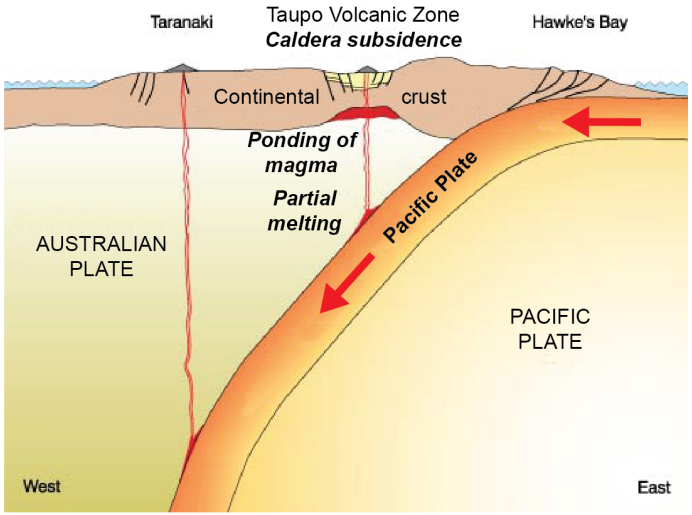
Assessment Schedule – 2023

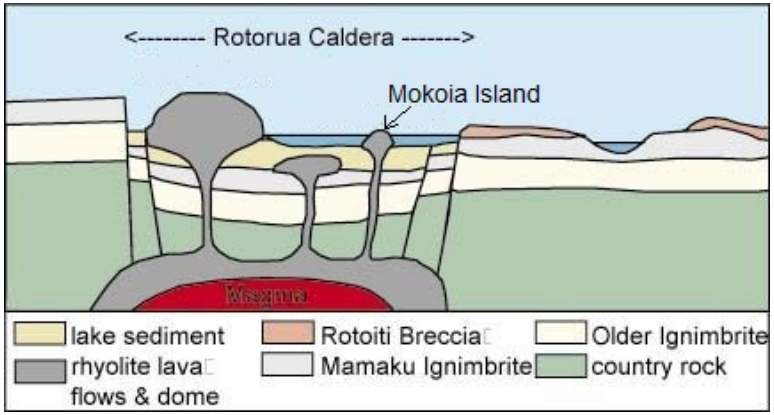
Earth and Space Science: Demonstrate understanding of the causes of extreme Earth events in New Zealand (91191)

Evidence Statement

Question One

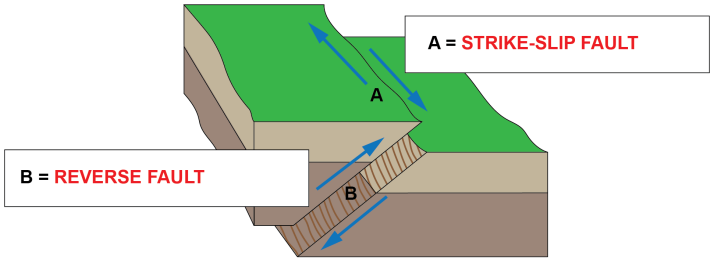
<table>
<tr><th></th><th>Expected Coverage</th><th>Achievement</th><th>Merit</th><th>Excellence</th></tr>
<tr><td>(a)</td><td>
<table>
<tr><td></td><td>Temperature</td><td>Silica Content</td><td>Viscosity</td><td>Gas Content</td></tr>
<tr><td>Rhyolitic Magma</td><td>LOW</td><td>HIGH</td><td>HIGH</td><td>HIGH</td></tr>
</table>
</td><td>• Two out of four correct</td><td></td><td></td></tr>
<tr><td>(b)</td><td>Off the east coast of the North Island of New Zealand, the oceanic Pacific plate (PP) subducts under the continental Australian plate (AP) as it is denser. Water within the oceanic PP lowers the melting point of the rock as it subducts, causing partial melting, forming (basaltic) magma. The magma is less dense than the surrounding rock, and therefore rises.
The less dense magma rises until it collects at the base of the AP, where it causes the silica-rich AP to melt, increasing the silica content of the magma, and making it into rhyolitic magma. This viscous magma traps gases, which are unable to escape, building up pressure beneath the surface of the Taupo Volcanic Zone (TVZ).
 

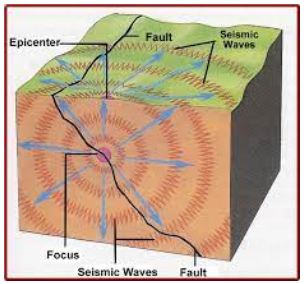
https: // teara.govt.nz / en / diagram / 8693 / subduction-under-the-north-island</td><td>• PP subducting under AP.
• PP as oceanic crust, and AP as continental crust.
• Relevant description of rhyolitic magma formation.</td><td>• Subduction of PP under AP causing partial melting of the plate, leading to less dense (basaltic) magma.
• Magma pooling under AP causing melting of silica-rich continental crust forming rhyolitic magma.</td><td>• Subduction of PP under the AP causing partial melting leading to (basaltic) magma formation, and pooling of magma below AP (continental crust) leading to increased silica content, forming rhyolitic magma.</td></tr>
</table>

(c)	The highly viscous rhyolitic magma below the TVZ (Rotorua area) traps gases, which are unable to escape, building up pressure. This pressure and the rising magma under the crust eventually becomes too great, leading to an explosive eruption, which releases all of the gases and rhyolitic magma. This empties the magma chamber. With nothing to support the weight of the crust above, the crater collapses forming a caldera (Rotorua). Over time the caldera fills with ash / pumice / ignimbrite and water. Magma continues to form in the same way below this area, but because the build up of gases has been released in the prior eruption, the magma is forced up through cracks / faults. The silica-rich sticky rhyolitic magma instead of exploding, oozes out to form steep sided domes, such as Mokoia Island.  	• Formation of caldera from rhyolitic magma with a high quantity of gas / explosive eruption. • Formation of dome from degassed / viscous lava. • Difference between rhyolitic magma in caldera and dome related to gas content.	• Caldera formation once the pressure is released, the crust collapses, which is then filled with ash / pumice / ignimbrite and water. • Degassed magma is forced out through the crust forming (steep sided) dome volcanoes within caldera.	• Viscous rhyolitic magma traps gases, building up huge pressure leading to an explosive eruption, emptying the magma chamber, leading to the collapse of the crater forming a caldera (Lake Rotorua). AND Sinking crust forces degassed (viscous) rhyolitic magma through cracks forming dome volcano (Mokoia Island).

NØ	N1	N2	A3	A4	M5	M6	E7	E8
No response or response does not relate to the question.	Describes ONE partial point at the Achievement level.	Describes TWO points at the Achievement level.	Describes THREE points at the Achievement level.	Describes FOUR points at the Achievement level.	Explains ONE point at Merit level.	Explains TWO points at Merit level.	Explains ONE point at Excellence level (with minor errors or omissions).	Explains comprehensively ONE point at Excellence level.

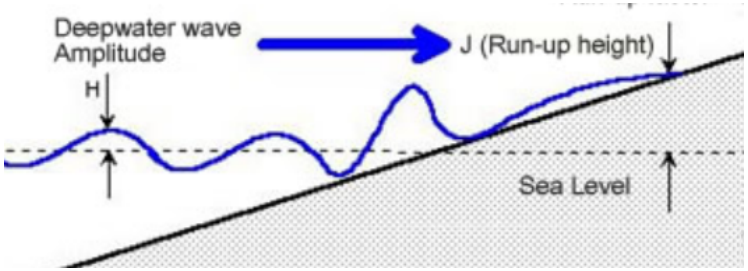
Question Two

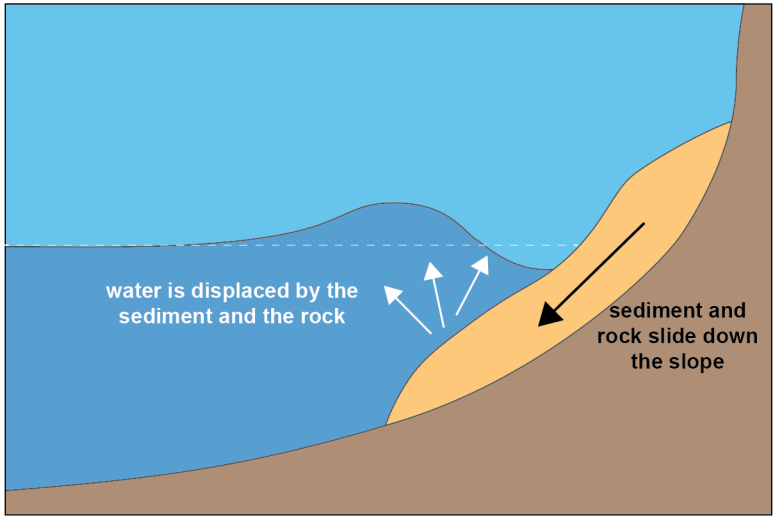
	Expected Coverage	Achievement	Merit	Excellence
(a)		• A as strike-slip or transform fault. • B as reverse or thrust fault.		
(b)	At the Alpine Fault, the AP is colliding with and moving along the PP. These two plates are pushing into each other in a transform (right-lateral strike-slip) fault. This collision compresses the crust to the west of the Alpine fault, building up a huge amount of stress in the surrounding crust over time. Eventually the rock cannot withstand any more stress, causing a fracture along the surface of White Creek fault. Faults are fractures in the Earth's crust where compressional and shearing forces have caused movement either side of the fracture as a result of the stress built up over time. When this happens, huge amounts of elastic potential energy are released as an earthquake, causing the earth to shake. The more stress that has built up over time, the greater the amount of energy released, leading to large magnitude earthquakes.	• AP colliding and moving along PP. • Earthquake as release of stress / elastic potential energy. • Stress build-up generates ruptures / fault. • Fault is a fracture in the crust due to compressional / shearing forces. • Large magnitude earthquake as release of built-up stress energy.	• Faults as fractures in the crust where compressional forces cause movement either side of fracture due to build-up of stress and release of stress energy built up.	• PP is colliding and moving laterally to the AP, leading to build-up of stress in the crust over a long time, which is finally released in a rupture on the White Creek fault, releasing large amounts of elastic potential energy, causing a large magnitude earthquake.

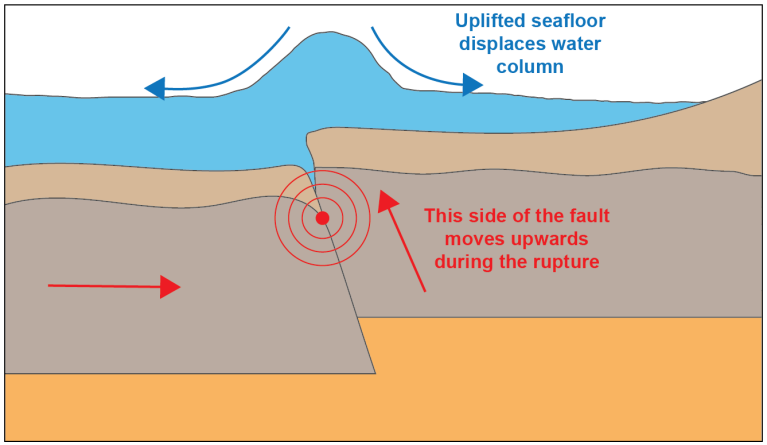
(c)	When an earthquake occurs, energy is released into the surrounding rock in the form of seismic waves (body waves and surface waves). The seismic waves travel out in all directions from the focus. As the waves travel through solid rock, they lose energy. As the focus was shallow, very little energy was lost by the time the seismic waves reached the surface, leading to intense shaking at the epicentre. The epicentre is on the Earth's surface, directly above the focus.  https: // www.google.co.nz / imgres?imgurl=https%3A%2F%2Fo.quizlet.com%2Fz-BkrjP4xOB3ta6ABgsfOw_b.jpg&imgrefurl=https%3A%2F%2Fquizlet.com%2F417334008%2Fessentials-of-geology-chapter-9-earthquakes-interiors-diagram%2F&tbnid=vbJAKeWG5jv_JM&vet=12ahUKEwj8047My4f8AhVfxXMBHQSUCdoQMygJegUIARDTAQ..i&docid=bLZ63EsRw2qfEM&w=583&h=547&q=seismic%20waves%2C%20epicentre%2C%20fous%2C%20shaking&hl=en&ved=2ahUKEwj8047My4f8AhVfxXMBHQSUCdoQMygJegUIARDTAQ The intensity of the seismic waves will be greatest closest to the epicentre, resulting in the strongest vibrations, and the most damage. As the waves travel further away from the epicentre, they lose more and more energy, making the vibrations less strong, resulting in less and less damage as you move further away. Therefore the earthquake was felt throughout NZ, but the damage was limited to the local area.	• Seismic waves carry the energy of the wave. • Seismic waves lose energy as they move away from epicenter. • Seismic waves travel in all directions. • The focus is where the seismic waves originate. • The epicentre is directly above the focus on the surface.	• Shallow focus leads to less energy lost by the time it reaches the surface. • That seismic waves originate from the focus carrying the energy of the wave, travelling in all directions. • Why the intensity of the shaking is most intense closest to epicentre.	• Why the earthquake can be felt throughout NZ, due to seismic waves continuing to travel out from epicentre, but losing energy reducing the vibration. • Why the shaking was most intense closest to the epicentre, but was felt throughout NZ as the seismic waves continue to move away from the epicentre, losing energy, meaning damage decreases with distance from epicentre.

NØ	N1	N2	A3	A4	M5	M6	E7	E8
No response or response does not relate to the question.	Describes ONE partial point at the Achievement level.	Describes TWO points at the Achievement level.	Describes THREE points at the Achievement level.	Describes FOUR points at the Achievement level.	Explains ONE point at Merit level.	Explains TWO points at Merit level.	Explains ONE point at Excellence level (with minor errors or omissions).	Explains comprehensively ONE point at Excellence level.

Question Three

	Expected Coverage	Achievement	Merit	Excellence
(a)	The run-up height of a tsunami is the maximum vertical height above sea level at its furthest point inland.  https: // www.sms-tsunami-warning.com / pages / runup-inundation#.YybaB3ZBw2w	• Run-up height (in diagram or words).		

(b)	A tsunami is a series of waves created by the displacement of the water column due to a disturbance, that carries the energy of the disturbance. The earthquake caused unstable material on the sides of Charles Sound to suddenly fail and collapse. Sediment and rock moved down the slope, due to gravity converting gravitational potential energy to kinetic energy. As the sediment and rock entered the water, it displaced the water from above generating a tsunami.  The amount of displacement of the water column is directly related to the amount of material entering the water from the landslide and the energy with which it enters the water. The energy of the landslide is directly related to the height (gravitational potential energy) of the source material, which in turn is converted to (kinetic) energy to cause water displacement. Therefore, a steeper side will lead to more gravitational potential energy and therefore greater displacement. The narrow width of Charles Sound means there is little opportunity for energy to be lost, meaning that the size of the initial wave hitting the opposite side of the sound is very similar to the size of the initial displacement, as there is little opportunity for any energy or displaced water to travel anywhere except back up the sides, resulting in a localised large amplitude wave.	• Tsunami as displacement of water. • Landslides within the sound will generate a lot of material and energy. • Shows correct direction of movement of material, displacing water up and out, on diagram. • Steep sides of sound lead to more energy (GPE). • Narrow width of Charles Sound means little or no opportunity for water displacement / energy to be lost.	• A tsunami as a displacement of water caused by energy transmission, which carries the energy of the disturbance. • Relationship between the height (GPE) of Charles Sound and the kinetic energy produced. • The narrowness of the sound generates a large amplitude wave, as little energy is lost, and the wave has nowhere else for it to go.	• How energy caused by the initial landslide material generates large water displacement, which radiates in all directions. Relates the amount of material entering Charles Sound to the size of the wave generated. • The relative relationship between the width and height of Charles Sound and the amplitude of the generated wave – amplitude is linked to the lack of opportunity for energy loss.

(c)	The earthquake on the fault causes one side of the fault to uplift. This causes the water column above to be displaced, causing a tsunami to be generated.  The energy transformed into movement of the water is due to the energy from the vertical displacement of the seafloor, which will relate to height of displacement. The energy of the uplift is directly related to the rise in height of the seafloor (gravitational potential energy), which in turn is converted to (kinetic) energy to cause the water displacement. Tsunami waves will travel outward in all directions on the surface of the ocean away from the source, and continue across the ocean, in this case the Tasman Sea. Tsunami waves in the deep ocean can travel at high speeds for long periods of time for distances of thousands of kilometres and lose very little energy in the process; this is why the tsunami was able to reach Australia.	• Uplift of the sea floor will generate displacement of water above. • Energy of uplift transferred to water displacement. • The greater the uplift the greater the water displacement or vice versa. • Tsunami waves travel out in all directions from their origin. • Tsunami waves travel at high speeds in deep water.	• Energy caused by the initial uplift generates water displacement, which radiates from the origin. • Tsunami continues over a long distance due to high speeds for long periods of time with very little loss of energy.	• How energy caused by the initial uplift generates water displacement, which radiates from the origin. • How tsunami continues over a long distance due to high speeds for long periods of time with very little loss of energy, meaning the waves can reach Australia.

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Cut Scores

Not Achieved	Achievement	Achievement with Merit	Achievement with Excellence
0 – 6	7 – 12	13 – 18	19– 24