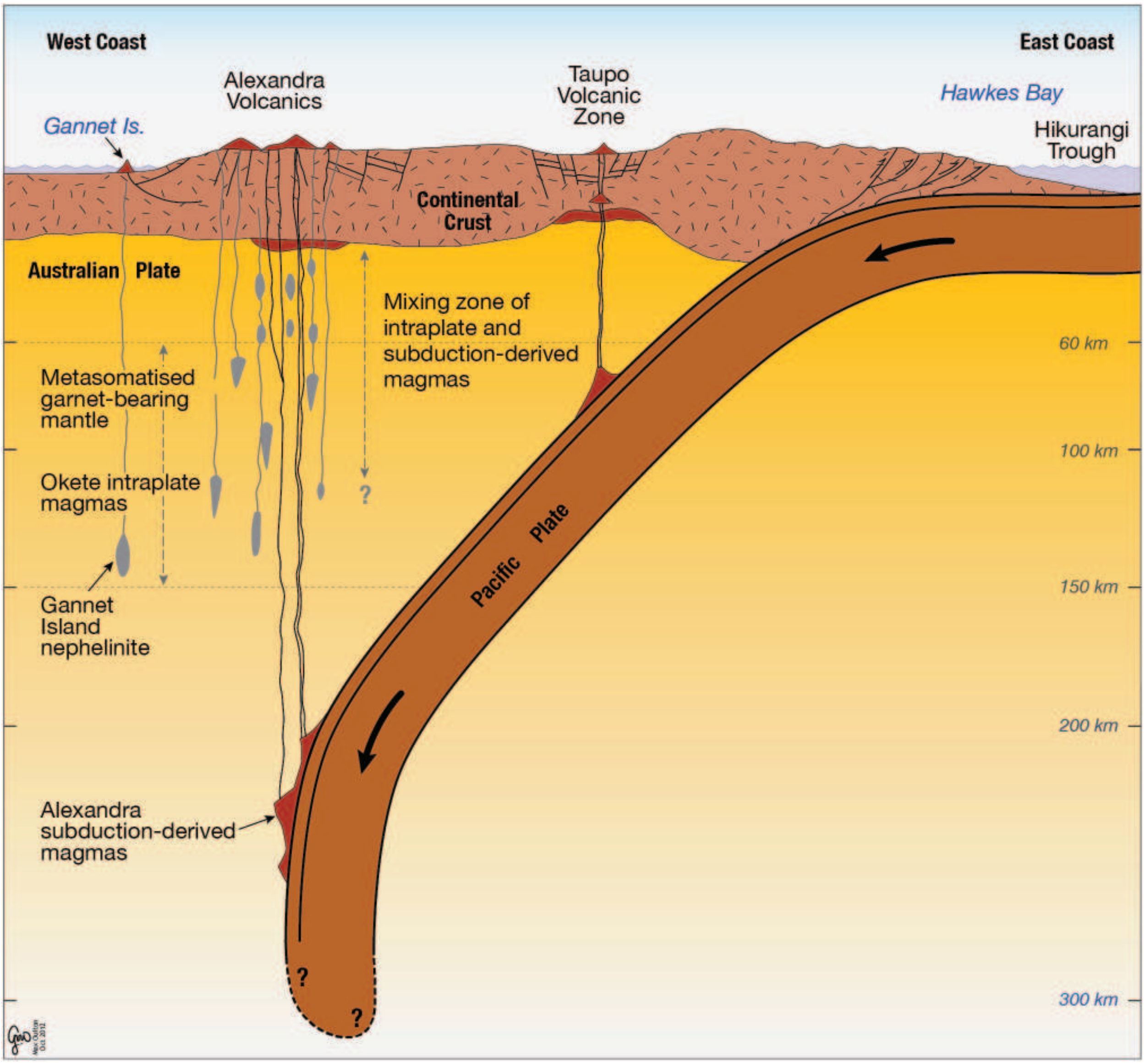


Figure 11 Schematic NW-SE cross-section across North Island.

Karioi and Okete Volcanics (Goles and Briggs unpubl. data)

Formation	Okete Lavas		Te Toto Lavas		Whaanga Lavas			Wairake Lavas	
Location	Te Toto North Wall	Te Toto South Point	Te Toto South Wall	Te Toto Vent Section	Te Toto South Wall	Te Toto East Wall	Te Toto Road Cut	Summit Cone	Summit Cone
Sample No	NIK-37	NIK-62	NIK-23	NIK-5	NIK-47	NIK-14	NIK-25	NIK-79	NIK-78
SiO_2	47.73	43.92	47.5	49.12	49.96	46.7	50.02	62.1	49.98
TiO_2	1.89	2.35	0.79	0.98	1.68	2.15	2.42	0.53	0.89
Al_2O_3	13.49	12.2	16.39	17.55	13.62	14.18	18.47	18.72	17.37
Fe_2O_3	1.91	1.98	2.9	2.92	2.88	3.31	2.77	1.45	2.73
FeO	9.72	10.12	7.84	7.88	7.77	8.92	7.47	3.92	7.38
MnO	0.18	0.2	0.18	0.15	0.18	0.18	0.14	0.11	0.18
MgO	10.69	13.98	9	6.15	11.11	10.85	3.72	1.39	6.55
CaO	10.27	11.4	12.66	11.72	11.9	10.12	9.05	5.49	11.12
Na_2O	2.57	2.41	1.87	2.38	2.3	1.99	3.8	3.92	2.28
K_2O	1.21	0.96	0.75	1.03	1.25	1.21	1.65	2.14	1.29
P_2O_5	0.33	0.48	0.12	0.12	0.34	0.4	0.5	0.24	0.22
Mg#	66.3	71.2	67.3	58.3	71.9	68.6	47.2	38.9	61.4
Ni	206	323	71	35	192	248	31	4	33
Cr	615	590	242	69	561	394	21	4	114
Sc	28	28	36	32	36	29	18	7	34
V	245	282	289	298	287	274	231	81	283
Rb	22	17	19	37	31	24	35	69	31
Sr	461	612	368	394	513	522	693	527	475
Ba	313	528	327	367	350	417	384	845	621
Cu	83	90	108	53	109	84	85	16	68
Zn	89	95	69	71	73	101	86	66	71
Ga	21	21	18	20	19	22	29	22	20
Pb	7	7	7	7	7	5	9	9	8
Zr	142	187	52	72	131	167	198	192	86
Nb	23.5	41.7	3.4	5.5	23.4	34.2	35.2	16.7	6.3
Th	3.3	4.2	3.7	3.7	4.6	3.1	6.3	13.8	5.9
U	1.3	1.9	0.7	0.6	1.7	0.6	1.1	3.4	1.4
La	23	40	13	16	28	32	33	37	29
Ce	51	82	30	34	57	63	65	63	48
Y	20	21	14	20	23	25	29	20	21

Continue along Whaanga Road with roadcuts exposing late-stage laharic breccias, past Papanui Point and Ruapuke Beach with views to the south of Albatross Point, Ruapuke Road to Te Mata School, and then turn south along the Kawhia Road to Bridal Veil Falls (approximately a 45-minute drive).

Stop 6 Bridal Veil Falls

Bridal Veil Falls are located about 5 km southeast of Te Mata on the Kawhia Road. The falls are about 55 m high and fall over a thick Okete basalt lava flow. The lava flow is quite thick here because the lava has ponded in an old valley, and shows curved columnar jointing (spaced 15-25 cm apart) formed during cooling and contraction of the lava. The typical pattern of columnar jointing in lavas is for cracks or joints to occur perpendicular to the cooling surface of the air above. However, the joints are distinctly curved and indicate that some late movement and flowage of the lava took place during the final stages of cooling which distorted the pattern.

The basalt lava is black and porphyritic and contains phenocrysts of green olivine 1-3 mm in diameter. Some of the basalt boulders at the base of the waterfall contain upper mantle xenoliths 5-50 mm across of dunites, harzburgites and wehrlites. These mantle xenoliths are interesting because they enable us to study the nature and composition of the Earth's mantle, and indicate that the magmas which brought them to the surface, did so at a very fast rate, fast enough so that the rate of ascent exceeded the rate of gravitational settling of the xenoliths in a hot basaltic magma. This means that these magmas could have risen from their source in the garnet peridotite zone at about 60-150 km depth (Fig. 11) to the surface in less than 2 days.

The basalt at Bridal Veil Falls has been dated by K/Ar dating methods at 2.57 million years old (Stipp 1968). This means that the lavas are about the same age as those from the volcanoes of Karioi and Pirongia. However, the lava flow has been derived from a separate vent, situated at a small eroded scoria cone volcano about 1 km to the NW of the falls, and SE from Te Mata. (This scoria cone is difficult to see and is covered in bush).

At the base, the waterfall has eroded into older and much softer sedimentary rocks that underlie the basalt lava, and excavated a deep plunge pool. These rocks are Oligocene in age (about 30 million years old) and are glauconitic calcareous sandstones of the Glen Massey Formation. They are mainly covered with moss and ferns.

Safety note: Keep strictly to designated track and stairway. The basalt is extremely hard and splintery, so be very careful if hitting the rock with a geological hammer. This should only be done using safety goggles and away from any other person because rock splinters can fly off and travel 10-20 m.

Return to Hamilton.

References

Briggs, R.M. 1983. Distribution, form, and structural control of the Alexandra Volcanic Group, North Island, New Zealand. New Zealand Journal of Geology and Geophysics 26, 47-55.

Briggs, R.M., Goles, G.G. 1984. Petrological and trace element geochemical features of the Okete Volcanics, western North Island, New Zealand. Contributions to Mineralogy and Petrology 86, 77-88.

Briggs, R.M., Itaya, T., Lowe, D.J., Keane, A.J. 1989. Ages of the Pliocene-Pleistocene Alexandra and Ngatutura volcanics, western North Island, New Zealand, and some geological implications. New Zealand Journal of Geology and Geophysics 32, 417-427.

Briggs, R.M., McDonough, W.F. 1990. Contemporaneous convergent margin and intraplate magmatism, North Island, New Zealand. Journal of Petrology 31, 813-851.

Briggs, R.M., Rosenberg, M.D., de Lange, P.J., Itaya, T., King, P.R., Price, R.C. 1997. Geology and geochemistry of Gannet (Karewa) Island, Tasman Sea: a rift-related nephelinitic tuff ring. New Zealand Journal of Geology and Geophysics 40, 263-273.

Brothers, R.N., Rodgers, K.A. 1969. Petrofabric studies of ultramafic nodules from Auckland, New Zealand. Journal of Geology 77, 452-465.

Goles, G.G., Briggs, R.M., Rosenberg, M.D. 1996. Late Pliocene stratigraphic succession and volcanic evolution of Karioi volcano, western North Island, New Zealand. New Zealand Journal of Geology and Geophysics 39, 283-294.

Graham, I.J., Gulson, B.L., Hedenquist, J.W., Mizon, K. 1992. Petrogenesis of late Cenozoic volcanic rocks from the Taupo Volcanic Zone, New Zealand, in the light of new Pb isotope data. Geochimica et Cosmochimica Acta 56, 2797-2819.

Graham, I.J., Cole, J.W., Briggs, R.M., Gamble, J.A., Smith, I.E.M. 1995. Petrology and petrogenesis of volcanic rocks from the Taupo Volcanic Zone: a review. Journal of Volcanology and Geothermal Research 68, 59-87.

Edbrooke, S.W. (compiler) 2005. Geology of the Waikato area. Institute of Geological and Nuclear Sciences 1:250 000 geological map 4. 1 sheet + 68p. Lower Hutt, New Zealand. Institute of Geological and Nuclear Sciences Limited.

Kear, D. 1957. Stratigraphy of the Kaawa-Ohuka coastal area, west Auckland. New Zealand Journal of Science and Technology B38, 826-842.

Keane, A.J. 1985. The age, form and volcanic mechanisms of the Okete Volcanics near Raglan. Unpublished MSc thesis, University of Waikato, Hamilton.

Lowe, D.J., Tippett, J.M., Kamp, P.J.J., Liddell, I.J., Briggs, R.M., Horrocks, J.L. 2001. Ages on weathered Plio-Pleistocene tephra sequences, western North Island, New Zealand. In: Juvigné, E.T.Raynal, J-P ed. Tephras: chronology, archaeology. CDERAD éditeur, Goudet. Les Dossiers de l'Archéo-Logis 1: 45-60.

Mankinen, E.A., Dalrymple, G.B. 1979. Revised geomagnetic polarity time scale for the interval 0-5 m.y. B.P. Journal of Geophysical Research 84 (B), 615-626.

Price, R.C., McCulloch, M.T., Smith, I.E.M., Stewart, R.B., 1992. Pb-Nd-Sr isotopic compositions and trace element characteristics of young volcanic rocks from Egmont volcano and comparisons with basalts and andesites from the Taupo Volcanic Zone, New Zealand. Geochimica et Cosmochimica Acta 56, 941-952.

Price, R.C., Stewart, R.B., Woodhead, J.D., Smith, I.E.M. 1999. Petrogenesis of high-K arc magmas: evidence from Egmont volcano, North Island, New Zealand. Journal of Petrology 40, 167-197.

Rodgers, K.A., Brothers, R.N., Searle, E.J. 1975. Ultramafic nodules and their host rocks from Auckland, New Zealand. Mineralogical Magazine 112, 163-174.

Sanders, R.J. 1994. Ultramafic and mafic xenoliths from the Okete, Ngatutura and South Auckland volcanics, northern North Island, New Zealand. Unpublished MSc thesis, University of Waikato, Hamilton.

Stipp, J.J. 1968. The geochronology and petrogenesis of the Cenozoic volcanics of North Island, New Zealand. Unpublished PhD thesis, Australian National University, Canberra.

Waterhouse, B.C. White, P.J. 1994. Geology of the Raglan-Kawhia area, scale 1:50 000. Institute of Geological and Nuclear Sciences geological map 13. 48p., 1 sheet. Lower Hutt, New Zealand. Institute of Geological and Nuclear Sciences Limited.