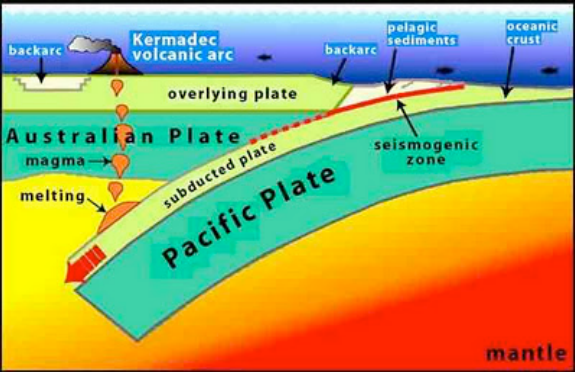


Assessment Schedule – 2014

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

Evidence Statement

QUESTION ONE			
Expected Coverage	Achievement	Merit	Excellence
<p>The oceanic Pacific Plate (PP) is subducting under the oceanic Australian Plate (AP) at a convergent boundary.</p>  <p>The tectonic plates collide at a convergent boundary, which leads to a subduction zone at the Kermadec ridge / trench. Subduction is happening because of the different densities of the plates. The Pacific Plate is wholly oceanic and mostly basalt so is denser than the Australian Plate. It is dragged down under the Australian Plate by gravity.</p> <p>This subduction is not smooth; friction between the top of the subducting crust and underside of overriding Australian Plate results in melting of crust, which is silica-rich magma (dacite) – eruptive material is a mix of both types of crust with higher amount from the overlying Australian Plate crust.</p> <p>Because the subducting oceanic sediments are waterlogged, the resulting volcanic activity tends to be explosive / gas-rich / sulfur dioxide-rich; as the melting temperature of the crust is reduced, hot buoyant fluid rises and produces explosive eruption.</p> <p>Characteristics: Intermediate to high silica 62–69%, Sticky (viscous) magma, thick block lava flow, explosive ejections of ash and pumice.</p>	<p>Describes:</p> <ul style="list-style-type: none"> • plate tectonics under Raoul (subduction as PP subducts due to PP being more dense than AP • PP melts due to friction • the role of water in producing explosive eruptions • that water lowers melting point • characteristics of a dacite eruption • eruption is a mixture of both crust types. 	<ul style="list-style-type: none"> • Explains the cause of volcanic activity in the Kermadec Islands (Raoul). Eg. due to the magma being sticky it traps gas thus a more explosive eruption. • Explains the role of water in either producing explosive eruptions at Raoul OR lowering the melting point of the crust material. 	<ul style="list-style-type: none"> • Explains comprehensively the cause of volcanic activity in the Kermadec Islands (Raoul), including explanation of the role of water in producing explosive eruptions due to lowered melting point of crust material. • Gives a comprehensive explanation that a dacite eruption would contain a higher percentage of overlying (AP) crust.

NØ	N1	N2	A3	A4	M5	M6	E7	E8
No response; no relevant evidence.	Describes subduction OR one aspect of a dacite eruption.	Describes ONE point.	Describes TWO points.	Describes THREE points.	Explains ONE point in detail.	Explains TWO points in detail.	Explains ONE point comprehensively.	Explains TWO points comprehensively.

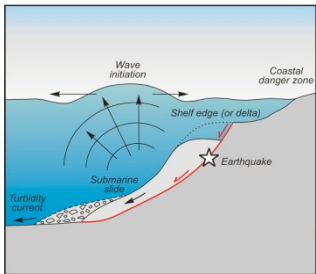
QUESTION TWO

Expected Coverage

A **tsunami** is a series of long wave-length water waves caused by the displacement of a large volume of a body of water.

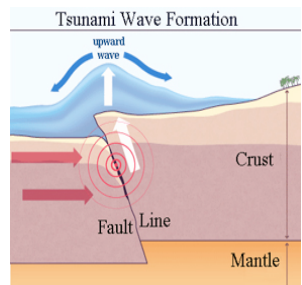
Tsunamis are most commonly caused by a seafloor earthquake over Richter magnitude 7. Other triggers are landslides, undersea volcanic eruptions, and meteorite impact. Sudden changes to the seafloor cause the ocean to flow away from the disturbance, causing waves.

Landslides:



Large tsunamis may be caused by submarine landslides. These rapidly displace large water volumes, as energy transfers to the water at a rate faster than the water can absorb.

Characteristically the first two waves are the largest and size diminishes. The waves are closer together than tsunamis triggered by earthquakes.



Tsunamis can be generated when the sea floor abruptly deforms and vertically displaces the overlying water.

Tsunamis can be generated when thrust faults associated with convergent or destructive plate boundaries move abruptly, resulting in water displacement, owing to the vertical component

Achievement

Describes:

- a tsunami as a displacement of water
- how a submarine landslide could lead to a tsunami
- how a sea floor earthquake could lead to a tsunami
- energy transfer from the landslide / earthquake to the water.

Merit

Explains:

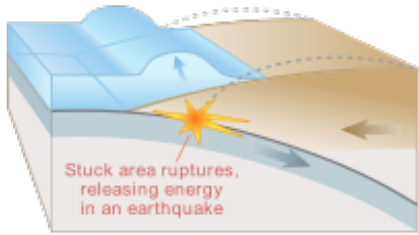
- a tsunami as a displacement of water caused by energy transmission
- causes of tsunamis by a submarine landslide
- causes of tsunamis by a sea floor earthquake.

Excellence

- Compares and contrasts the two likely causes of this tsunami with justified conclusion (can be opposite with reasonable justifications):
 - sea floor earthquake unlikely cause as the Chatham Islands are not close to any known fault
 - submarine landslide most likely cause due to lack of known fault lines.

of movement involved.

Tsunami starts during earthquake



Contrast:

Chatham Islands are not close to a plate boundary, so a sea floor earthquake is a less likely cause than a landslide on the edge of the Chatham Rise. The plate boundary is to the west and north of Chatham Islands, but the area most affected was to the east and north.

Sudden substantial movement of previously unknown faults above magnitude 7 have occurred in this area (upper South Island) and because of the remoteness and lack of monitoring, this is a possible cause. It is not possible to be certain that a substantial earthquake, above 7 did not occur.

Both sea floor earthquakes and submarine landslides can occur in this area – both will cause water displacement which may result in tsunamis.

A small sea floor quake (below magnitude 7) may have caused displacement of loose material on the edge of the plateau to the north and east. This would cause water displacement and a resulting tsunami.

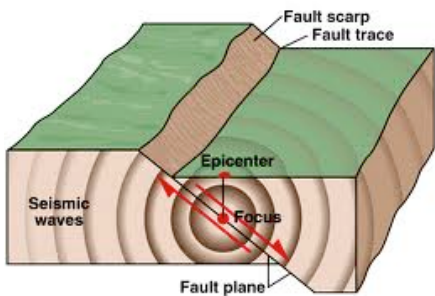
Because of the position of the tsunami (east and north), and the fact that this is not close to a plate boundary, and recorded earthquakes in the area are more frequently below magnitude 7 (therefore unlikely to directly trigger tsunami), a more likely cause is a submarine landslide. A lower magnitude earthquake may have contributed to the landslide, however.

NØ	N1	N2	A3	A4	M5	M6	E7	E8
No response; no relevant evidence.	Partially describes ONE point.	Describes ONE point OR partially describes TWO points.	Describes TWO points.	Describes THREE points.	Explains ONE point in detail.	Explains TWO points in detail.	Comprehensively explains ONE likely cause of this tsunami.	Comprehensively explains TWO likely causes of this tsunami.

QUESTION THREE

Expected Coverage

The continental crusts of the Pacific and Australian Plates are locked together under the Seddon / Lake Grassmere region (top of the South Island).
 These two plates are pushing into each other in a transform (strike-slip) fault, as their densities are similar – there are a number of faults in this area which may be responsible. This pushing causes pressure to build up, and eventually some pressure is released and the plates move, releasing a huge amount of energy in an earthquake.
 The focus is the point of origin of the seismic waves, and the epicentre is the point above it on the earth’s surface. The energy from the earthquake radiates out from the focus of the quake and is transmitted in different directions through absorption, reflection, and refraction from the focus. As the distance from the focus increases, the amount of energy that is present from the earthquake is reduced.



The observed damage at Lake Grassmere and Seddon was due to a variety of reasons including local conditions, such as the type of soil and water content of sediments and buildings.

The material above the focus directly affects visible surface damage, eg loosely consolidated material is more likely to result in sand boils, sand volcanoes, or similar signs of liquefaction.

Seddon and Lake Grassmere earthquakes were of similar size, but Seddon was the deeper earthquake which means that there was a greater distance to the surface, and so the Lake Grassmere earthquake caused a greater amount of surface damage.

Long cracks in the ground or structures are caused by lateral spreading.

Sand boils, sand volcanoes, and other signs of liquefaction are caused by pressures generated during large earthquakes with many cycles of shaking. This can cause the

Achievement

- Describes:
- plate tectonics under Lake Grassmere/Seddon area as (mainly) a transform fault
 - plates have similar densities
 - that earthquake damage decreases further away from the earthquake
 - damage on the surface depends on what is underneath
 - focus is source of an earthquake
 - epicentre is the point directly above the source of the earthquake on the surface.

Merit

- Explains:
- how a transform fault can lead to earthquakes
 - how earthquake damage decreases with distance from epicentre/focus due to dissipation of energy
 - how surface damage depends on underlying soil, water content and rock and the structures.

Excellence

- Explains comprehensively:
- how distance from the focus has a direct influence on the amount of damage seen at the surface
 - how composition of the land near the surface has a direct influence of the damage seen in that location.

<p>liquefied sand and excess water to force its way to the ground surface from several metres below the ground.</p> <p>Buildings whose foundations bear directly on sand which liquefies will experience a sudden loss of support, which will result in drastic and irregular settlement of the building causing structural damage, including cracking of foundations and damage to the building structure itself.</p> <p>These earthquakes and ‘aftershocks’ were considered ‘shallow’; energy is released in the form of ground shaking. As distance increases from the focus point, the shaking is reduced (by inverse square of distance). The amount of shaking gets reduced as the distance increases from the focus point. The amount of shaking affects the amount of structural damage, therefore, because the focus was closer to the surface, the Lake Grassmere earthquake caused more damage than the deeper Seddon earthquake.</p>			
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NØ	N1	N2	A3	A4	M5	M6	E7	E8
No response; no relevant evidence.	Partially describes ONE point.	Describes ONE point OR partially describes TWO points.	Describes TWO points.	Describes THREE points.	Explains ONE point in detail.	Explains TWO points in detail.	Comprehensively explains ONE of the TWO points.	Comprehensively explains BOTH of the points.