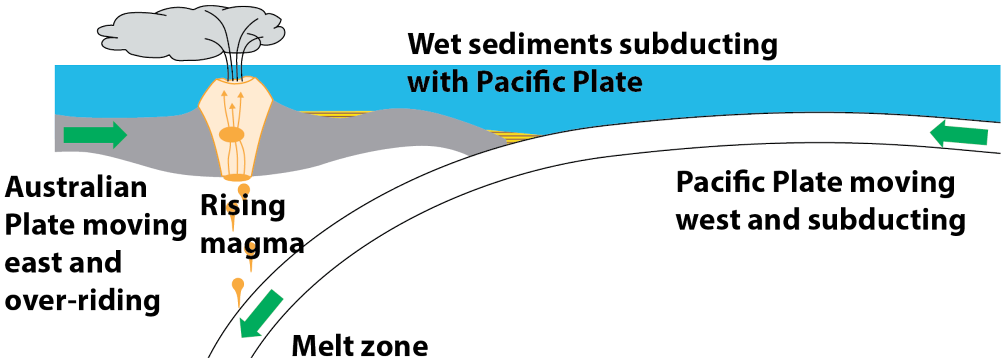
Assessment Schedule – 2018

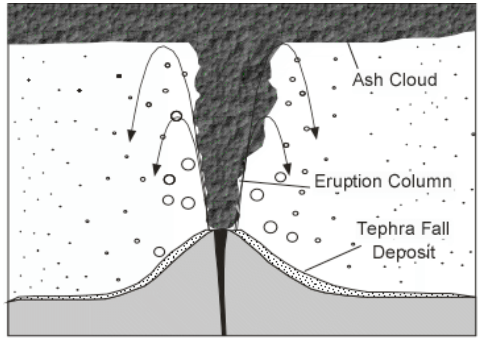
Earth and Space Science: Demonstrate understanding of the causes of extreme Earth events in New Zealand (91191)

Evidence Statement

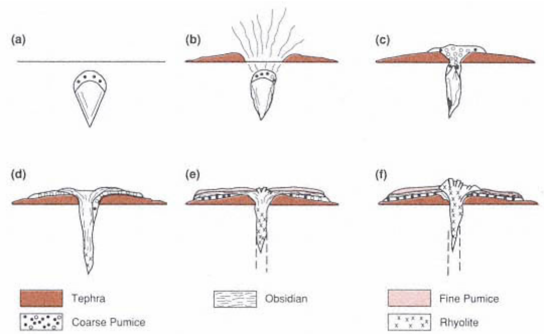
Question One: Havre Seamount Eruption

Expected Coverage	Achievement	Merit	Excellence
 The Pacific and Australian plates are converging, and the denser oceanic crust of the Pacific plate is subducting under the less dense oceanic crust of the Australian plate due to gravity. Heat generated at the boundary by friction between the two oceanic crusts causes a partial melting zone. The presence of water in the subducting sediments causes the melting point of the crusts to be lowered. The less dense magma rises and melts the overlying Australian plate and mixes with the molten basaltic crust of the subducting Pacific Plate oceanic crust to form rhyolitic magma. The less dense magma rises and melts the above silica-rich gaseous Australian Plate crust with the basaltic Pacific Plate crust forming rhyolitic magma. Rhyolitic magma is high in silica, so is highly viscous and will trap the dissolved gases which have not had time to be released due to proximity to surface, therefore, is low in temperature, and is highly explosive. This produces eruptions that are characterised initially by gas (mostly water, some carbon dioxide with smaller amounts of sulfur dioxide, chlorine and fluorine), ash and tephra (pumice) as an eruption column through the overlying sea water. This results in gases dissolving in the sea water, and a pumice raft which floats due to low density. The calderas are formed due to the collapse of the magma chamber and the domes are due to the degassing of the lava, which does not travel very far.	Describes: • plate tectonics under Kermadec Trench (subduction as Pacific Plate (PP) subducts and melts beneath Australian Plate (AP)) • one characteristic of silica-rich rhyolitic magma (high gas content, high viscosity, but low temperature) • trapped gases being released explosively (to produce first stage of eruption, ash, pumice or caldera formation) • (second stage) as rhyolitic lava in form of domes and sea floor lava flows.	Explains in detail: • the plate tectonic process under the Kermadec trench where the PP is subducting under the AP, due to PP being more dense/ or brought down by gravity AND reason for plate melting or mixing of plates • the characteristics of rhyolite magma, e.g. explosiveness of the magma because of gases trapped due to high viscosity caused by high silica content • the two stages of an eruption: first ash, gas, and pumice and second rhyolitic lava as flows or domes.	Explains comprehensively: • the plate tectonics in the region with specific focus on the plate density difference between both types of ocean crust of AP and PP and effect of proximity to subducting zone and role of water in lowering the melting point of the crusts • the characteristics of rhyolitic magma, e.g. high gas content because gases are trapped and unable to be released slowly due to shallow depth of melt zone. AND links to the two stages of a typical rhyolitic eruption, first gas, ash, and pumice / lapilli, and second rhyolitic lava in form of flows and domes. *(Note: may use both in less detail.)*

Stage One – Gas, Ash and Pumice



Multiple stages of rhyolite eruption



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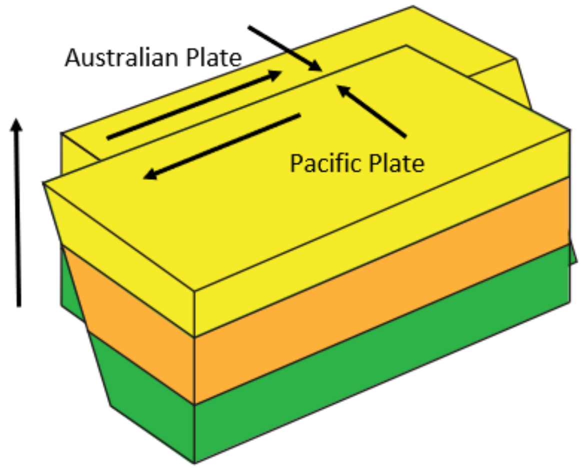
Following the initial gas, ash, and pumice eruption, there would be lava flow / formation of lava domes, within the caldera, of rhyolitic magma, high silica (69–77%), low temperature (650–800°C), high viscosity and initially high gas content.

If rhyolite magma is gas rich, it can erupt explosively, forming a frothy solidified magma called pumice (a very lightweight, light-coloured, vesicular form of rhyolite) along with ash deposits; the low density allows it to rise to the surface as pumice rafts.

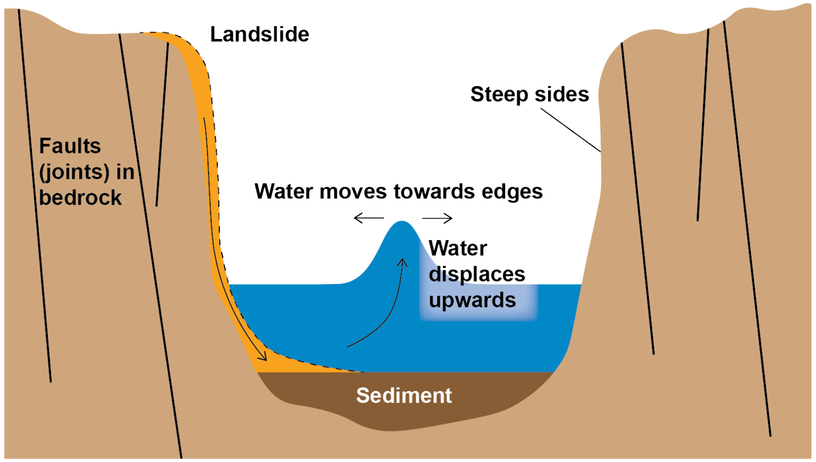
Not Achieved			Achievement		Achievement with Merit		Achievement with Excellence	
NØ	N1	N2	A3	A4	M5	M6	E7	E8
No response: no relevant evidence.	Partially describes one point.	Describes two points.	Describes three points.	Describes four points.	Explains ONE point.	Explains TWO points.	Explains comprehensively one point, or two with minor omissions.	Explains comprehensively two points.

Question TWO: Dusky Sound Earthquake

Expected Coverage	Achievement	Merit	Excellence
The Pacific and Australian Plates with the same densities are converging and locked together (under the Dusky Sound area of Fiordland) at a transition zone between the subduction zone of the Puysegur Trench, where the oceanic Australian Plate is subducting under the continental Pacific crust and the transform boundary along the Alpine Fault where the Australian Plate crust is moving northwards, and the Pacific Plate is moving to the south. The two plates are under considerable stress, and there are several reverse and transform faults throughout the region, including the best known, the Alpine Fault.  Strain / Stress energy builds up over a period of time and eventually the rock cannot withstand any more strain, causing a break along a reverse or transform fault line. The energy is released as the plates move, releasing a huge amount of energy in an earthquake. Earthquakes in this area would be shallow, as no subduction is occurring.	Describes: • plate tectonics along Puysegur Trench, AP under PP • plate tectonics along Alpine Fault, AP and PP sliding past each other • earthquake as a built-up overtime of elastic potential energy. • earthquake as release of built-up strain / stress energy.	Explains: • the transition zone as AP no longer subducting and now pushed upwards by convergence with PP OR the transition zone is at Dusky Sound, as both plates are now locked and would slide past each other when stress released • earthquake as release of strain energy built up over time – long build-up between events allows substantial energy to be stored in rocks.	Explains comprehensively: • earthquake as release of strain energy built up over time – long build-up between events allows substantial energy to be stored in rocks before release, and this further complicated by twisting movement at plate boundary • complexity of convergence zone, where the plate tectonics in the region change from the subduction zone of the Puysegur Trench, the transition zone and the transform boundary of the Alpine Fault zone.

Not Achieved			Achievement		Achievement with Merit		Achievement with Excellence	
NØ	N1	N2	A3	A4	M5	M6	E7	E8
No response: no relevant evidence.	Partially describes one point.	Describes two points.	Describes three points.	Describes four points.	Explains ONE point.	Explains TWO points.	Explains comprehensively one point with minor omissions.	Explains comprehensively ONE point.

Question Three: Doubtful Sound, Fiordland – Landslides and Tsunamis

Expected Coverage	Achievement	Merit	Excellence
 Tsunamis are water waves caused by the displacement of a large volume of water. The amount of displacement 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. The relatively small size of the body of water means there is little opportunity for energy to be lost, meaning that the size of the initial wave hitting the fiord side is of a very similar size to that of the initial displacement. Tsunami waves travel outward from the point of initiation in all directions and continue across the surface of the water body – in this case the travel distance of the wave is very small. In this fiord area, a large summit-to-valley-floor landslide has a considerable amount of material and energy as it enters a very narrow width of water body. There is little opportunity for any energy or displaced water to travel anywhere except back up the sides of the fiord, and this can result in a localised large amplitude wave.	Describes: • tsunami as large displacement of water • summit-to-valley-floor landslides will generate a lot of material and energy • amount of material in the landslide is proportional to the water displaced • shows correct direction of movement of material from landslide down, which displaces water up and out, on diagram • narrow width of fiord means no opportunity for water / displacement energy to be lost – all transformed into wave.	Explains: • a tsunami as a large displacement of water caused by energy transmission which radiates out from the point of origin – the point of entry of the landslide material • the narrowness of a fiord means that the large amount of landslide material entering the water generates a large amplitude wave, as there is nowhere else for it to go .	Explains comprehensively: • how energy caused by the initial landslide material generates large water displacement, which radiates in all directions. Relates the amount of material entering the water body of the fiord to the size of the wave generated • the relative relationship between the width of the fiord / size of water body and the amplitude of the generated wave – amplitude is linked to the lack of opportunity for energy loss.

Not Achieved			Achievement		Achievement with Merit		Achievement with Excellence	
NØ	N1	N2	A3	A4	M5	M6	E7	E8
No response: no relevant evidence.	Partially describes one point.	Describes two points.	Describes three points.	Describes four points.	Explains ONE point.	Explains TWO points.	Explains comprehensively one point, or two with minor omissions.	Explains comprehensively two points.

Cut Scores

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