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Draw a cross through the box (☒) if you have NOT written in this booklet

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NZQA

Mana Tohu Mātauranga o Aotearoa
New Zealand Qualifications Authority

Level 2 Earth & Space Science 2023

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 2–20 in the correct order and that none of these pages is blank.

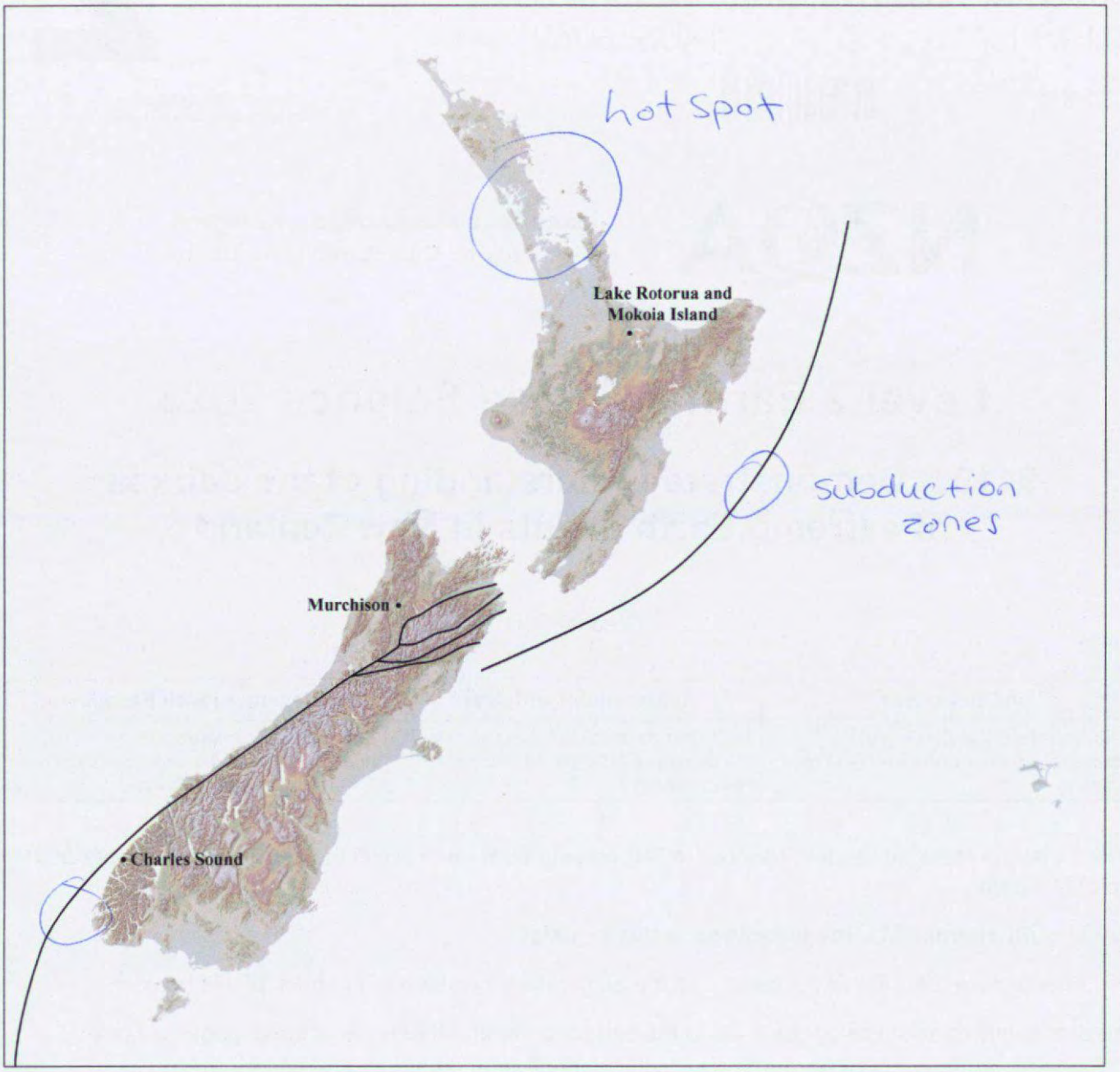
Do not write in any cross-hatched area (DO NOT WRITE IN THIS AREA DO NOT WRITE). This area will be cut off when the booklet is marked.

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

Merit

TOTAL 16

Regional map showing locations referred to in this paper



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The assessment begins on the following page.

QUESTION ONE: LAKE ROTORUA AND MOKOIA ISLAND

Lake Rotorua is a large rhyolitic caldera found in the Taupo Volcanic Zone (TVZ) in the North Island of New Zealand.

It was formed in a single eruption about 240 000 years ago.

Mokoia Island, found roughly in the centre of Lake Rotorua, is a rhyolitic lava dome that erupted sometime after the Rotorua caldera collapsed.

Adapted from www.mokoiaisland.co.nz

(a) Complete the table below to describe the characteristics of rhyolitic magma as either HIGH, LOW, or INTERMEDIATE.

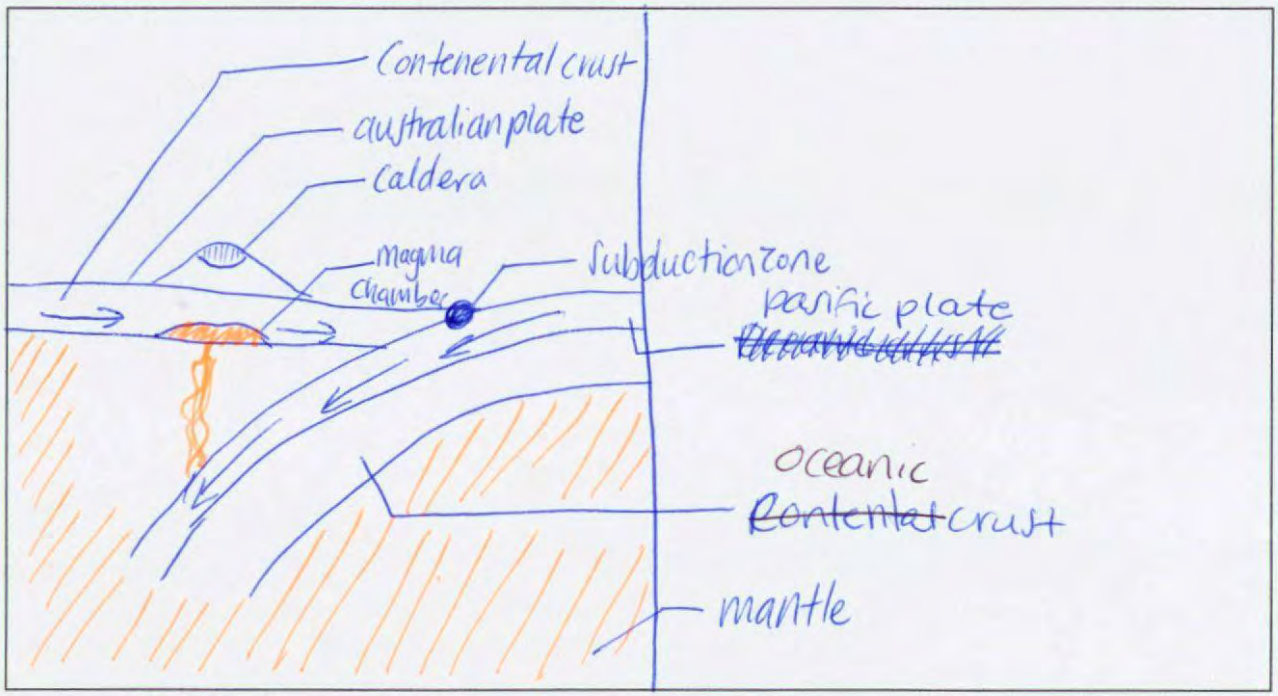
	Temperature	Silica Content	Viscosity	Gas Content
Rhyolitic magma	~~[illegible]~~ LOW	~~[illegible]~~ HIGH	HIGH	HIGH

(b) Explain, in detail, how tectonic processes led to the formation of rhyolitic magma in the TVZ.

In your answer you should consider:

- the map on page 2
- the tectonic plates involved and their movement relative to each other Subduction
- the type of crust involved at the plate boundary
- the key tectonic processes that led to the formation of rhyolitic magma at this boundary.

An annotated diagram may assist your answer.



The location of the lake rotorua caldera, is on the Subduction zone in the north island. Here the Australian plate gets pushed up over the pasific

plate which is Subducting down. the contental crust that the Australian plate sits on is ~~more~~ less dense, where as the oceanic crust which the pasific plate sits on is move dense ~~and~~ and sinks under. This causes a subduction zone. This boundry causes alot of friction and distorts both plates. ~~be~~ also because of this the oceanic plate sinks and melts into magma in the mantle. This hot magma Slowly begins to melt the thin crust above until this magma is able to escape. ~~this slowly broke~~ the thin crust that it has melted away leaves a magma chamber close to the surface. because of the small amount of crust still above the magma chamber gas begins to build as it cannot escape making the magma inside very viscous and high in silica content. The gas comes from water vapor that is created when the oceanic crust is being melted.

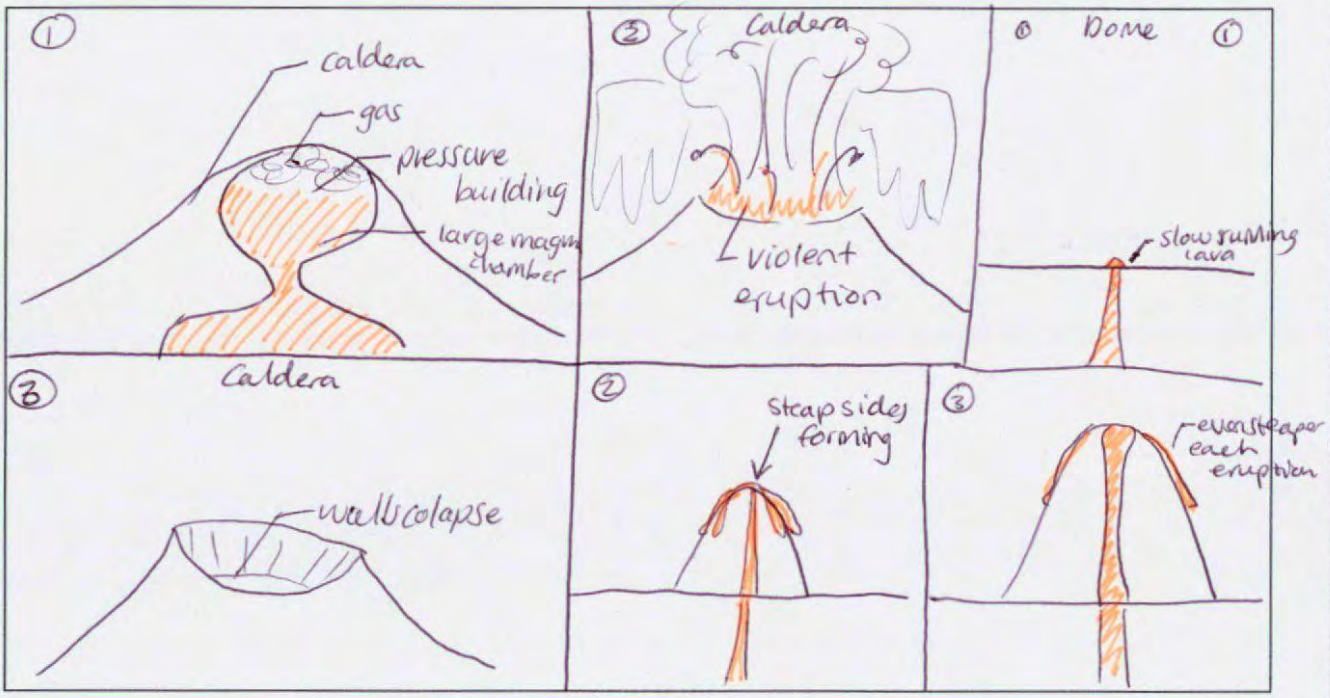
~~Rhyolitic~~ magmatic eruption 6 pleatomagmatic eruption.

(c) Explain, in detail, with reference to Lake Rotorua and Mokoia Island, how rhyolitic magma could produce both a caldera and a dome in the same location.

In your answer you should consider:

- any differences in the characteristics of rhyolitic magma in a caldera and dome volcano
- how a caldera is formed violent eruption
- how a dome volcano is formed. gentel eruption

An annotated diagram may assist your answer.



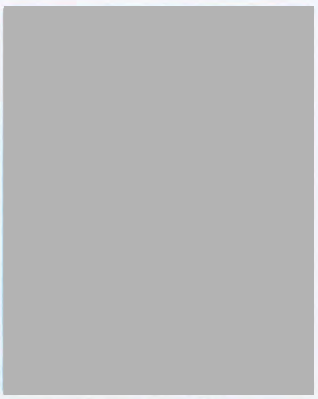
Rhyolitic magma can be highly explosive because of its gas and silica content. But if the gas can escape pressure is released and the explosion will be much less violent. Calderas are formed by gas being unable to escape the large magma chamber, the pressure becoming too great and it ~~exp~~ violently erupting. ~~whereas Dome volcanos also contain rhyolitic magma only the gas is able~~ and the walls of the volcano ~~to~~ collapsing in on themselves creating the Crator, this crator often fills with rain water turning ~~from~~ into lakes such as Lake rotorua and lake taupo. where as Dome volcanoes still also contain rhyolitic magma only the gas is able to escape making the eruptions more gentle. The dome volcano gets its

shape by the highly viscous magma. The ryolitic ~~make~~ magma causes the lava to be very sticky and slow running. Every time the volcano erupts the viscous lava slowly runs down the sides and solidifys quickly causing extremly steep ~~##~~ sides. Calderas often have magmatic eruptions which the gas in the magma causes it to bubble, they also tend to have phreato magmatic eruptions which is when the water particles are turned in to water vapour and increase the liquid content ~~by~~ 10,000 times, which makes these eruptions extremely explosave, damaging ~~to~~ the bioshpere, geophere hydrosphere and especially the atmosphere.

QUESTION TWO: 1929 MURCHISON EARTHQUAKE

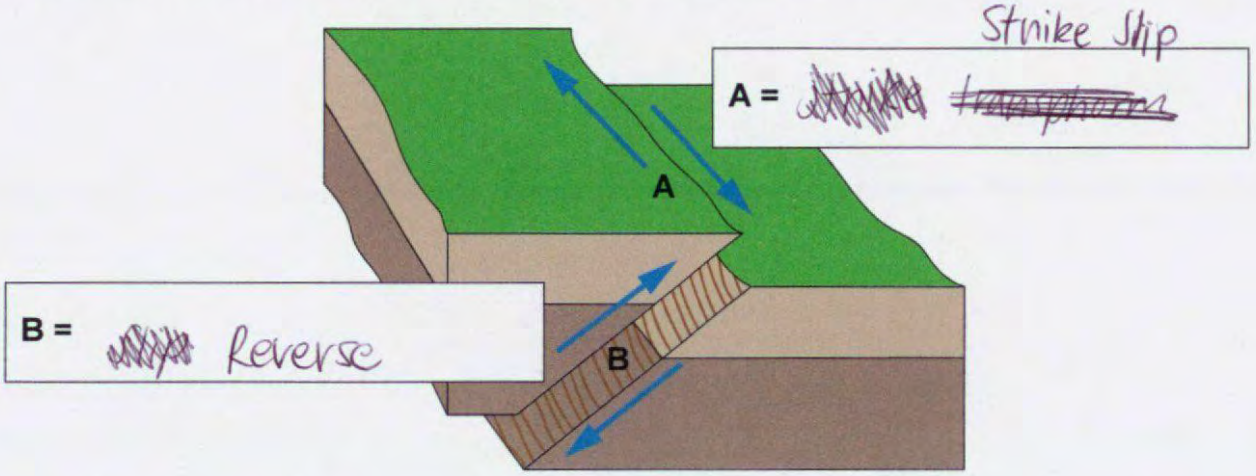
On 17 June 1929, a magnitude 7.3 earthquake at a depth of 20 km struck on the White Creek fault, 15 km northwest of Murchison.

The earthquake resulted in approximately 4.5 m of vertical uplift, and 2.5 m of sideways movement, along the White Creek fault.



Source: https://en.wikipedia.org/wiki/1929_Murchison_earthquake

(a) On the diagram below, name the fault type represented by the movement at **A**, and the fault type represented by the movement at **B**.

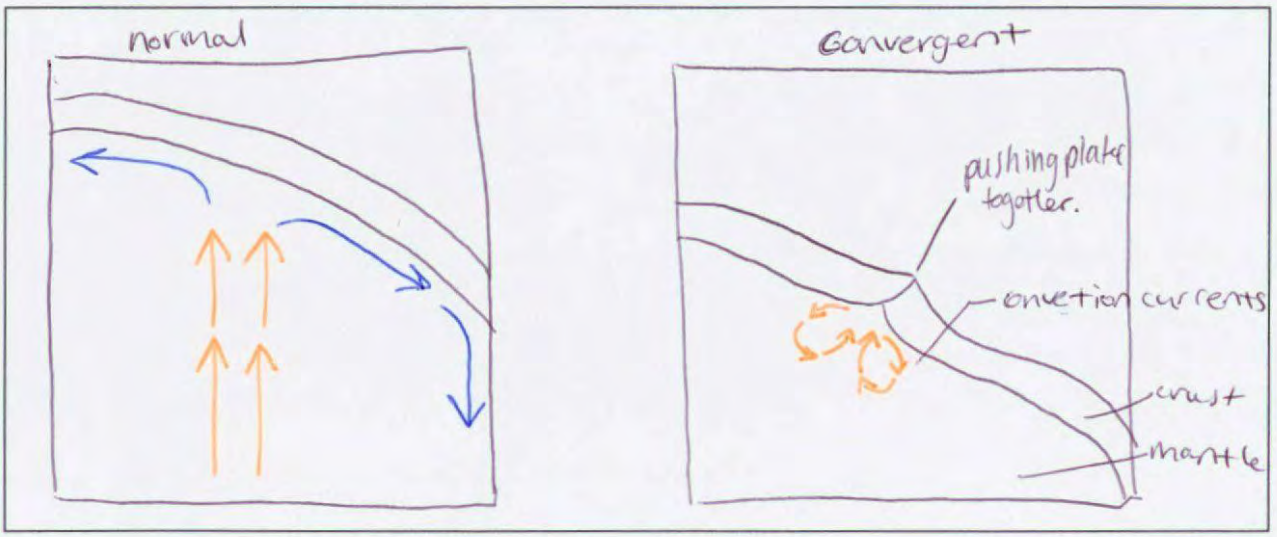


(b) Explain, in detail, how a rupture along the White Creek fault line could lead to a magnitude 7.3 earthquake.

In your answer you should consider:

- the map on page 2
- the tectonic plate movements associated with this earthquake
- what a fault is
- the likely cause of this large-magnitude earthquake.

An annotated diagram may assist your answer.



This is a complicated fault line as it is an oblique strike slip, reverse fault. A fault line is a small fracture in the rock caused by an earthquake or high pressure. fault lines can be far away from plate boundarys. depending on the sizes of the fault and how large the pressure is & the magnitude of the earthquake that will be generated. Because of the close proximity of the alpine fault the pressure will be great, because of the constant movement this will aply high stress to the surround faults causing large magnitude earthquakes such as the white creek fault that had a 7.3 magnitude earthquake. Convergent plate boundarys are often accociated with this earthquake as the pressure from convection currents in the mantle forcing the plates together one slips causing this earthquake convergent plate baundarys are also very common in the south island which is evidant from the alpine fault which are large mountains made by this converging. another plate movement often accosiated with this fault type is transphorm plate boundarys which slip past each other vertically causing high amounts of friction and stress pressure.

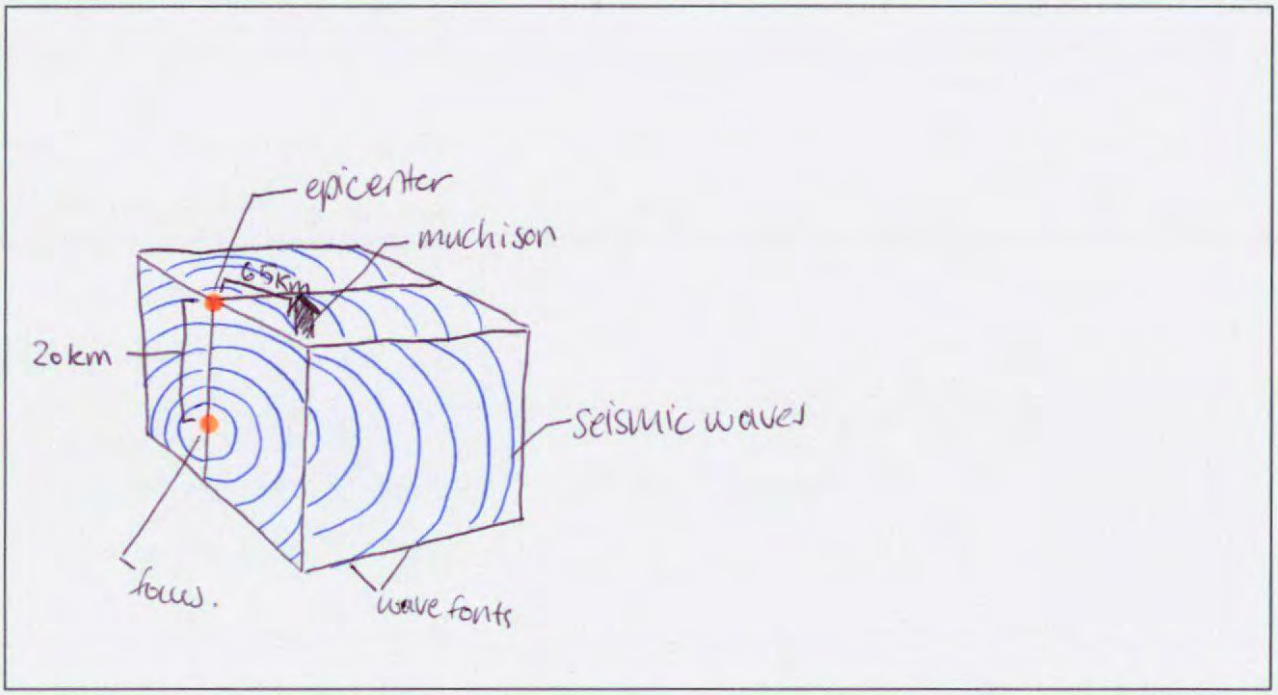
(c) The earthquake was felt throughout New Zealand, with the most intense shaking occurring within approximately 65 km of Murchison.

Explain, in detail, why damage and shaking was greatest close to Murchison, but the earthquake was felt throughout New Zealand.

In your answer you should consider:

- energy
- seismic waves
- the focus and epicentre of an earthquake.

An annotated diagram may assist your answer.



The focus is the point ~~which~~ which the earthquake started ~~at~~ under ground, the point directly above the focus on top of the ground is the epicenter, and the space inbetween the two is the depth of the earth quake. Seismic waves are waves of energy released by the fault rupturing, they are due to elastic potential energy being stored and suddenly released. There are two types of seismic waves Body and Surface. Body waves come in primary which move particles back and ~~forth~~ forth, ~~and~~ as well as secondary which move particles perpendicular. These seismic waves can be felt and do little to no damage. where as surface waves are much

more distructaive. Surface waves ~~also~~ have Love waves and reighly waves. Love waves travel close to the surface and role in the same motion as ocean waves. Reighly waves also move close to the surface exept they rock the earth ~~to~~ side to side. Both of these waves are ~~very~~ highly distructave because of their proximity to the earths surface. The depth of the earthquake was 20km this is shallow for an earthquake because of this ~~and~~ the 7.3 magnitude and close proximity (65km) the earthquake would have been very damaging to murchison. because of the relitave closeness to the focus the energy would be great and so would the damage. because the seismic waves had no time to displace ~~the energy~~ energy the concentration of the waves would have ~~gone~~ caused alot of shaking and damage. because of the magnitude and shallow depth of the earthquake the seismic waves given off could have bounced of the basaltic hills and amplifyed, or triggered other smaller faults to rupture.

QUESTION THREE: 2003 FIORDLAND TSUNAMI

On 22 August 2003, a magnitude 7.2 earthquake struck off the coast of Fiordland, triggering many landslides in the remote area.

One of these landslides fell into Charles Sound causing a small local tsunami with a 4 to 5-metre high run-up.

The earthquake also generated a small tsunami in the Tasman Sea, recording a 300 mm high run-up in Jacksons Bay, and a 170 mm run-up at Port Kembla, Australia.

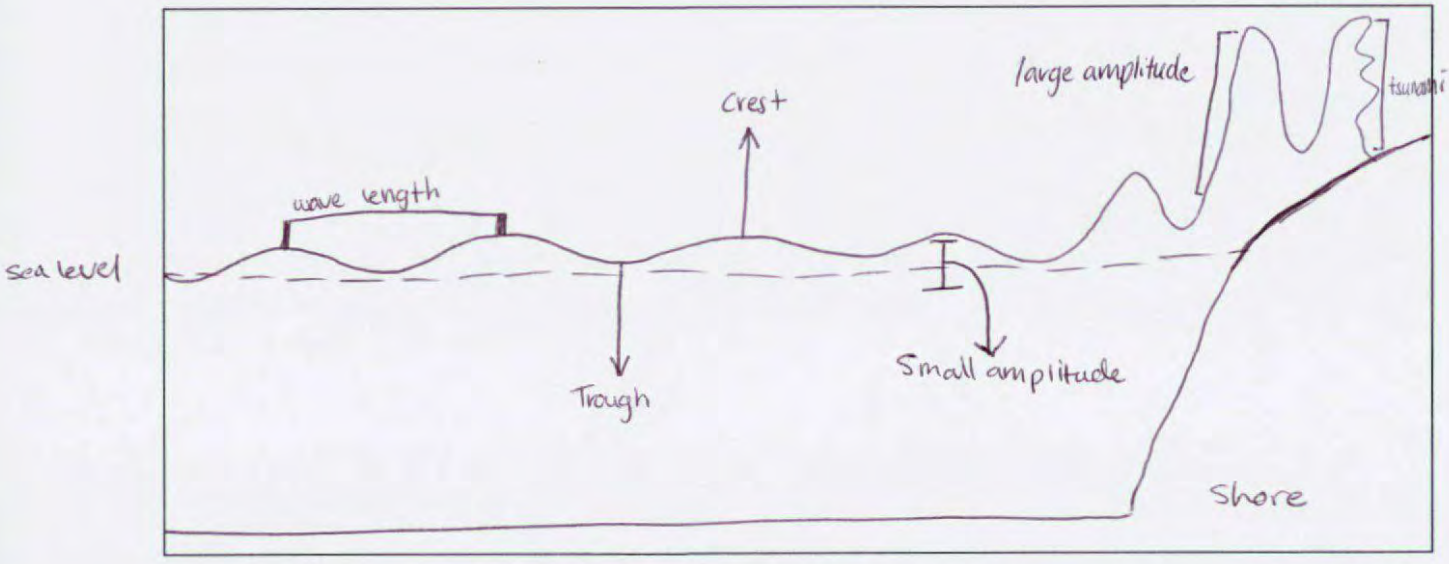
Adapted from https://static.geonet.org.nz/info/images/tsunami/historic/Fiordland-earthquake-tsunami-August-22-2003.png

Charles Sound

Source: https://teara.govt.nz/en/photograph/6209/landslide-fiordland

(a) Describe what is meant by the run-up height of a tsunami.

An annotated diagram may assist your answer.



A tsunami is a large displacement of water caused by a major geological event, the run up of a tsunami is when the energy within the water is fourced upward because of the shore line. if a tsunami is originated in deeper waters than the amplitude of the wave stays smaller as the energy is driving the water forward but as the water gets shallower the energy gets fourced upward and creates a large amplitude/run up height.

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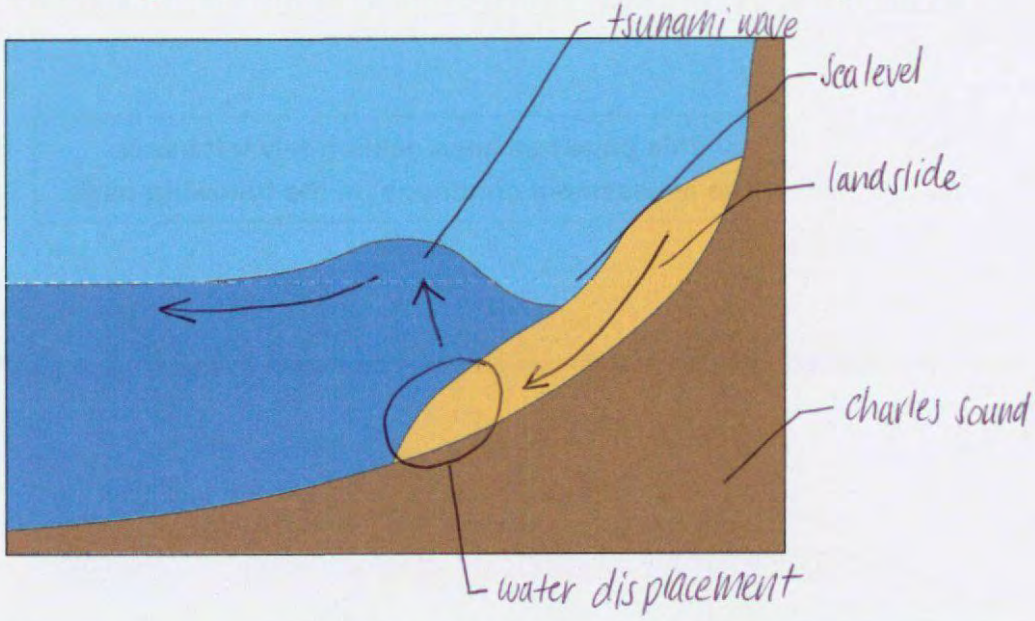
The assessment continues on the following page.

(b) Explain, in detail, how the landslide in Charles Sound generated a tsunami, and why it produced a large run-up height.

In your answer you should:

- consider what a tsunami is
- use arrows and annotations on the diagram below to show how a landslide can produce a tsunami
- consider how the height and width of Charles Sound affected the tsunami produced.



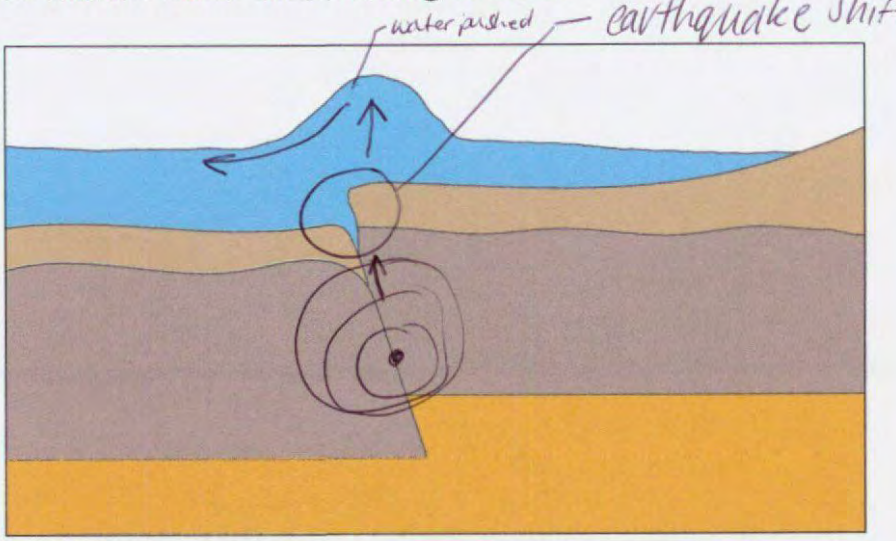
a tsunami is la large displacement of water caused by a major geological event. in this case a large landslide in the charles sound, this slide fourced the water upward transpheving the potential energy into the water. this sudden shift in water propels the water forward. The charles sound is a narrow channel that ~~#~~ runs near the coast of fiordland, because of the narrowness of the channel the energy within the water can't displace. As the charles sound goes further in land it also gets shallower So the energy in the water is also pushed upwards making the amplitude /run up heigher. (4-5 meters)

Question Three continues on the next page.

(c) Explain, in detail, how the earthquake generated a tsunami in the Tasman Sea, and how this tsunami could produce a tsunami wave in Australia.

In your answer you should:

- annotate and add arrows to the diagram below to show how a tsunami can be produced by an earthquake in the Tasman Sea
- explain the energy transfers that occur
- explain how tsunami waves can travel long distances.



Because of the 7.2 magnitude earthquake of the coast of the Charles Sound, some of the land was lifted. This uprise of land caused a mayjor displacement of water, the energy produced by the uplift was enough to generate a large tsunami. because of the mass amount of energy with in the water the tsunami wave was able to cross the tasman sea. This is because when an earthquake is generated the pressured land suddenly shifts back to its original position as it is doing this, seisulic waves are sent in every direction causing shaking. often itimes land surrounding the earthquake will also shift back into its original or a ~~dif~~ different position. in this case a different position. The energy from the seismic waves pushed one plate over the other causing a subduction zone. This forceful push of land upwards sent

energy up through the water generating the tsunami wave. Because so much energy was transplored it carryed to ~~the~~ port kembla Australia. a tsunami can start off with great height out at sea but the longer it travels the less energy within the wave and the smaller it gets. Hense why the tsunami in the charles Sound was Significantly (4-5m) larger than the tsunami in port kembla Australia. (170mm)

Extra space if required.
Write the question number(s) if applicable.

QUESTION NUMBER

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QUESTION NUMBER

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QUESTION NUMBER

91191

Achievement with Merit

Subject: Earth and Space Science

Standard: 91191

Total score: 16

Q	Grade score	Marker commentary
One	M5	To reach M6 the candidate needed to describe the gas content when Dome volcanoes were formed or magma rising to melt the above plate.
Two	M5	To reach M6 the candidate needed to describe the plates being stuck, elastic potential energy builds and is then released as kinetic energy.
Three	M6	To reach an E7 the candidate needed to link energy to amplitude, frequency, and speed of the tsunami.