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91191

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NZQA

NEW ZEALAND QUALIFICATIONS AUTHORITY
MANA TOHU MĀTAURANGA O AOTEAROA

QUALIFY FOR THE FUTURE WORLD
KIA NOHO TAKATŪ KI TŌ ĀMUA AO!

Tick this box if you have NOT written in this booklet

# Level 2 Earth and Space Science 2022

## 91191 Demonstrate understanding of the causes of extreme Earth events in New Zealand

Credits: Four

| Achievement | Achievement with Merit | Achievement with Excellence |
|---|---|---|
| Demonstrate understanding of the causes of extreme Earth events in New Zealand. | Demonstrate in-depth understanding of the causes of extreme Earth events in New Zealand. | Demonstrate comprehensive understanding of the causes of extreme Earth events in New Zealand. |

Check that the National Student Number (NSN) on your admission slip is the same as the number at the top of this page.

**You should attempt ALL the questions in this booklet.**

If you need more room for any answer, use the extra space provided at the back of this booklet.

Check that this booklet has pages 2–16 in the correct order and that none of these pages is blank.

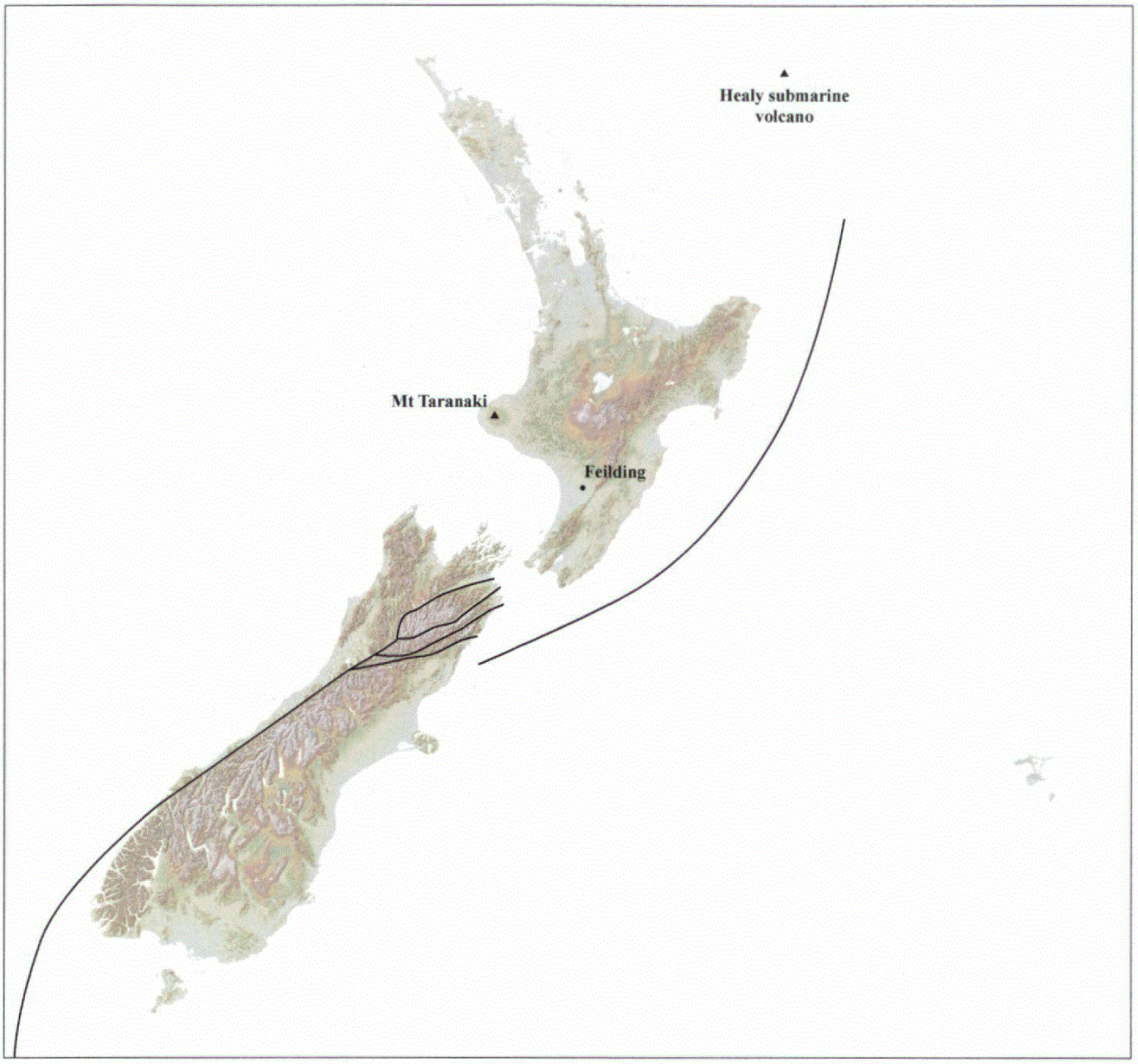
Do not write in any cross-hatched area (▨). This area may be cut off when the booklet is marked.

**YOU MUST HAND THIS BOOKLET TO THE SUPERVISOR AT THE END OF THE EXAMINATION.**

**Achievement**

**TOTAL** 12

**Regional map showing locations referred to in this paper**



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**The examination continues on the following page.**

## QUESTION ONE: MT TARANAKI

Mt Taranaki is a stratovolcano (conducive) found on the west coast of the North Island of New Zealand. It is the most recent of a sequence of volcanoes that erupted in this region over the last 600 000 years (see the diagram below). Mt Taranaki last erupted in 1854; Fantham's Peak is expected to be the next location of an eruption.

Adapted from: https://upload.wikimedia.org/wikipedia/commons/b/b7/NEO_egmont_big.jpg

(a) Annotate and label the diagram below to show how plate tectonics led to the formation of Mt Taranaki.

In your answer, you should:

- add arrows to show the plate movements
- name the two tectonic plates
- explain the key process indicated.

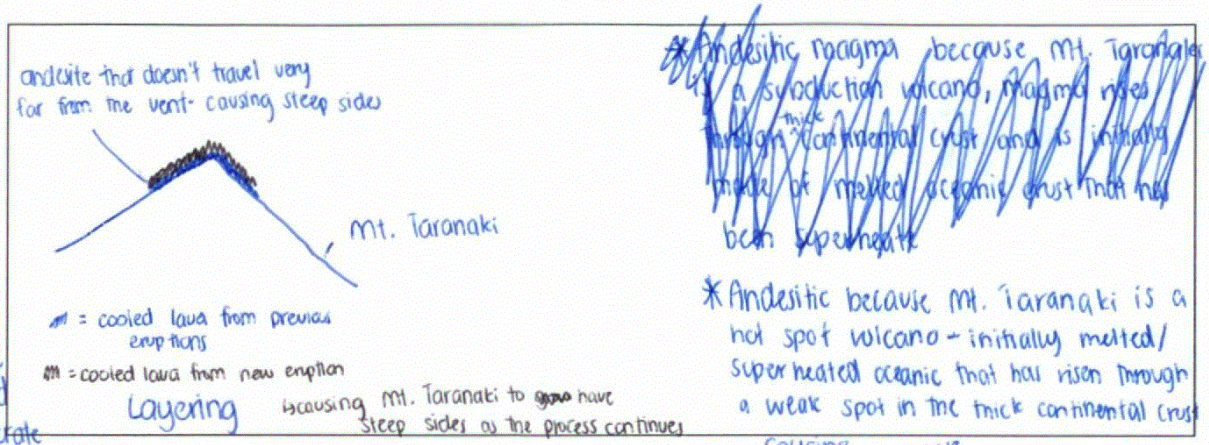

Adapted from https://teara.govt.nz/en/diagram/8693/subduction-under-the-north-island

(b) Explain, in detail, how andesitic magma leads to the formation of a stratovolcano.

In your answer, you should:

- describe the characteristics of andesitic magma
- explain how layering contributes to the shape of Mt Taranaki
- explain the link between magma composition and the shape of Mt Taranaki.

*An annotated diagram may assist your answer.*




*Andesitic magma because Mt. Taranaki is a subduction volcano, magma rises through thick continental crust and is initially made of melted oceanic crust that has been superheated

*Andesitic because Mt. Taranaki is a hot spot volcano - initially melted/ superheated oceanic that has risen through a weak spot in the thick continental crust causing to have

*It is moderately hot (≈ 600°c - 1000°c) and has a moderate silica/gas content,

Andesitic magma is a mixture of basalt and rhyolite. It has an intermediate viscosity/ a 'golden syrup' type of flow. This means it will not travel a very large distance from the vent before cooling, forming Mt Taranaki's steep sides. *Layering contributes to the shape of Mt. Taranaki because each time it erupts, the andesitic lava doesn't travel very far (due to andesite's moderate viscosity), so each time new lava cools on top of the cooled lava from previous eruptions, it forms layers. These layers eventually build up to form the steep sides of Mt. Taranaki /stratovolcanoes (also, if Fanthams Peak erupts, that erupted magma/lava will also cool to form a layer, leading to the steep sides). As andesitic magma is moderately viscous/has a moderate gas content, the lava erupted won't travel a great distance from the vent (further than rhyolite but less distance than basalt), meaning that as it builds up each time Mt. Taranaki erupts, it will cool relatively close to the vent, forming the steep sides/peak of Mt. Taranaki.

*Stratovolcanoes tend to be very tall and have steep sides due to the magma cooling close to the vent.

(c) Past eruptions of Mt Taranaki have produced lavas, pyroclastic flows, ash, and landslides.

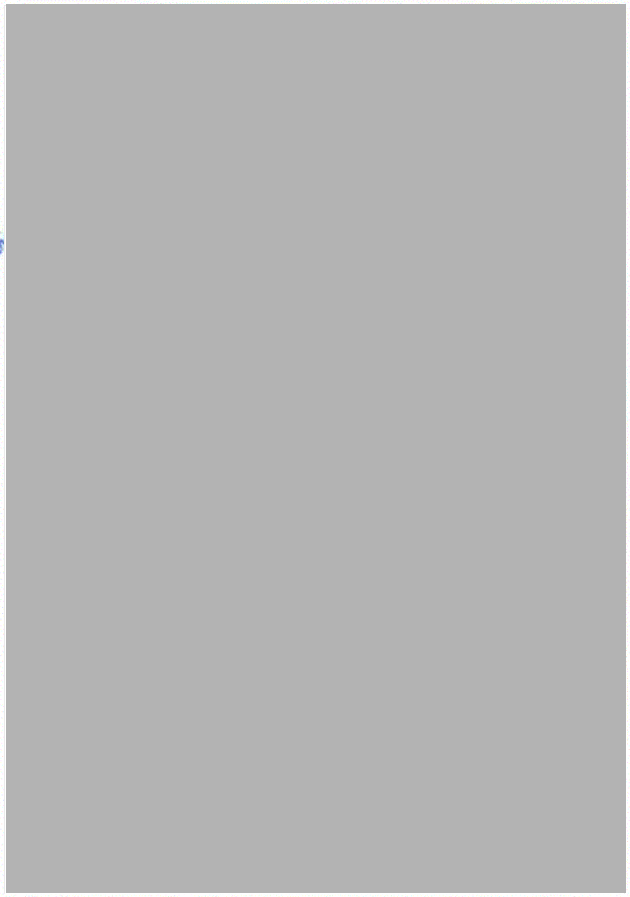
A volcanic eruption from Fantham's Peak, south-west of Mt Taranaki, has been assessed as a moderate to very high hazard for the Taranaki region.

lavas, pyroclastic flows, ash, landslides, coastal tsunami

Explain, in detail, how the likely products of a future eruption may affect the surrounding area.

In your answer, you should consider:

- the links between magma composition and eruptive products produced
- the potential distance travelled by the eruptive products
- the potential effects of the eruptive products on the surrounding area.



Adapted from: https://resiliencechallenge.nz/wp-content/uploads/2018/08/McDonald-Cronin-et-al-2017.pdf

Because andesitic magma has a moderate viscosity/gas content, and doesn't travel very fast, lava flows when Fantham's Peak erupts will only affect those relatively near by/close to Fantham's Peak's vent (golden syrup' flow so won't travel very far). The lava flows will cool before reaching any large 'townships', so will not be the main concern for this eruption. (Lava won't encounter water so phreatomagmatic eruption won't occur).

Pyroclastic flows are large, dense, ground-hugging clouds of dust/ash/volcanic material that can travel at extremely high speeds. This could be of concern to the Taranaki region because Andesite can erupt moderately violent (due to intermediate silica/gas content - expand and cause violent eruptions), meaning surrounding rock/tephra may be erupted with it, forming violent pyroclastic flows. These flows may travel a large distance, so will have the greatest effect on the red region (tephra/volcanic material hasn't 'settled' in a new area) as the pyroclastic flows will have the most force. As it travels away from the vent, the energy behind it will dissipate, so it will decrease in speed, but may effect those

in the orange/yellow areas (pyroclastic flows are extremely hot and powerful, they can severely burn people, tephra can injure them, and they can cause structural damage - meeting the moderate - high hazard).

Ash is a cloud of gases/dust/tephra that rises into the atmosphere during a volcanic eruption. As andesite erupts moderately violently, a large amount of ash may be produced (moderate amount of gas in the magma that erupts and joins the ash cloud). This ash can be extremely dense and contain rocks/tephra that may cause injury. Due to the force of gravity, the ash will fall back to the earth at relative speeds and at points far from the vent (due to wind carrying it). This means that the ash will affect those all around the Taranaki region due to it having travelled with the wind and it can cause serious breathing issues (polluted air), injury (from falling tephra) and environmental issues (as the air purity is disrupted for large distances/ash may enter water-ways, affecting wildlife and drinking ability), again, meeting the moderate - high hazard.

* structural damage (ash is heavy/dense so can cause buildings to collapse - potentially harming people),

Landslides are a large movement of land (or vegetation) that can cause severe damage. Because andesite erupts moderately violently, it can trigger earthquakes (if it occurs near a fault). This (shaking/movement of rock) can lead to landslides that may affect region areas closer to Mt. Taranaki. As landslides often 'wipe-out' most things in their path and can travel large distances, those in the red/orange area will likely be effected. The landslide may remove vegetation, structures and water-systems, which will severely impact all of those in the surrounding region.

Tephra/debris carried in pyroclastic flows, ash and landslides can land in the water surrounding Taranaki, potentially causing tsunamis, which would impact those close to the coastline the most.

## QUESTION TWO: RECLASSIFIED FAULT LINE IN FEILDING

A science report published in 2021 has reclassified a number of fault lines in the Manawatū area from inactive to active.

One of these fault lines is the Rauoterangi fault, which passes through the centre of Feilding township, including underneath a local school.


Adapted from: https://data.gns.cri.nz/af/

(a) Describe what a fault line is.

~~A fault line is where 2 tectonic plates move past eachother~~

A fault line is a 'crack' (fracture) in the rock/crust that has been formed (in a weak spot) by a build up of stress between the rocks.

(b) Explain, in detail, how tectonic plate movement could lead to an earthquake along the Rauoterangi fault, which is over 200 km away from the plate boundary (refer to the New Zealand map on page 2).

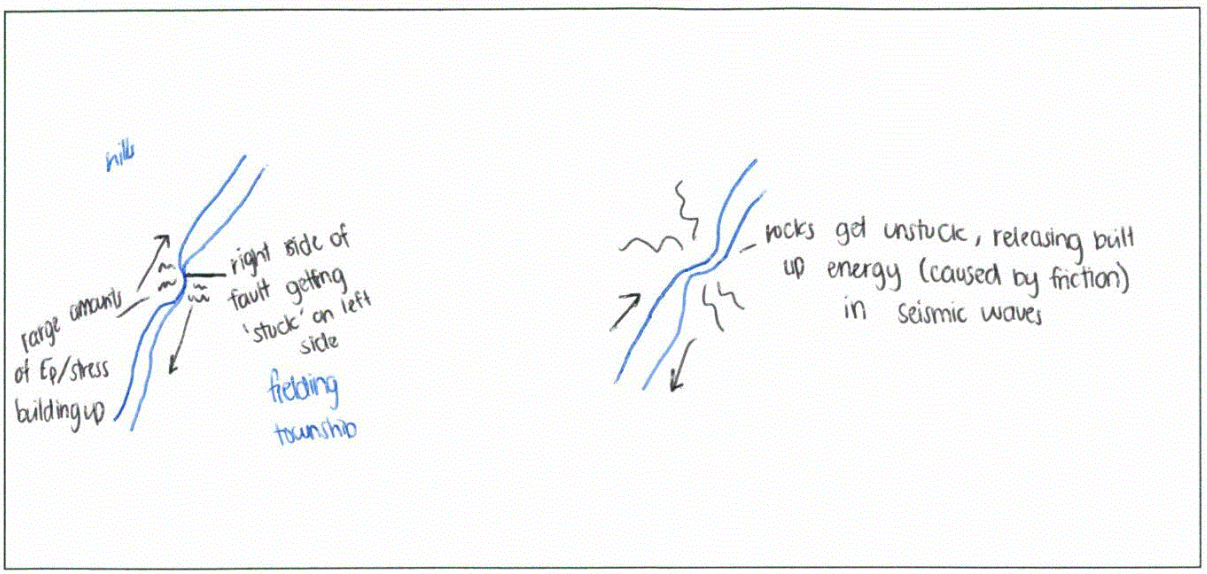
In your answer, you should:

- name and describe the tectonic plates involved
- describe the type of plate boundary involved
- link the plate movement to the formation of an earthquake.

(what)

*An annotated diagram may assist your answer.*

Tectonic plates move due to convection currents in the mantle (where hot/less dense magma rises, travels along parallel to the crust and sinks back down into the mantle when it cools). The 2 tectonic plates that have lead to the Rauoterangi fault are the Pacific Plate and the Australian Plate (AP). Off (PP)




The east coast of NZ, the dense PP (made of oceanic crust) subducts underneath the less dense AP (made of continental crust). These don't always move smoothly, so they can get 'stuck', which causes a large amount stress / Ep to build up and travel through the rocks. This stress is what caused the fracture over 200km away from the plate boundary (where subduction occurs and the PP is pushed under the AP). When the plates 'unstick' at the boundary, a massive amount of energy gets released, causing the earthquake. As the Raoteranga fault is over 200km away from this boundary, earthquakes here are formed due to the 2 rocks (with a crack between them) moving in a dextral fault/sliding past eachother. These 2 rocks can also get 'stuck' and build up a large amount of stress/Ep, causing deformation of the surrounding rock. When they finally get unstuck, all of the built up energy is released, causing an earthquake along this fault that is now classified as active. An active fault is one that has had an earthquake in the last 10,000 years.

in seismic waves

* An earthquake is the movement of rock in the crust due to a sudden release of energy.

| Standard | AS 91191 | Display ID | 62074542<br>NSN-142637128 | Total score | 12 = A |
|---|---|---|---|---|---|
| **Q** | **Grade score** | **Annotation** | | | |
| 1 | A4 | The candidate has a well labelled diagram, has provided a characteristic of the andesitic magma, the shape of the volcano and has stated the eruptive products will cause damage. To reach an M5 the candidate needed to link ideas, such as the effect of landslides | | | |
| 2 | A4 | The candidate provides enough evidence in this question for an A4. They explained aspects of earthquake formation, however, more detail is needed to reach M5. | | | |
| 3 | A4 | This answer provides evidence towards A4 rather than M5. They have described how the water was displaced and the energy transferred to the water but for a higher grade a link to the eruption size and energy is required. | | | |