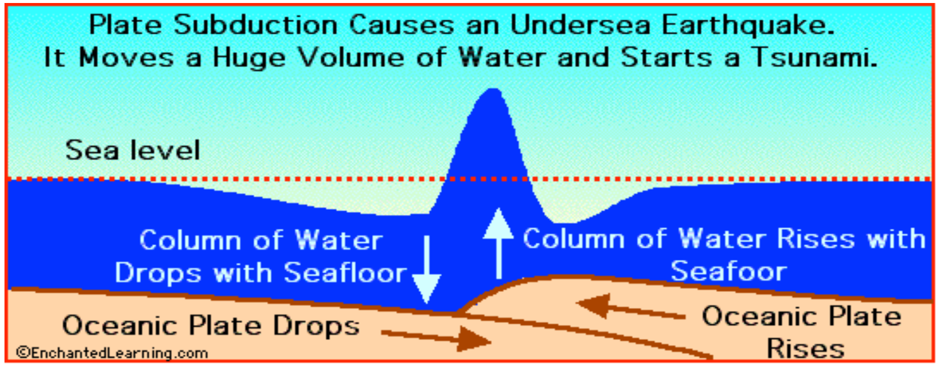
Assessment Schedule – 2017

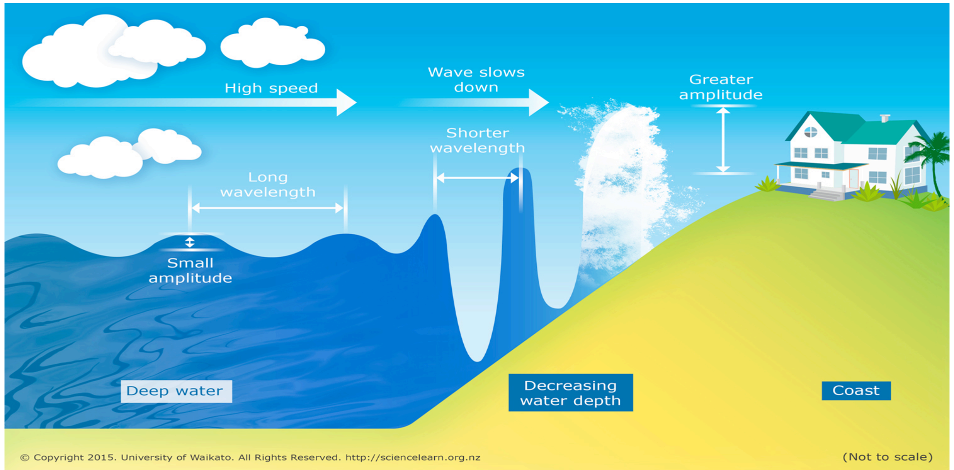
Earth and Space Science: Demonstrate understanding of the causes of extreme Earth events in New Zealand (91191)

Evidence Statement

Question One

Expected Coverage	Achievement	Merit	Excellence
A tsunami is a series of long wave-length water waves caused by the displacement of a large volume of a body of water. The most physically destructive tsunami is most commonly caused by a seafloor earthquake generated at a subduction zone (generally earthquake is over magnitude 7 – which this one is). Sudden changes to the sea floor cause the ocean to flow away from the disturbance / displacement, causing waves. A tsunami, like that generated by the earthquake off the East Cape, can be generated when thrust faults associated with convergent (destructive) plate boundaries move abruptly, resulting in large water displacement, owing to the vertical component of plate movement involved. Energy is transferred to the water at a rate faster than the water can absorb.  http://www.enchantedlearning.com / subjects / tsunami / Tsunami waves will travel outward on the surface of the ocean in all directions away from the source / epicentre and continue across the ocean. As the waves approach the coast, their wavelength decreases and wave height increases (shoaling). Tsunamis have a small amplitude in deep water (often much less than a metre), but they can shoal up to many metres high in shallow waters. Shoaling happens because waves experience force from the sea bed as the water gets shallower. This slows down the wave – the shallower the water, the slower the wave. (*Note: students may state – as waves slow down, they start to bunch together, so they have a*	Describes with understanding: • earthquake caused the displacement of water • tsunami carries energy which leads to wave • waves increase in height/ smaller wavelength/ decrease in wave speed as they approach land. • monitoring difficulties of tsunami's in the Pacific	Explains in depth: • a tsunami as a displacement of water by the vertical displacement of the plate. Energy transmission from the earthquake to the water • as waves approach land, wavelength shortens/ height / amplitude increases/ wave slows down due to friction of the shallow land • it is difficult to predict the size and effect because of the time the earthquake occurred / no seismic monitoring off the coast / earthquake occurred very close to land.	Explains comprehensively: • a tsunami as a large displacement of water by the vertical displacement of the plate. Energy is transferred from the earthquake and transmission radiates out from the point of origin – the epicentre of the earthquake. Energy transfer rate • as waves approach land wavelength shortens, height / amplitude increases and waves slow down – **linked to** force from sea floor • how predicting a potential wave is difficult due to the position of the earthquake being only 125 km from the coast, (the time in the morning, communication), the lack of seafloor seismic monitoring.

shorter wavelength than before. This can also be explained by the wave equation $v = f \times \lambda$ which shows that, when a wave's speed decreases, it must have a shorter wavelength than before.)



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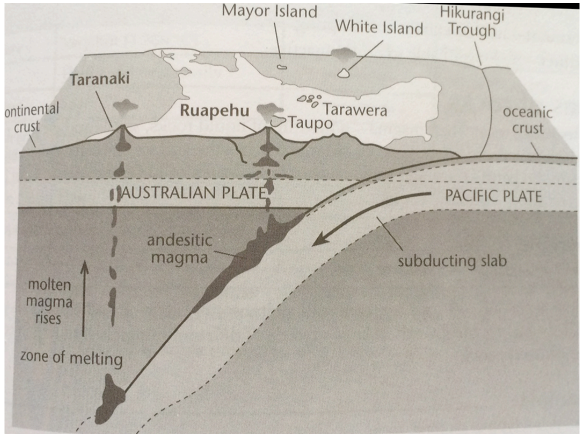
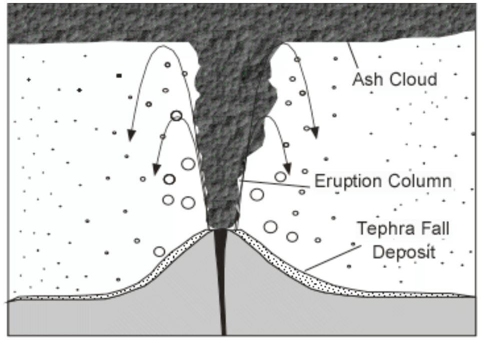
http://sciencelearn.org.nz / Science-Stories / Tsunamis-and-Surf / Shoaling

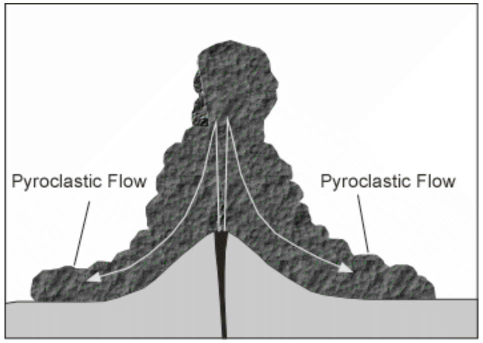
The inability to measure both wavelength and amplitude makes predicting possible impact difficult. In addition, this earthquake occurred at 4.30 am and it was 125 km off the coast (between Kermadec Trench and Kermadec Ridge) and tsunami can travel at 1000 kilometres per hour in open water, although this speed would decrease substantially as it approached the coast. There would be about 15 minutes warning before the first wave.

Not Achieved			**Achievement**		**Achievement with Merit**		**Achievement with Excellence**	
NØ	N1	N2	A3	A4	M5	M6	E7	E8
No response: no relevant evidence.	One point.	Two points.	Three points.	Four points.	Explains in detail one point.	Explains in detail two points.	One point explained fully or two with minor omissions.	Two points in full.

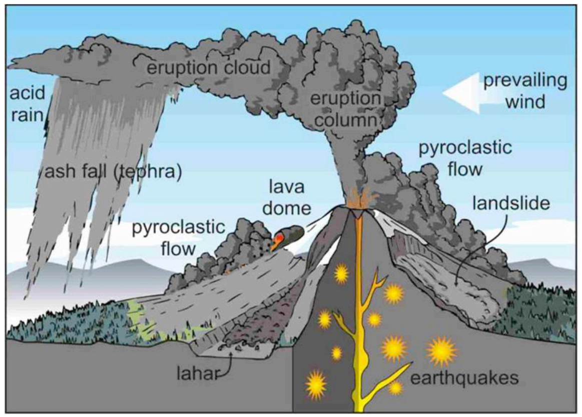
Question Two

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 Australian plate due to gravity. Heat generated by friction at the boundary between the two crusts causes a partial melting zone where the overlying Australian plate melts and mixes with the molten basaltic crust of the subducting Pacific oceanic crust. Water brought down from subduction lowers the melting point. The less dense magma rises and melts the above Australian plate.  (diagram from ESA year 13 Science Study guide Blacker and Talbett 2005 – page 163) This mix of silica rich gaseous melted continental crust and higher temperature, lower gas content basaltic crust rises as andesitic magma with dissolved gases (which are trapped due to the viscosity) until pressure is reduced and the gas is released. This produces eruptions which are characterised initially by gas (mostly water, some carbon dioxide with smaller amounts of sulfur dioxide, chlorine and fluorine) and ash, as an eruption column which has a high gas content and may be explosive – as the column descends pyroclastic flows may result.	Describes with understanding: • plate tectonics under TVZ (subduction as Pacific Plate (PP) subducts and melts beneath Australian Plate (AP) • characteristics of andesitic magma (intermediate: gas, temperature, and viscosity) linked to silica content • describes trapped gases being released explosively • one hazard – pyroclastic flow, lahar, lateral blast.	Explains in detail: • the plate tectonic process under the TVZ where the PP is subducting under the AP due to PP being more dense (and resultant magma is a mix of both crusts). • the characteristics of andesitic magma, e.g. Explosiveness due to gases trapped due to intermediate viscosity caused by silica content. • the two typical stages of an eruption: first ash and gas, and then andesitic lava. • one hazard of these types of eruptions, e.g. pyroclastic flow or lahars.	Explains comprehensively: • Explains comprehensively the processes leading to the formation of andesitic magma – i.e. molten overlying continental crust. • the characteristics of andesitic magma e.g. gases trapped due to intermediate viscosity caused by silica content. AND links to the two stages of a typical strato eruption: ash and gas and then andesitic lava • ONE hazard of these types of eruptions e.g pyroclastic flow or lahars with link to speed or lack of warning.





http://www.tulane.edu / ~sanelson / Natural_Disasters / volcan&magma.htm



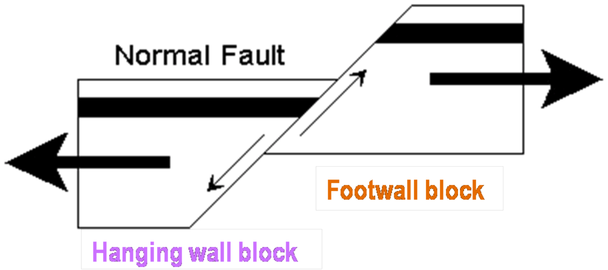
http://worldlywise.pbworks.com / w / page / 25833576 / Unit%202%20Section%20B%20-%20Causes%20and%20effects%20of%20volcanoes%20and%20responses%20to%20them

Following the initial ash and gas eruption, there would be lava flow of andesitic magma, intermediate silica (52-63%), intermediate temperature (800–1000°C), intermediate viscosity

and gas content. Eruptions from these composite strato volcanoes can be hazardous due to many factors including: the initial blast may be lateral instead of straight up; the sides of the volcanoes are steep (due to the viscosity of andesite); and pyroclastic flows speed up (due to gravity) as the eruption column collapses. A lahar of sufficient size and intensity can erase virtually any structure in its path, and can carve its own pathway, making the prediction of its course difficult. They carry much debris in the form of uprooted vegetation, pyroclastic material and rocks, in addition to water (from the crater lake or melted snow). The energy of the initial eruption determines the hazardous effects. The speed of pyroclastic flows and lahars mean they cannot easily be avoided.			

Not Achieved			**Achievement**		**Achievement with Merit**		**Achievement with Excellence**	
NØ	N1	N2	A3	A4	M5	M6	E7	E8
No response: no relevant evidence.	One point.	Two points.	Three points.	Four points.	Explains one point.	Explains two points.	One point with minor omission	One point.

Question Three

Expected Coverage	**Achievement**	**Merit**	**Excellence**
The Pacific and Australian Plates are locked together (under the Hauraki Plains / Hamilton / Waikato area) at a subduction zone causing friction. The overlying Australian continental plate is under stress and there are several stress / stretch normal faults, including the known Kerepehi fault.  http://www.mrleehamber.fusedfiber.com / Unit%202.htm Strain / Stress energy builds up over a period and eventually the rock cannot withstand any more strain, causing a break along a normal fault line. The energy is released as the plates move, discharging a huge amount of energy in an earthquake causing the earth to shake. Earthquakes in this area would have a shallow focus (where seismic waves radiate out). Damage decreases away from the epicentre. The amount of energy released and shaking affects the amount of structural damage. Earthquakes of this size (magnitude 7) will result in significant damage to weaker buildings, disrupt services, threaten flood defence structures due to the shaking, and cause liquefaction in weak soils where the water table is close to the ground surface (water logged soils). Liquefaction occurs when waterlogged sediments are agitated by seismic shaking. This separates the grains from each other, reducing their load bearing capacity. Buildings and other structures can sink down into the ground or tilt over, whilst underground pipes and tanks may rise to the surface. When the vibrations stop, the sediments settle down again, squeezing groundwater out of fissures and holes in the ground to cause flooding. The aftermath of liquefaction can leave large areas covered in a deep layer of mud.	Describes with understanding: • plate tectonics along Hauraki Plains / Hamilton / Kerepehi Fault subduction or PP under AP • earthquake as release of strain / stress energy • the amount of physical damage is proportional to the energy released. • example of physical damage or landscape change caused by earthquake • damage decreases from point of origin / focus / epicentre.	Explains in detail: • how earthquakes are generated e.g. earthquake as release of strain energy built up over time • explains that physical damage to weaker / older buildings or structures in central city (close to the river) likely • physical changes to the landscape caused by the earthquake e.g. rupture of flood defences / liquefaction • physical causes and effects of liquefaction.	Explains comprehensively: • earthquake as release of strain energy due to the stretch movement of the overlying continental crust of the AP • relates physical changes to the landscape AND physical damage to structures in the area in terms of buildings, roads, bridges to the release of energy in the form of seismic waves / liquefaction.

Not Achieved			**Achievement**		**Achievement with Merit**		**Achievement with Excellence**	
NØ	N1	N2	A3	A4	M5	M6	E7	E8
No response: no relevant evidence.	One point.	Two points.	Three points.	Four points.	Explains one points.	Explains two points.	One point with minor omissions.	One point.

Cut Scores

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