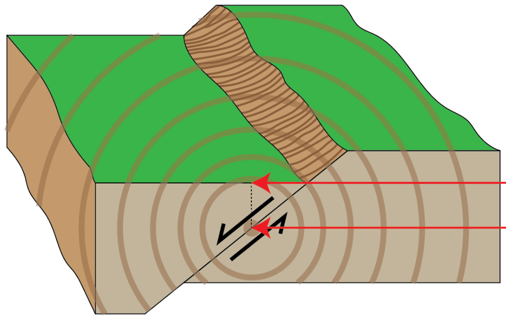
# Assessment Schedule – 2021

## 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) | <br>Type of fault shown: Normal<br>Epicentre<br>Focus | Describes with understanding:<br>• by labelling epicentre and focus, and normal fault<br>• naming PP and AP<br>• plate tectonics along Rangitaiki Plains / Edgecumbe area as subduction or PP under AP<br>• earthquake as release of stress / elastic potential energy<br>• the amount of physical damage is proportional to the energy released (magnitude)<br>• shallower focal depth leads to greater energy at surface. | Explains in detail:<br>• how earthquakes are generated, e.g. earthquake as release of stress energy built up over time<br>• that physical damage to weaker / older buildings or structures are likely<br>• physical changes to the landscape caused by the earthquake, e.g. deviation of rivers, railways, fences<br>• physical causes and effects of liquefaction. | Explains comprehensively:<br>• how magnitude and focal depth affect the amount of energy that reaches the surface, and that damage decreases with increasing distance from epicentre<br>AND<br>relates physical changes to landscape and structures in the area in terms of landslides, fissures, liquefaction, buildings, roads, railways, bridges to the release of energy in the form of seismic waves. |
| (b) | The Pacific and Australian plates are locked together (under the Rangitaiki Plains / Edgecumbe / Bay of Plenty area) at a subduction zone, causing friction. The overlying Australian continental plate is under stress (force placed on rock), and there are several stress / stretch normal faults, including the known Edgecumbe Fault. Stress / elastic potential energy builds up over a period, and eventually the rock cannot withstand any more stress, causing a break along a normal fault line. The stress / elastic potential energy is released as the plates move, discharging a huge amount of energy in an earthquake, causing the earth to shake. | | | |

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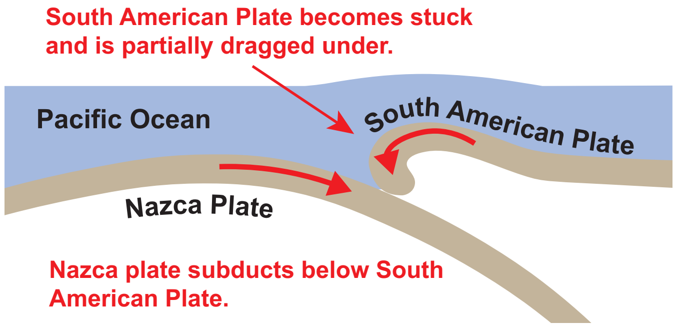
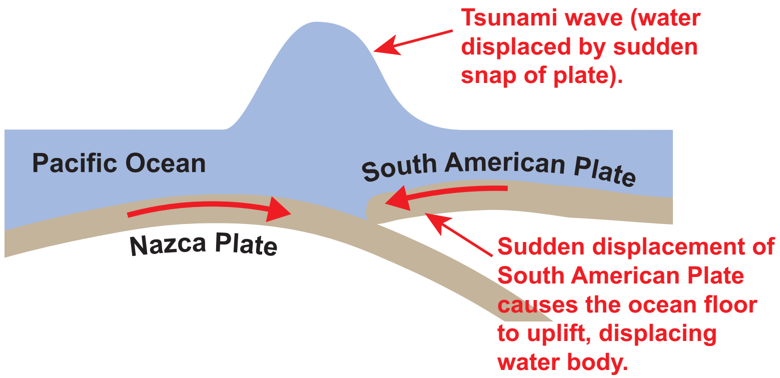
| (c) | Damage decreases away from the epicentre. The amount of energy released and shaking affects the amount of structural damage. The magnitude and focal depth affect the amount of damage. The greater the magnitude, the more energy that is released. The shallower the focal depth, the less energy is lost as heat by the seismic waves as they travel to the surface, meaning more energy reaches the surface.<br>Earthquakes of this size (magnitude 6.5) and focal depth will result in:<br>• physical damage to structures e.g. buildings, roads, railways, bridges<br>• landscape changes e.g. landslide caused by rock on hillside collapsing, deviation to the river, deviation to roads and railways<br>• 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<br>• aftershocks causing further physical damage to structures, rock falls, or further liquefaction. | • damage decreases from point of origin / focus / epicentre<br>• example of physical damage or landscape change caused by earthquake. | | |

| 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**

<table>
<tr><th></th><th>Expected Coverage</th><th>Achievement</th><th>Merit</th><th>Excellence</th></tr>
<tr><td>(a)</td><td>


</td>
<td rowspan="2">Describes with understanding:<br>• plate becomes stuck / SAP partially dragged under NP<br>• sea floor raised when SAP snaps up<br>• plate movement caused the displacement of water<br>• tsunami carries energy which leads to wave<br>• waves increase in height / smaller wavelength / decrease in wave speed as they approach land<br>• tsunami waves travel in all directions from epicentre<br>• tsunami waves lose little energy in water.</td>
<td rowspan="2">Explains in detail:<br>• a tsunami as a displacement of water by the vertical displacement of the plate. Energy transmission from the earthquake to the water<br>• as waves approach land, wavelength shortens / height / amplitude increases / wave slows down due to friction of the shallow land<br>• tsunami waves travel at high speeds in deep water meaning they can travel long distances<br>• one possible factor that might affect the height of the wave<br>• rupture causes plate to flick up, displacing the water above, causing tsunami waves to travel in all directions.</td>
<td rowspan="2">Explains comprehensively:<br>• that a tsunami wave is a series of long-wavelength water waves created by the large displacement of water, due to uplift created at a subduction zone. The tsunami waves travel in all directions from the epicentre, losing little energy to the water, and moving at high speeds in the deep water, meaning they can travel the entire length of an ocean, allowing them to reach New Zealand.<br>AND<br>Explains change to height, wavelength, and speed of the wave as it approaches the coastline.</td></tr>
<tr><td>(b)</td><td>A tsunami is a series of long-wavelength water waves caused by the displacement of a large volume of water. Energy from the plate movement is transmitted to the water.<br>As the Nazca Plate subducts below the South American Plate, it becomes stuck, causing it to buckle. When the stuck area ruptures, it causes the plate to “flick up”, displacing the water above, releasing energy into the water, which travels in all directions away from this point as a “train” of waves.</td></tr>
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| (c) | **How tsunami reaches Lyttelton 15 hours later**<br>Tsunami waves will travel outward on the surface of the ocean in all directions away from the source / epicentre of the earthquake that caused it, and continue across the ocean.<br>Tsunami waves in the deep ocean can travel at speeds as high as 1000 km / h for long periods of time for distances of thousands of kilometres and lose very little energy in the process. This is why the tsunami waves created on the opposite side of the Pacific Ocean could arrive in New Zealand 15 hours later.<br>**Effects on height (amplitude), wavelength, and speed**<br>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 frictional force from the sea bed as the water gets shallower. This slows down the wave – the shallower the water, the slower the wave. | | | |

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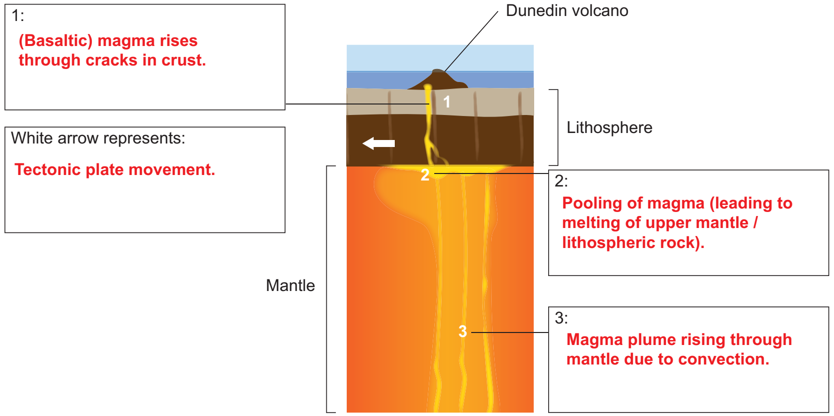
**Question Three**

| | Expected Coverage | Achievement | Merit | Excellence |
|---|---|---|---|---|
| (a) |  | Describes with understanding:<br>• general idea of hot-spot formation (through diagram or description)<br>• basaltic lava is low in silica / not very viscous / low in gas content / usually not explosive<br>• less silica means the lava has low viscosity<br>• runny lava travels long distances before cooling / runny lava leads to shallow slopes of volcano<br>• when magma meets water, an explosive eruption will occur<br>• volcanos become extinct once they have moved off hot spot. | Explains in detail:<br>• rising of magma plume to base of tectonic plate causing rock to melt (hot-spot formation)<br>• formation of lava flows / shield volcano in relation to a characteristic of basaltic magma<br>• role of sea in producing possible initial explosive eruption of steam / tuff ring<br>• once water can no longer reach hot lava, continuous lava flows create gentle slopes of volcano<br>• tectonic plate movement carries plate away from the hot spot, leading to extinction of volcano. | Explains comprehensively:<br>• basaltic magma meets seawater, leading to explosive eruption of steam, forming a tuff ring. As the material continues to increase, basaltic lava flows from the base of the cone flow long distances forming a gentle sloped shield volcano<br>• as the plate carries the volcano vents away from the hot spot, lava production decreases until eventually it completely stops, leading to the volcano becoming extinct, and eroding. |
| (b) | Basaltic magma arises from deep in the mantle and contains a low silica content, and therefore is not very viscous (runny) and contains little dissolved gas, as well as having a high temperature. Basaltic lava is therefore usually associated with less explosive eruptions. The very hot, runny lava will flow a long way before cooling and solidifying, forming volcanoes with very shallow sides, called shield volcanoes. | | | |

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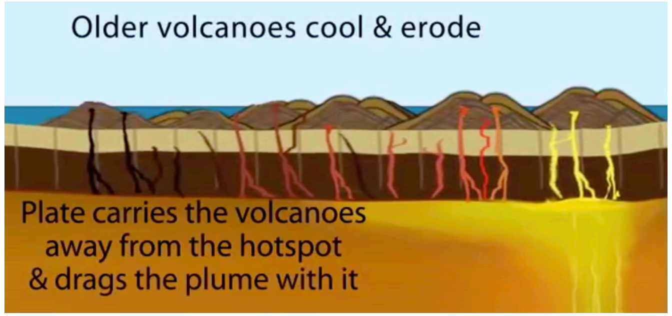
| (c) | **How volcano formed**<br>The Dunedin Volcano would have been formed through a series of stages. The first stage of the eruption in the water could have been explosive / violent (phreatomagmatic) eruption, as cold seawater meets magma / molten rock, rapidly creating an explosive amount of steam (tuff ring formation). Once the water can no longer reach the hot lava, the ongoing fire fountain would build craters of loose erupted material (scoria cones). Later stages may produce lava fountains and basaltic lava flows from the base of the scoria cone which, as it is quite runny (compared with other lavas), may spread long distances from the vent, producing a gentle sloped shield volcano.<br>**Why volcano is extinct**<br>As the tectonic plate continues to move over the hot spot / magma plume new volcanoes are formed, and the plate drags the plume with it. The older volcanoes cool as they move further away from the hot spot, cease being active, and eventually erode. Alternatively, the hot spot may cease, meaning that the volcano cools, and stops erupting, becoming extinct.<br><br><br>Source: www.youtube.com/watch?v=AhSaE0omw9o | | | |

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## Cut Scores

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