



SOILS
ROTORUA 2024



WEAVING SOIL SCIENCE ACROSS CULTURES & ENVIRONMENT



SOIL SCIENCE
AUSTRALIA

Joint NZSSS and SSA Conference “Te Kiri o Papatūānuku”
2nd to 5th December 2024, Rotorua Energy Events Centre, NZ



VOLCANIC VIGOUR - MOUNT TARAWERA FIELD TRIP HANDBOOK

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SESSION

Volcanic vigour - Mount Tarawera – the 1886 eruption: soils and land management on erupted materials

*Penny MacCormick, Bay of Plenty Regional Council, Janine Krippner, University of Waikato, Emily McKay Manaaki Whenua Landcare Research, Megan Balks University of Waikato, Kaleb McCollum, Manaaki Whenua Landcare Research
Ken Raureti, Ngāti Rangitahi Kaumātua*

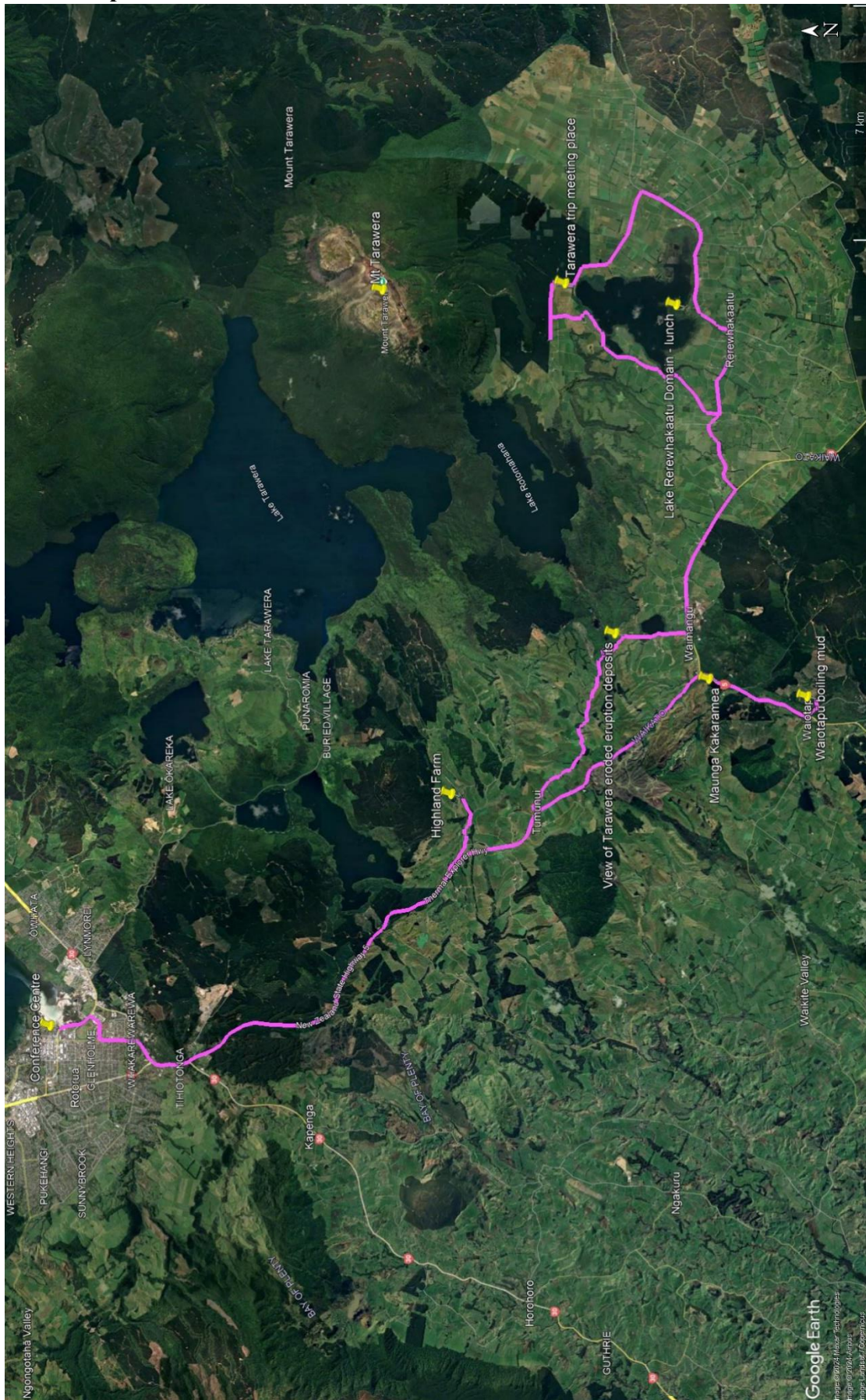
TRIP A Penny, Emily

- **8.00 am Depart from Energy Event Centre Rotorua**
- **8.30 – 10.30 Highland station** (Highland Road) (soil judging site) Soil profile, farming in an N sensitive catchment, detention dams and history of Highland Station.
- **11.00 – 11.30 eruption deposition/erosion mounds.** Roadside stop on Okaro Rd (travel up Waimangu Rd) to view eruption deposition/erosion mound and closer view of Tarawera. Intro to geology of Tarawera. Talk on bus as drive through about Onuku sheep milking etc.. Ahuwhenua award and Maaori land management, lake wetland work.
- **12-12.45 Packed picnic lunch at Rerewhakaaitu Domain** (on Ash Pit Rd, eastern side of Lake Rerewhakaaitu) – great view of Tarawera and lake, public toilets.
- **1.00 – 3.30 Mt Tarawera rift** - a 2 hour round trip from the base of the mountain. There are 2 x 25-30 seat 4WD buses that take people up the mountain.
 - Visit the crater rim. Learn about the 1886 Tarawera eruption and its aftermath.
 - Learn about the iwi management and cultural significance of the site.
 - Wildling pine issues (Thomas Paul)
- **4.00 - 5.00 Waioatapu mud pools** – if time permits.
- **5.30 arrive Rotorua**

TRIP B Kaleb, Janine

- **8.00 am Depart Rotorua**
- **9.00 – 11.30 Mt Tarawera rift** - a 2 hour round trip from the base of the mountain. There are 2 x 25-30 seat 4WD buses that take people up the mountain.
 - Visit the crater rim. Learn about the 1886 Tarawera eruption and its aftermath.
 - Learn about the iwi management and cultural significance of the site.
 - Wildling pine issues (Thomas Paul).
- **12-12.45 Packed picnic lunch at Rerewhakaaitu Domain** (on Ash Pit Rd, eastern side of Lake Rerewhakaaitu) – great view of Tarawera and lake, public toilets.
- **1.00 – 1.30 eruption deposition/erosion mounds.** Roadside stop on Okaro Rd (which links on to Waimangu Rd) to view eruption deposition/erosion mounds... and closer view of Tarawera. Talk on bus as drive through about Onuku sheep milking etc. Ahuwhenua award and Maaori land management, lake wetland work.
- **2.00 – 4.00 Highland station** (Highland Road) (soil judging site) to view Tarawera and associated lakes – geological history intro, Rotomahana mud soil profile, farming in an N sensitive catchment, detention dams and history of Highland Station.
- **4.00 - 5.00 Boiling mud** geothermal activity if time allows.
- **5.30 arrive Rotorua**

Route Map:



Geological Setting of New Zealand (Reproduced and adapted from Hewitt, Balks and Lowe 2021, *Soils of Aotearoa NZ*, Chapter 1).

“New Zealand lies on the collisional plate boundary between the Pacific and Australian tectonic plates which are moving towards each other at about 40 mm/year (Figure 1). In the North Island the Pacific plate is being subducted beneath the Australian plate resulting in current volcanic activity in the central North Island and Taranaki. To the south of the South Island the Australian plate is being subducted beneath the Pacific plate. Through the central part of New Zealand, the boundary of the two plates is marked by the Alpine Fault, a transform or strike-slip fault which passes mainly along the western margin of the Southern Alps. The crumpling, uplift, and lateral movement, are marked by numerous hill and mountain ranges, and fault-lines, in both the North and South Islands.



Figure 1. The Zealandia continent and plate tectonic setting of New Zealand (Adapted from Q-map GNS)

As the Pacific plate descends into the Earth's hot mantle, the crustal rocks are heated causing magma to form. The magma is mostly made up of materials low in silica called basalt. This evolves into andesite, with intermediate silica content, that erupts to form cone or stratovolcanoes such as Mt Ruapehu. Heat from the basalt magma causes the continental crust (mainly greywacke) to melt, leading to huge rhyolite eruptions, with high silica content, that can result in collapse of the land to form calderas such as those occupied by Lakes Taupo and Rotorua.

The volcanoes, and associated geothermal activity, are concentrated in a linear zone stretching from Ruapehu in the south to Whakaari (White Island) in the north called the Taupo Volcanic Zone (TVZ) (Figure 2). Large volumes of pyroclastic material or tephra has been explosively erupted from volcanoes in the TVZ and deposited over the landscape of the central North Island and beyond. Hence many soils in the central North Island are formed from tephra deposits which, because of their intermittent deposition, often comprise multiple layers of tephra with buried soil horizons (paleosols) within them. Such soils are said to be formed by “upbuilding pedogenesis” whereby the deposition of tephra on the land surface causes the land to rise at the same time top-down soil-forming processes modify and transform the tephra materials to form soil horizons.

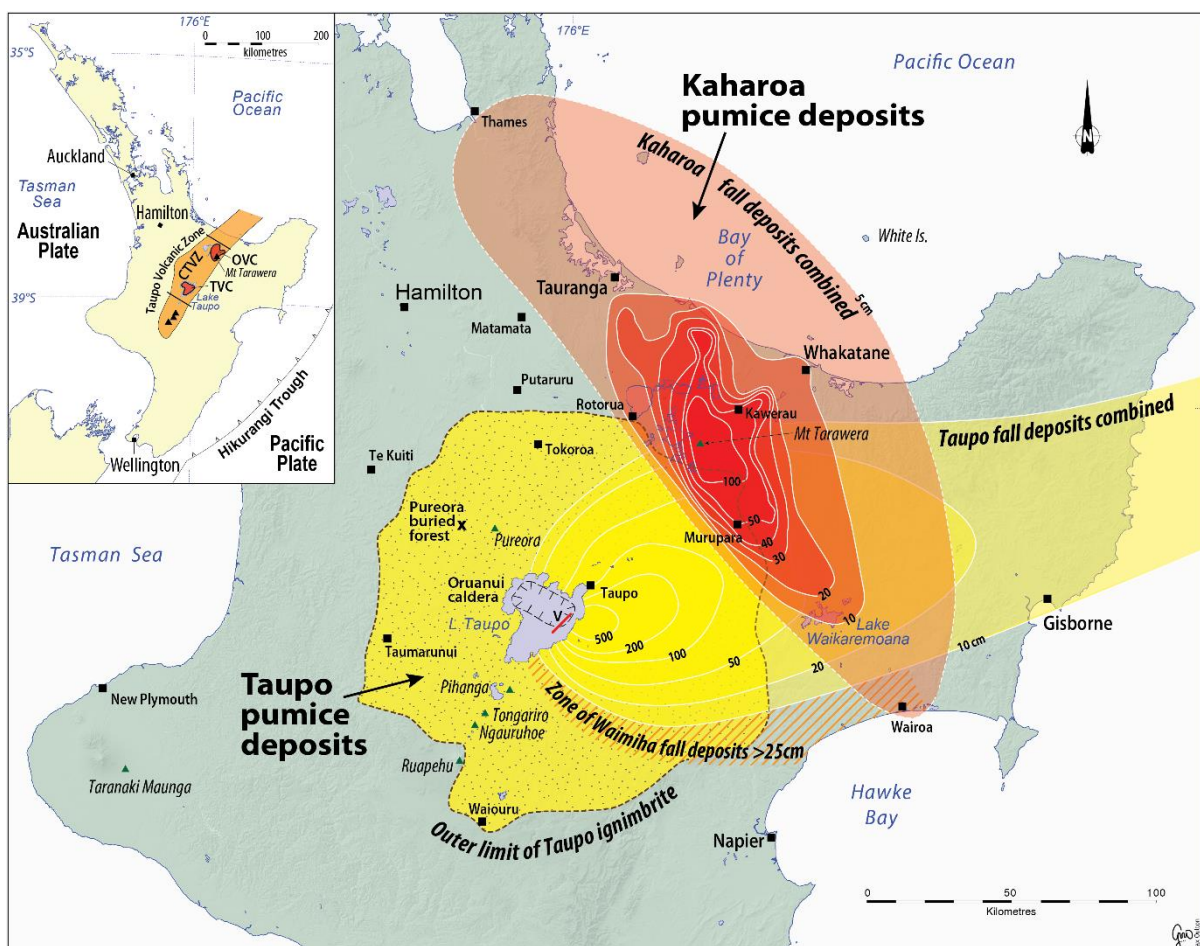


Figure 2 Taupo volcanic Zone and thickness of deposits from the Taupo (232 AD) and Kaharoa (1314 AD) eruptions. From Hewitt, Balks and Lowe 2021, Chapter 12.

The Last glaciation, which extended from about 115 000 to 11 700 years ago, with a glacial maximum between about 31 000 and 18000 years ago, had marked impacts on New Zealand. The average temperature in New Zealand was about 6 to 6.5 °C colder, and it was about 25% drier, frostier, and windier. Sea level was about 135 m lower than that at present. The treeline was lowered by about 800 m, and forest in most places (except Northland) was replaced by grassland or shrublands, or both, except in refugia where small patches of forest remained.”

Mt Tarawera – 1886 eruption. *(Reproduced and adapted from Balks and Zabowski, 2016, Celebrating Soil: Discovering soils and landscapes)*

Mount Tarawera is a rhyolite volcanic dome complex within the Ōkātina Volcanic Centre, which is the highest threat volcano in New Zealand. Tarawera last came to life on June 10th 1886 with very little warning, producing the largest historic eruption in New Zealand with profound impacts for nearby communities (Figure 3). A ~17-km-long eruptive fissure opened along the summit of the volcano and the Waimangu region, and a lava fountain eruption of basaltic scoria and ash commenced. During the four-hour-long eruption the rising magma intercepted two adjacent lakes, causing an explosive steam-based eruption.

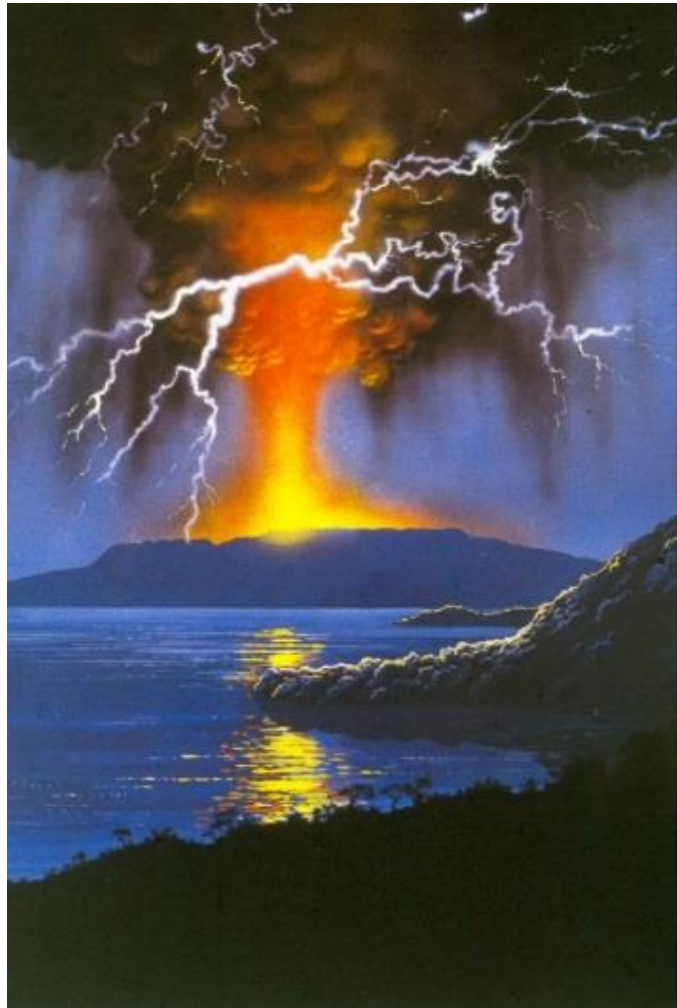


Figure 3. Painting of the Tarawera eruption by Ronald Cometti in 1986 based on historical accounts. Reproduced with permission of the copyright holder: R.J. Kear. www.tarawera.com.

The pre-existing landscape, including a famous tourist attraction, the pink and white silica terraces (Figure 4) was destroyed. A grey mud rained down over the region much to the amazement (and in some cases terror) of the more distant residents who, in the days before radio, had no idea what the material was or from whence it had come from. Ash clouds were observed on ships up to 1000 km north of New Zealand.

Explosions from the eruption were heard hundreds of kilometres away in Auckland and Wellington, causing some people to think a war must have broken out. Several villages within about 6 km of the mountain were buried and about 120 people were killed. Altogether about 2 km³ of material was erupted leaving a rift across the mountain top (Figure 5).



Figure 4. The 'white terraces' painted prior to the 1886 eruption when the terraces were destroyed, buried or lost. Painted by Carl Kahler (photographed with permission of Chateau Tongariro).

Figure 5. The rift that formed across the top of Mt Tarawera in the 1886 eruption. The dark reddish and black deposits are from the 1886 basaltic eruption.



In some places the mud deposited during the Tarawera eruption was eroded into a large-scale hummocky rill pattern, possibly by water-rich outfall from the eruption, or by rainfall immediately after the eruption. The surface then stabilized and became revegetated, however the hummocky erosion pattern is still visible in many areas over 100 years after the event (Figure 6).

Figure 6. The rill eroded hummocky landscape formed in material deposited during the 1886 Tarawera eruption. Vegetation became established and a new topsoil is forming (Figure 7). Farmers added fertilizer and grass-seed to hasten recovery of the productive potential of the land. Further from the source of the eruption, where only a few millimetres of tephra was deposited, it became mixed into the existing soil.



Figure 7. A thin new topsoil has formed in the grey tephra deposit in the 138 years since the eruption. The buried soil that formed the ground surface prior to the 1886 eruption is evident beneath the grey tephra layer.”

Highlands Station

John and Catherine Ford, bull beef and sheep farm.

My father Allen Ford took up and developed the property from 1931, through till 1981, when I returned home to the farm after earning a degree at Lincoln University and some overseas travel. My wife Catherine and I bought this portion of the family farm in 1995. Since then we have intensified it in the usual manner with better access, more paddocks, reticulated water, fertiliser, yards, and renovated all the houses.

- Situated approx. 15 km south Rotorua on Highlands Road.
- 1240 ha total, 922 effective in grass, the balance being mainly retired bush.
- A mix of approx. 450 ha easier rolling contour on which we mainly run bulls, and 470 ha of steeper country on which the sheep are mainly grazed.
- The farm lies within the catchments of Lake Tarawera, and Lake Rotokakahi
- It runs from 420 m to 730 m above sea level.
- 80 % of the farm is Rotomahana Mud soil originating from the Mount Tarawera eruption of 1886. and the remaining 20% Kaharoa Ash soil from the previous eruption in approx. 1350 AD.
- Annual October soil tests are done on the same 8 transects to monitor fertility, currently Olsen P averages 25. pH's's have been gradually dropping on the ash soils and Al levels have gradually increased over the years with a planned lime program being put in place to address this.
- Aerial fertiliser is used annually to put on 20 kg phosphate and 50 kg sulphur per ha on mud soils and an additional 50 kg potash on ash soils.
- Rainfall averages 1850 mm but can range from 1300 to 3100 per annum
- Average pasture growth rates from June to May are 8, 8, 12, 21, 45, 65, 52, 40, 37, 36, 27, 18 in kg dry matter per ha per day.
- We make no supplements and have no crops, but we do use nitrogen in the spring and strategically after a drought in the autumn.
- We have adopted stock policies and stocking rates that as much as possible match the grass growth, slope, and soil type of the farm. So, breeding ewes at approx. 10.5/ha on the steeper hill country, and young cattle at 2.3/ha only on the easier slope and also easily pugged Rotomahana mud soil type area of the farm. Rotational grazing management to also minimise soil and pasture damage.
- The 3,300 ewes are a Romney Wiltshire cross working towards a pure Wiltshire "no-shear" flock with the start of lambing being August 25th, older ewes lambing from September 2nd and hoggets 17th September. The average lambing percentage of the ewes is 155%, the hoggets average 75% lambing. We try to grow our lambs to about 16kg carcass weight over summer, but if the summer is dry, up to half may be sold store to other farmers to be finished.
- Ewes that need shearing are shorn in December and we are gradually phasing out shearing altogether as the sheep breed changes to Wiltshire.
- 930 bull calves arrive in October and November at a minimum of 100 kg, they are grown here for 15 months and then sold to slaughter at an average of 285 kg from

late December through to March depending on markets and season. Calves are drenched monthly and receive B12, 5 in 1, and copper as required through the year, receiving their last drench in September. All animals are weighed whenever yarded, calves are kept in mobs of approx. 25-70 through till February when they go onto their blocks in mob sizes from 14 to 27. The blocks are usually 3 or 4 paddocks and are further subdivided up into 12 cells with polly-wire and rotational grazed around these until spring when half the wires are removed, they continue to shuffle, around these cells until sold, following the replacement calves from October onwards. Grass control is done with topping, and/or big mobs of ewes.

- Our soil is deficient in Co and Se, and we put Co and Se in with our spring fertiliser, as well as supplementation with these in their drenches and vaccines, 2ml of Cu is injected into the cattle every second month and annually for our sheep to counter Cu deficiency due to very high levels of Mo inhibiting the uptake of Cu from the pasture.
- We have 3 staff living on farm and 1 who travels from Rotorua, we use quad and two wheel motorbikes to get around the farm, and the on farm staff have approx. 5 working dogs each.
- Our average Economic Farm Surplus for the last 5 years is \$575 / ha/ yr

Look us up at : <https://www.highlandstation.co.nz/>

And : <https://www.nzfeatrust.org.nz/great-farming-stories/id/163>

John Ford.

See also separate soils information to be handed out on the bus.

Maunga Kākaramēa (Rainbow Mountain) drive by

Maunga Kākaramēa is a dacite lava dome that lies within the active Waiotapu geothermal system. The ~180,000-year-old dome is along or just outside of the southern end of the Ōkātina Volcanic Centre, and the high degree of alteration gives the namesake range in colours. On and around the dome are numerous explosion craters related to the 600 yr Kaharoa eruption at Tarawera, resulting from the disturbance of the hydrothermal system on a regional scale. The surface deposits are from younger eruptions including Taupō pumice, and Rotomahana mud from the 1886 Tarawera eruption was deposited on the lower NE flank. Across the road to the SW is Maungaongaonga, a dome of similar age.

Boiling mud near Waiotapu (if time allows)

The boiling mud here is an “acid steam feature” powered by geothermal heat. Groundwater is heated to steam deep beneath the ground surface. The steam rises through the ground, interacting with the earth materials. The mud is generally about 60 – 80 °C and the steam 100 °C. The form of the boiling mud varies depending on the moisture content. The acids are derived from sulphur and CO₂ dissolved in the water. The combination of water, heat, and acidity makes the steam highly reactive, dissolving and precipitating out minerals, and altering the materials that it moves through to a variety of “hydrothermal clays” including alunite, kaolinite, montmorillonite, silica residue, cristobolite, pyrite and sulphur.

Hazard Management Plan: Australia/NZ Soil Science Conference 2024 Fieldtrip

Date: 3 December 2024

Field Trip Leader: Penny MacCormick

First Aid: A first aid kit will be carried on the bus. Bus leaders have 1st aid training.

F/T Supervisor Mobile Phone: Penny MacCormick 029 368 7464

Other Contributor's Mobile phone(s):

Janine Krippner 0210 866 5566

Emily McKay – 027 233 9801

Kaleb McCollum – 027 336 1450

On Cue Conference organiser: Lea Boodee 021 117 0916

Emergency contacts:

On Cue Conference organiser: Lea Boodee 021 117 0916

Location and Route: Highland Station, Mt Tarawera, Lake Rerewhakaitu, Waiotapu Boiling mud site

Transport arrangements: Commercial bus: departs and returns to Rotorua Energy Events
Centre

Departure Time: 8 am

Return Time: approx 5.30 pm at Rotorua Events Centre

Emergency Plan: Staff ensure site safety – traffic direction - then provide first aid and seek emergency help - police, fire, ambulance call 111.

Alcohol and Drugs

“All persons engaged in field activities have a responsibility to ensure that they are not, through the consumption of alcohol or a drug, in a state that may endanger themselves or any other person.”

Smoking

No smoking in vehicles or buildings during the field trip and smoking outdoors should be limited to areas where non-smokers are unaffected. Care must be taken to ensure that wild-fires are not started in dry vegetation. Please do not leave cigarette butts in the environment.

Participant Capability

Participants must be physically capable relative to the terrain and conditions likely to be encountered. Those with a medical condition which may require special consideration must inform the trip leader. It is the responsibility of the participant to ensure the availability of the necessary medication(s). Other individual factors may also compromise safety of the individual or group and should similarly be notified to the organisers before departure. Personal capability may also change during the field trip, such as through exhaustion or injury. Significant loss of capability should be immediately notified to the field trip leader.

Location 1: Highland Station	Time: A: 8.30 – 10.30am, B: 2-4pm
Hazard: Hypothermia if cold/wet, sunburn if fine. Uneven terrain – tripping hazard, Use of spades and knives to clear profile. Farm vehicles, animals, normal farm hazards such as electric fences. Biosecurity hazard to farm. Fire.	
Mitigation: Participants to bring warm, wind and waterproof clothing, strong covered footwear, and sun hat. Retreat to shelter of bus if necessary. Only nominated, suitably fit, people to use digging equipment, others to keep back. Participants to follow advice of farmer and leaders regarding on-farm hazards. Participants to stay with group, no wandering off unaccompanied. Ensure boots are clean to prevent import of pest plant seeds. Ensure any smoking products are fully extinguished – preferably refrain from smoking.	

Location 2: Okaro Rd, large entrance to farm	Time: approx A: 11.00-11.30am, B: 1:00-1.30pm
Hazard: Proximity to road, farm vehicles, arriving or departing, tripping hazard due to uneven terrain and wet muddy, slippery conditions. Hypothermia if cold/wet, sunburn if fine. Fire.	
Mitigation: Bus to park off road. Participants to wear boots, or other strong, water and mud tolerant footwear, warm clothing. Ensure boots are clean to prevent import of pest plant seeds. Participants to bring warm, wind and waterproof clothing and sun hat. Retreat to shelter of bus if necessary. Participants to stay with group, no wandering off unaccompanied. Keep off main entranceway to avoid obstructing vehicles accessing the farm. Fire – appropriate care with smoking products.	

Location 3: <i>Rerewhakaaitu Domain</i>	Time: approx 12-1.00 pm
Hazard 1: Lake is drowning hazard, uneven terrain, wildlife, fire, sun and cold weather,	
Mitigation: Bus to park near lake within the domain, participants to remain in vicinity of bus and public toilets. No swimming or wading in lake, use common sense, don't feed the wildlife, dispose of cigarette butts responsibly, wear appropriate clothing for conditions.	

Location 4: Mt Tarawera	Time: A: approx 1.00-3.30 pm B: 9.00 – 11.30am
Hazard: 4WD vehicles on rough terrain, trips and falls, sharp scoria, hyperthermia, sunburn, fire.	
Mitigation: Obey instructions of professional trip leaders, seat belts, stay with group, stay back from crater rim, strong closed footwear, sun hats, warm wind and rainproof clothing. No smoking.	

Location 5: Waiotapu mudpool	Time: varies depending on decisions on the day
Hazard: Cars in carpark, cold, sun, getting separated from tour group, severe burn hazard of falling into acidic boiling mud, fire hazard.	
Mitigation: Participants to remain with group, on formed boardwalk and behind barriers. Wear appropriate clothing, seek shelter in bus if necessary. Preferably no smoking. Watch for other cars and be courteous to other visitors to the site.	

Participant Information

Soil Science Conference Fieldtrip, Mt Tarawera, 2024.

My name:
My mobile phone number:
Emergency contact person (name):
Emergency contact person's relationship to me:
Emergency contact person's phone number:
Special requirements dietary and/or health relevant to this field trip:

I have been advised about the physical and safety requirements and the hazards and their mitigations of this field trip and have been given the opportunity to advise the field trip organisers of any special requirements I have. Under the Privacy Act 1993, I agree to the NZSSS collecting this information for the purposes of ensuring that information necessary for Health & Safety in an emergency is available.

Signed: _____

Date: _____ 2021

