

Middle Earth Field Trip



Overview

Welcome to the Middle Earth field trip. We will explore the landscapes and dramatic natural history of this beguiling part of the world. Following the course of the vacillating Waikato River, we'll discover its explosive past and then the tranquil, clear, waters of the Blue Spring. Finally, we'll indulge in the charming film setting of Hobbiton, signing off at the Green Dragon.

Itinerary

8:30 am Depart Claudelands Events Centre, Hamilton

Travel to the Hinuera Gap (60 kms, 1 hour)

9:30 to 10:10 Stop at the Hinuera Natural Stone Quarry

Travel to Blue Springs – Leslie Rd car park (28 kms, 25 minutes)

10:35 to 11:45 Blue Springs

Travel to Hobbiton (35 kms, 35 minutes)

12:20 to 3:30 pm Lunch and tour

Travel to Hamilton via airport (92 kms, 1.5 hours)

Arrive airport 4:15 and return Claudelands by 5:00 pm



Our trip heads south-east and up-stream for the Waikato River from its deeply incised channel through Hamilton City to Cambridge. Although appearing flat, we travel up a large, low angle, alluvial fan of volcanoclastic sediments deposited by the river. Isolated, partly buried, older Pleistocene hills protrude through the large thickness of younger Tauranga Group alluvium near Hamilton.

The Waikato (Aotearoa NZ's longest river at 425 kms) rises on the central north island volcanoes and flows through our largest lake (Lake Taupo, 616 km²). The modern Waikato enters the Hamilton Basin via the Maungatautari Gorge near Cambridge and heads north-west eventually entering the Tasman Sea. For much of its life, however, the Waikato flowed down the Hauraki rift valley and into the Firth of Thames, which opens into the Pacific Ocean.

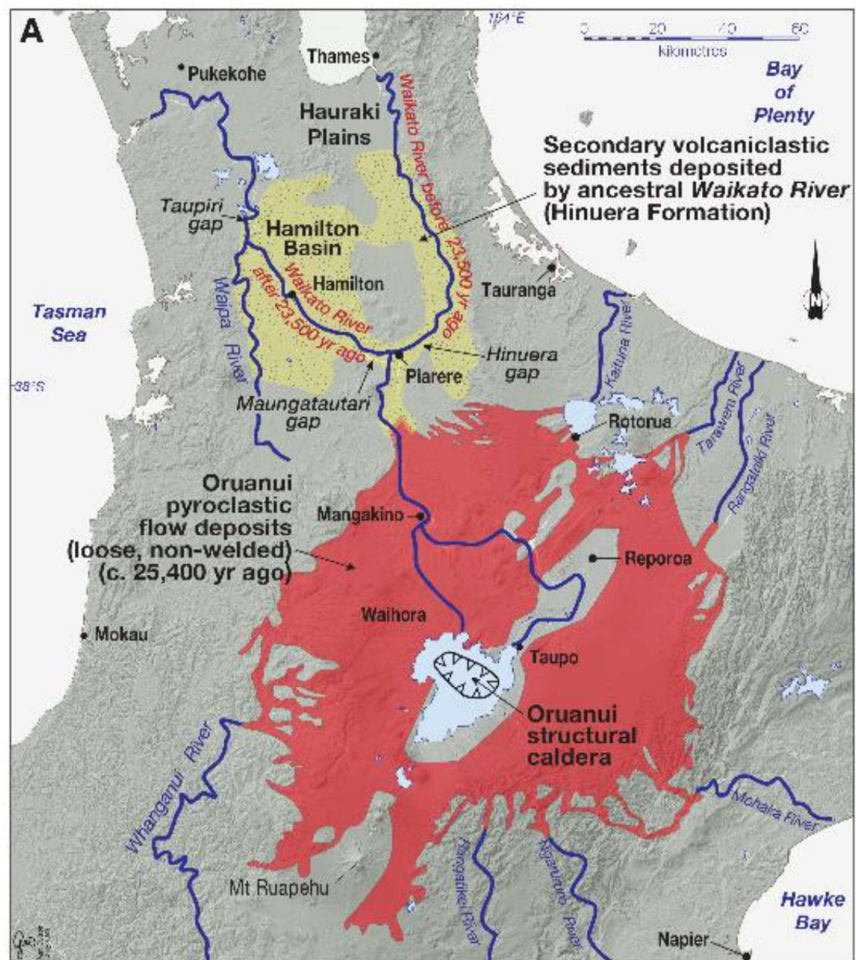
Maori legend recognised the changing path of the Waikato. It is said Taupiri Mountain sent a servant to ask Tongariro for healing waters from a sacred spring.

Tongariro struck a rock releasing a river that followed the servant. At the base of the mountain a huge depression was filled to form Lake Taupo before continuing north.

The Arawa people tried to entice the river through the Bay of Plenty but the servant turned the river back at the Pareroa Range. At Paerere, however, the smell of the sea was too much and it turned down the Hinuera Valley and along the Hauraki Plains to the Firth of Thames.

Taupiri appealed to Tongariro who awakened Ruaumoko (god of volcanoes). He shook the land which heaved and twisted and blocked off the river. The river was forced westward to the foot of Taupiri and on to the Tasman Sea.

(from 'The Wandering River', McCraw, 2011).



Map of current and ancestral Waikato River with Oruanui eruptive deposits
(from Pittari et al., 2023)

We will cross the Waikato River near Cambridge and pass the Karapiro Dam on our left (constructed in 1947 and now producing ~112 MW).

The massive Oruanui eruption in the Taupo area occurred about 26,000 years ago and showered tephra over the greater part of the North Island. It formed Lake Taupo where water rose to a high stand due to the large thickness (up to 200m) of eruptive material in the vicinity. A large breakout flood and the vast amounts of eroded materials contributed to the “avulsion” of the Waikato River from the Hauraki to the Hamilton Basin. It is possible the river vacillated between the two routes before settling on its current preference through the Hamilton Basin. There, it had multiple flow paths forming the large, low-angle fan before becoming entrenched in its current course.

For simulation of an ignimbrite eruption check out <https://youtu.be/Fiq9TSKiWaw?si=QJyXJQ1XBibsoSnq>

The Mighty Waikato River provides water through 60% of the Waikato Region and beyond. Typically, 150 to 400 cumecs is released from Karapiro dam as part of highly coordinated management of a series of eight hydro-dams from Aratiatia near the control gate at Lake Taupo’s outlet. The complex interaction of hydro-lake storage and power generation is considered in managing flows.

The Waikato River is under pressure in respect to water availability. Only about 4% of its total allocation limit (~18.8 cumecs or 10% of the Q5) and 14% above Karapiro (7.4 cumecs or 5% of the Q5) remain available. This leaves limited room for regional growth and expanding demand from Auckland. Projected climate change poses further risk. Consequently, Waikato Regional Council (WRC) is actively assessing long-term water supply security for the region, focusing on summer water availability under future climate projections.



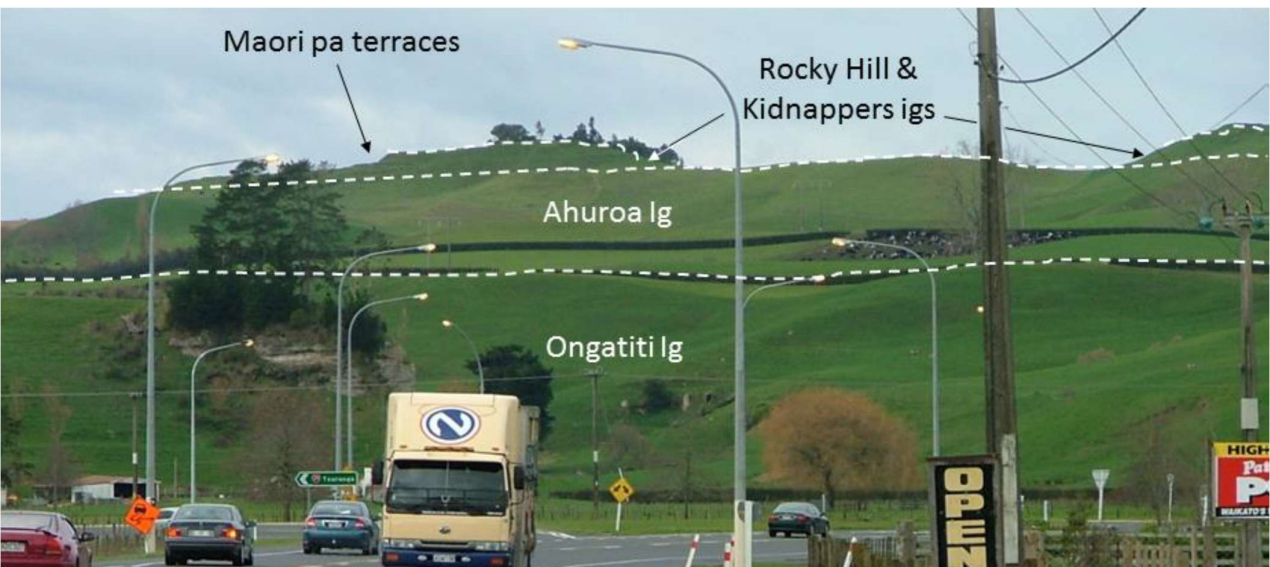
The dam at Karapiro forms the lake at which RowingNZ has its headquarters. Further south Mt Maungatautari is visible rising 600 m above the landscape on our right. This andesitic-dacitic volcano, formed 1.8 M years ago, is the site of a large ecological sanctuary and restoration project. We cross back over the Waikato at Horahora and like the ancestral river head for the Hinuera Gap. This is where the northward course of the river now makes an almost right-angle turn to shoot the Maungatautari Gap for the Hamilton Basin.

About two million years ago there was a violent eruptive episode in Middle Earth. Clouds of red-hot pumice and other volcanic debris raced at high speed from rhyolite volcanoes in the central North Island. These pyroclastic flows swept carpets of ‘ignimbrite’ over the land. This term first used by Patrick Marshall and NZ geologists in the 1920s has since been adopted worldwide. Where there was sufficient thickness and heat the ignimbrites became welded and fractured. The unwelded ignimbrites remained soft and easily eroded, providing large quantities of alluvium. The resulting landscape with rolling hills and bluffs were ideal for the hobbits of the Shire.

Hinuera Gap and Natural Stone Quarry (Stop 1):



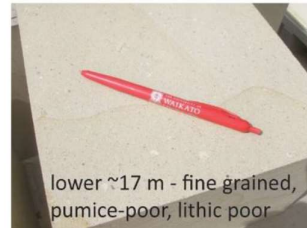
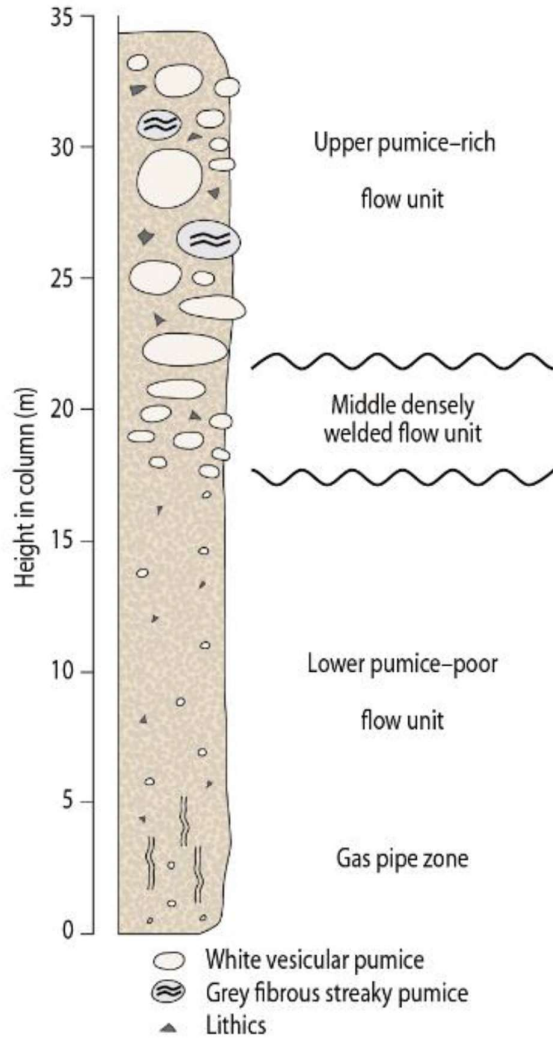
A succession of ignimbrites of the Pakaumanu Group are visible forming the landscape and prominent bluffs on either side of the Hinuera Gap. These erupted from the early, rhyolitic Mangakino Volcanic Centre active from 1.6 to 0.9 Ma.



Hinuera Valley near Piarere showing the tiered landscape, each terrace representing different ignimbrites of the MVC (from Pittari et al 2023).

The Hinuera Natural Stone Quarry crafts stone of character and story. The Ongatiti Ignimbrite in the quarry (1.37 Ma) erupted in a cataclysmic event ($\sim 1000 \text{ km}^3$) from the Mangakino Caldera ~ 50 kms to the south. Ongatiti Ignimbrite has a buff to light yellow, vitrophyric matrix. The pumice content increases upwards from $<15\%$ to about 30% . Lithic clasts ($<2\%$ Upper) include greywacke, andesite and rhyolite. Ongatiti Ignimbrite forms prominent bluffs (>35 m at the quarry) with wide, columnar to block joints (1-5 m). There are three main quarry grades 'Awa' (lower), 'Dura' (middle), and 'Vitric' or 'Ahi' (upper), which vary in strength, hardness and appearance.





Stratigraphic log of Ongatiti Ignimbrite at the Hinuera Quarry with photos of the three main facies (Pittari et al., 2023).

There is a groundwater well (64_311) at the quarry which is 71 m deep with 45 m of casing. The static water level is about 32 m below ground and the aquifer has a modest transmissivity of about $15 \text{ m}^2 \text{ d}^{-1}$.

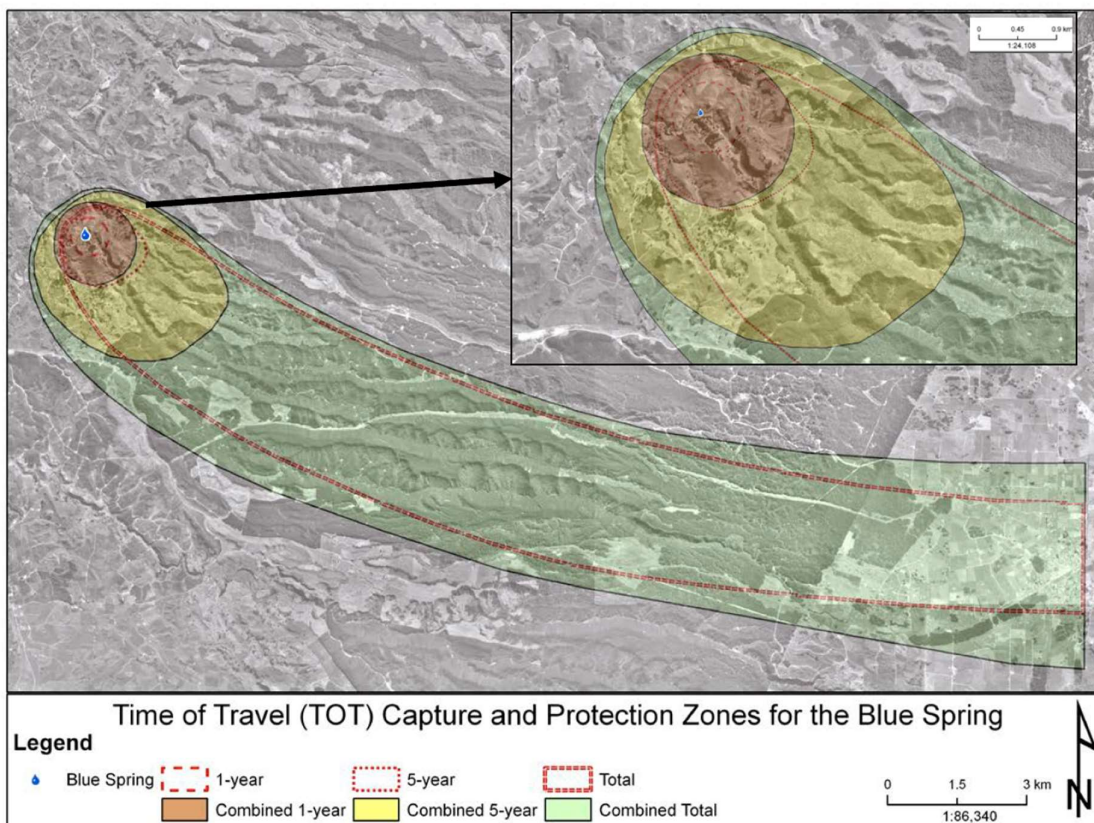
Blue Spring (Stop 2):

The Blue Spring on the true right bank of the Waihou River near Putaruru has, in recent years, become a tourist attraction due to its exceptionally clear, turquoise water and picturesque walkway.

It has significant cultural importance for local iwi Ngati Ruakawa who are mana whenua and have a kaitiaki role.



The Blue Spring is a source of community water supply providing up to 4,000 m³ d⁻¹ of water for the town of Putaruru, as well as providing much of Aotearoa NZ's bottled water. It is on the eastern edge of the Mamaku Plateau. The bluffs in the area are generally formed of Pokai Ignimbrite, although the spring itself discharges from a fracture probably in Whakamaru Ignimbrite. GNS Science was contracted to delineate preliminary protection zones (below) for the Blue Spring in 2011 using the GWFLOW semi-analytical model (Gusyev, et al., 2011).



Delineated protection zones based on 1 and 5 year travel times and total capture.

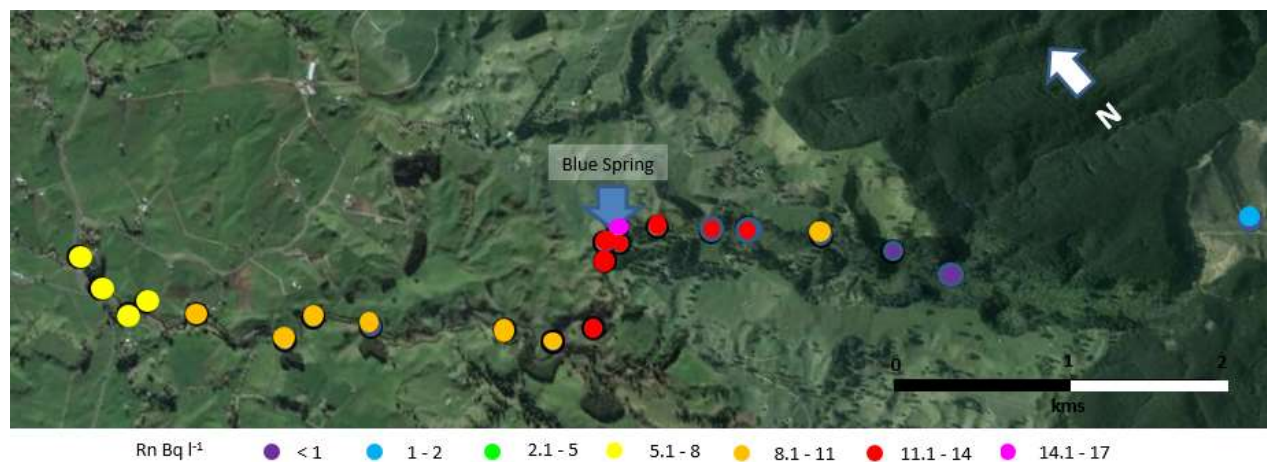
The delineation zones mapped above are based on estimated one (~0.5 km²) and five (~2.2 km²) year travel times. The total capture zone (~64 km²) was also delineated extending to the flow divide in the Mamaku area. Uncertainty has been considered by using a range of probable aquifer and other parameters. Isotopic water age dating indicating a mean residence time at the Blue Spring of about 56 years provided important calibration information.

Further investigation of groundwater surface water interaction in the vicinity of the Blue Spring was undertaken by WRC (Hadfield et al, 2016). A combination of flow gauging, radon and hydrochemistry surveying was used to identify groundwater inflows to the Waihou River.

Although flow from the Blue Spring had been estimated at 0.682 m³ s⁻¹ and 0.498 m³ s⁻¹ in 1988 and 2001 respectively, previous hydrogeological information was limited. Simultaneous surveys of flow and water quality included 19 flow gaugings and 26 radon samples along the main stem of the Waihou and selected tributaries. Radon is a noble gas continuously produced by radioactive decay of ²²⁶Rn present in formation. It is readily volatilised from water on exposure to air. It can therefore be used as a tracer of groundwater input to surface waters.

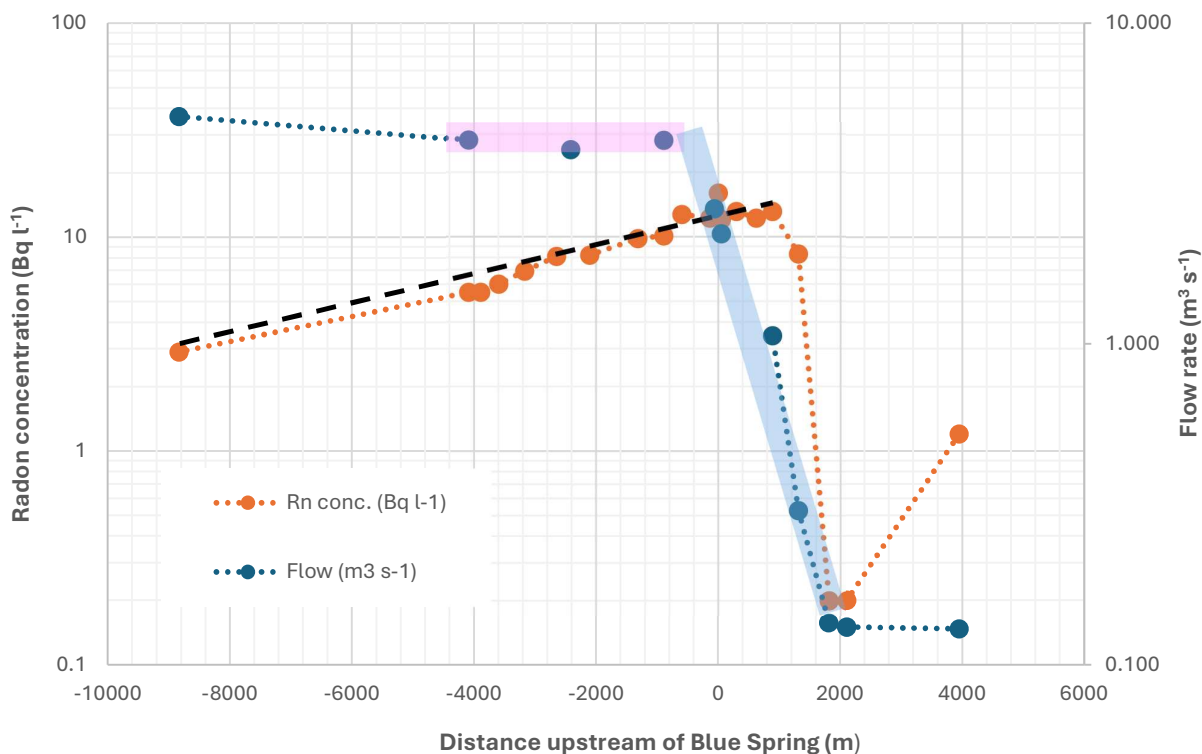


Radon concentrations from the 22 Waihou River main stem samples varied substantially from 0.2 Bq L⁻¹ to 16.0 Bq L⁻¹, with the highest concentration measured in the Blue Spring (figure below). Due to this signal contrast, radon was found to be a very useful and cost-effective indicator of groundwater inflow. Results showed the majority of groundwater inflow (about 4.5 cumecs) occurred via seepage from 1,200 m above the Blue Spring to 800 m below it. The spring itself was calculated to be flowing at a rate of about 0.43 cumecs or only about 10% of the total groundwater discharge to the Waihou River in the vicinity.



Radon concentration variation in the vicinity of Blue Spring (downstream to the left)

The figure below shows that the radon concentration increases along the section of groundwater inflow (blue shaded). It then dissipates to the atmosphere downstream where the flow remains roughly constant (pink shaded). The loss of radon to the air is exponential (dashed line), with an estimated first order rate of about $2 \times 10^4 \text{ Bq l}^{-1} \text{ m}^{-1}$. The steady nature of the radon concentration decline suggests relatively little groundwater surface water interaction further downstream (pink zone.)



Radon concentration and flow variation in the vicinity of Blue Spring

WRC has been monitored the quality of water in the Waihou River at Whites Rd (1122_41) about 4,100 m downstream of the Blue Spring since 1983. In that time the nitrate concentration has steadily increased from about 0.4 g m^{-3} to now about 1 g m^{-3} . This reflects the slow and lagged impacts of land-use via groundwater.

We now drive north to Hobbiton through a small part of the southern Hauraki Plains. Although traditionally dairy country there has been increased market gardening in more recent years. Groundwater is utilised from coarser sandy aquifers near the Hinuera Gap with sediments generally becoming finer toward the north.

Hobbiton (Stop 3)

Here we will have lunch and tour the movie set. The landscape of rolling hills and grassy farmland forms the ideal Hobbit homeland. Ignimbrite, such as the Rocky Hill member of the Pakaumanu Group is draped with tephra-loess-paleosol cover. In the distance to the East are the upthrown Kaimai Ranges (over which the sun [sets](#)). Major faults on either side of the Hauraki Plains form part of the larger rift valley.



References

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- Pittari, A., Prentice, M. and Yousefzadeh, E., 2023: IAVCEI Field trip guide, School of Science, University of Waikato, Hamilton, New Zealand.

Acknowledgements

We would like to thank the staff of Hinuera Natural Stone, Raukawa and South Waikato District Council for their contributions at the quarry and Blue Spring. Also, Adrian Pittari from the University of Waikato for helpful comment about the ignimbrites of Middle Earth.

