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SCHOLARSHIP EXEMPLAR

NZQA

NEW ZEALAND QUALIFICATIONS AUTHORITY
MANA TOHU MĀTAURANGA O AOTEAROA

QUALIFY FOR THE FUTURE WORLD
KIA NOHO TAKATŪ KI TŌ ĀMUA AO!

Tick this box if you have NOT written in this booklet

Scholarship 2021
Earth and Space Science

Time allowed: Three hours
Total score: 24

Check that the National Student Number (NSN) on your admission slip is the same as the number at the top of this page.

You should answer ALL the questions in this booklet.

Pull out Resource Booklet 93104R from the centre of this booklet.

If you need more room for any answer, use the extra space provided at the back of this booklet.

Check that this booklet has pages 2–16 in the correct order and that none of these pages is blank.

YOU MUST HAND THIS BOOKLET TO THE SUPERVISOR AT THE END OF THE EXAMINATION.

Question	Score
ONE	
TWO	
THREE	
TOTAL	

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QUESTION ONE: EL NIÑO – SOUTHERN OSCILLATION (ENSO) AND NEW ZEALAND

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Discuss and evaluate how the effect of the Southern Oscillation on the West Coast of the South Island can be used to further understanding of past climate.

Consider in your answer:

- how the sediment core can be dated
- the origin of the eroded rock and sediment, and how the deposition of the material varies between years
- what evidence is present in the sediment cores to show how often El Niño and La Niña have occurred in the past
- what other information is available from a core and how this could be useful.

The El Nino Southern Oscellation affects New Zealand weather in a variety of ways as a result of the irregular periodic variation in winds and sea surface temperatures over the tropical pacific ocean. During an El Nino year, warmer waters flow east resulting in warmer then average sea temperatures off the coast of South America in consunction with increased precipitation levels over tropical South America such as the Amazon Rainforest. A similar process occurs when warm, moist wind blows across the Tasman Sea, before reaching the West Coast of New Zealand's South Island. As the warm westerly winds travel across the Tasman Sea, they pick up moisture as they get nearer towards the coastline. As the warm, moist winds approch the west coast of the South Island, the winds are forced upward as they encounter the Southern Alps. This process is called orographic uplifting and is responsible for reletivly wet west coasts and a dry eastern coast of New Zealand.

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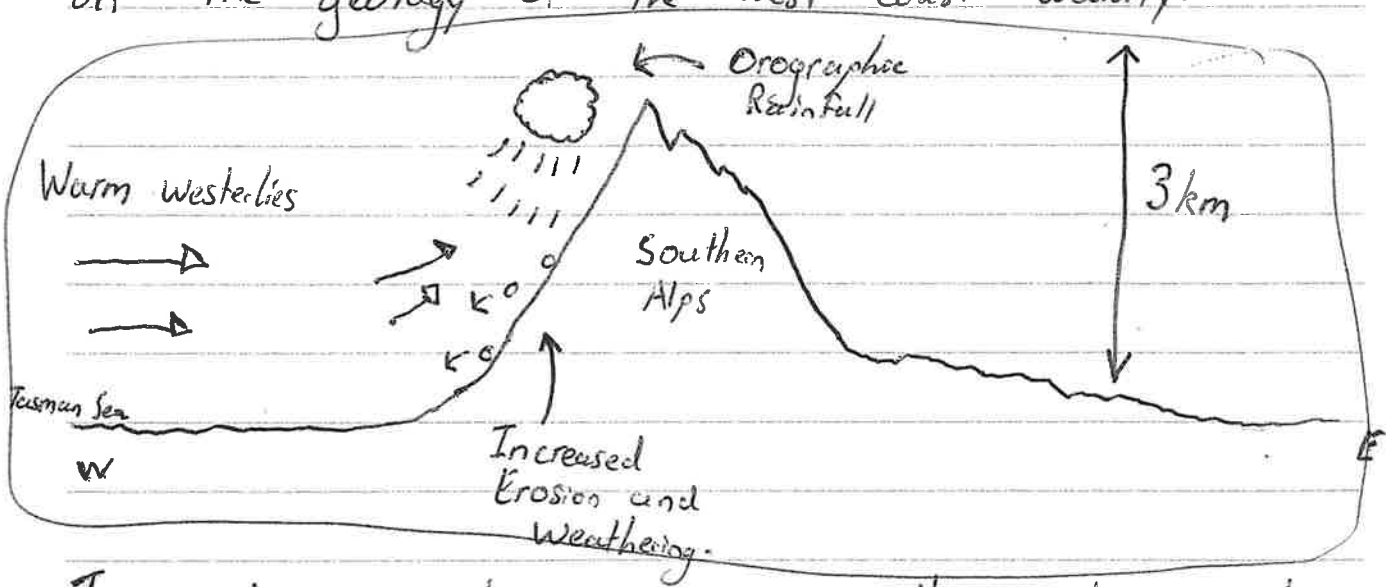
The orographic uplift of moist air over the Southern Alps causes the air to cool as it increases in altitude. As warm, moist air cools, it condenses, forming droplets of water, which in large quantities cause precipitation. The continuous orographic uplifting of moist air over the Southern Alps causes the increase orographic rainfall on the west coast and this has a direct impact on the geology of the west coast locality.



Increased orographic rainfall on the west coast of the South Island increases rates of mechanical erosion and weathering caused by high rainfall levels. As the rain falls, it seeps through cracks in the rock causing it to erode and tumble down the west face of the Southern Alps. By the time the rock reaches the bottom of the mountain, it has broken apart into smaller sediments where it gathers at the bottom of lakes and rivers. The sediment core sample taken from Lake Ohau highlights the darker and lighter layers in the rock from different years, where //

darker regions highlight winter periods and lighter regions highlight Summer periods. The darker sediment present in the winter period is due to the increase moisure level in the Sediment as a result of Seasonal rainfall. It is important to note that the Size of the darker and lighter regions can often extreme at some years, indicating the presence of the El Nino Southern Oscellation that year. The years that have larger winter Sediment samples are likely due to the presence of El Nino causing increased rates of orographic rainfall which results in erosion and weathering of rock down the mountain side, causing the larger Sedimentry layers in core samples from Lake Ōhau. In contrast, during a La Nina year, New Zealand experiences greater north-easterly winds which bring with it increased levels of rainfall across North-eastern areas of the North Island, and as Such the air loses its moisture and is dry by the time it reaches the South Island and as a result caused reduced rainfall to lower and western regions of the South Island. The presence of a La Nina year in the Sedimentry core Samples taken from Lake Ohau is visible as there is a Steady trend of Summer periods followed by an irregular, periodic variation is Sediment indicating the presence of a La Nina year.

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The sediment core can be dated by using relative dating methods by comparing it to surrounding rock. The oldest core sample sediment is at the bottom of the core sample, where the youngest sediment is at the top. The change is colour of the layer is an important tool in measuring the lengths of dry or rainy periods in the West Coast of the South Island and the method of dating can likely predict future years where the Southern Oscellation is present. This will be very useful as is can provide farmers, who heavily populate regions of the west coast of the South Island, the time to prepare for a dry season where their livestock and crops will arguably be affected. Furthermore, it will aid local councils in preparing for abnormal amounts of rainfall that will fall on the west coast of the South Island as a result of an El Nino year which caused high levels of orographic rainfall. Towns will have the time to prepare should increase chances of flooding directly impact houses and roads. In addition, the El Nino / La Nina Southern Oscellation can cause economic uncertainty, in particular when livestock is at risk. Livestock is New one of New Zealand largest exports, and with dry, La Nina years, decreased exports of livestock and livestock products such as dairy and cheese can directly impact the local farmers as well as the national economy//

QUESTION TWO: VOLCANISM ON THE MOON AND THE EARTH

Compare and contrast the Moon's volcanic history with that of the Earth.

Consider in your answer:

- the effect of asteroids
- the characteristics of the crust
- the role played by gravity in the formation of the maria
- the presence or absence of water.

The moon formed at the same time as the Earth. During the early years of the Solar system, the Earth formed as a large, hot, rotating proto-planetry disk and as gravity began to dominate the disk morphed into a hot spherical ball. The underlying theory is the the moon formed as a result of a large asteroid impact on the molten earth, sending billions of tonnes of rock into orbit around the earth where gravity there after gathered them into the moon that we recognise today. The proto-planetry phase of the Earth's history consisted of rotation and angular momentum. As the Earth gravitated into the recognisable spherical shape it is today, the conservation of angular momentum kept the Earth rotating about an axis. The moon however does not rotate and is tidally locked, meaning one side permanently faces the Earth, giving rise to the term 'The Dark Side of the Moon' as the side facing away from the Earth all the time. During early stages of the Earth's history, any water that was present simply evaporated away as

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the high temperatures did not tolerate liquid water. Although, during the Late Bombardment, the Earth had cooled at interstellar carbonaceous condrites with the molecular structure of water 'bombarded' the Earth, giving it its oceans. The moons tidally locked nature prevents it from rotating which causes its orbit around the Earth to be in swinging like motion, where the far side of the moon was subject to increase levels of centripetal forces which has resulted in an uneven distribution of crust on the moon. The increased centripetal force on the farside of the moon has caused what was a molten moon to 'gather' higher quantities of magma on the farside before cooling and solidifing resulting in thick crust developments. The thick crust on the farside of the moon has resulted in very little presence of lunar maria as partially molten rock is further into the core of the moon relitive to the near side of the moon. Therefore, as a result of this, asteroid impacts on the moon will form lunar maria in large quantities if it strikes the near side, and will leave white star like patches if struck on the far side. This is because the thin crust on the near side can be easily broken and expose the partially melted region of the earth as a result of an asteroid impact. The exposure of the partially melted basaltic magma is what cause the

dark lunar maria. Basaltic magma is highly felsic and contains a high concentration of iron, Basaltic magma is dark in coulor and has a very low viscosity. The dark colour of the magma is a result of a lack of white silica minerals that cannot tolerate high temperatures and pressures basaltic magma forms in. The high temperature of the basaltic magma is a direct cause of the low viscosity of the magma which activly demonstrates the large pools of hardend basaltic lava on the moon. These range from 200-1200 km in diameter and are dominent on the near side of the moon due to asteroid impacts breaking through the thin crust. The far side of the moon is only covered by 2% of lunar maria, although it is important to note that the farside of the moon is littered with asteroid impact as the white, scar-like patches suggest evidence of asteroid impacts. The volcanism ~~from~~ on the moon is not caused by plate tectonics but rather by the influence of asteroids whereas the Earth has two primary causes of volcanism. These are either hot-spot or subduction based. Both of these forms of volcanism incorperate the process of plate tectonics and the movement of magma by way of convection current along the mantle. Hot-spot volcanism is a result of a plume of magma residing in the mantle

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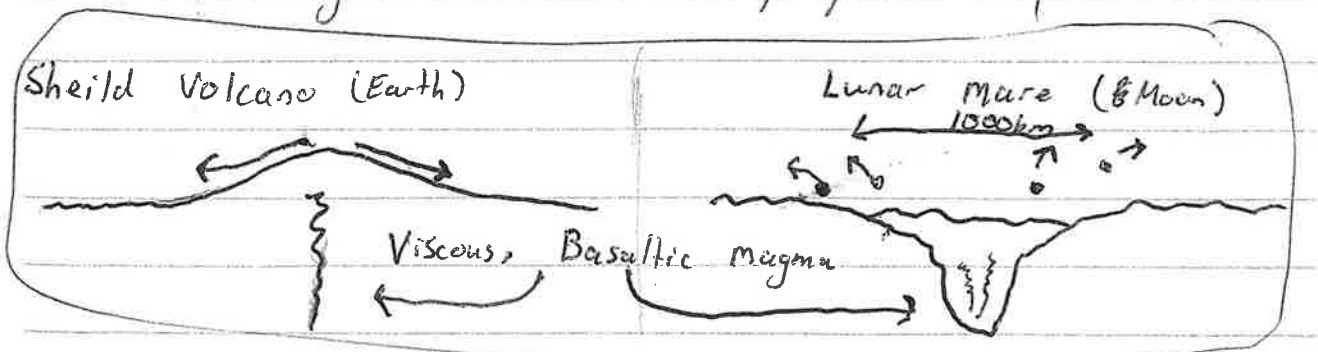
being dragged along a moving plate. The motion of the tectonic plate drags the plume lead along the basalt asthenosphere, where it rises through cracks and fissures in the crust forming long chains of island volcanoes that progressively age as they are further away from the magma plume. Magma seeping through ocean ridges is responsible for the development of undersea volcanism and hydrothermal vent activity. Subduction driven volcanism, however, is driven by one plate 'diving' underneath another causing partial melting and ponding of magma in shallow boundaries along the subduction zone. Ponding of magma has a high risk of forming calderas, where the collapse of a volcanic crater is caused by the sudden release of pressure in the magma chamber due to the high viscosity of rhyolitic magma having the ability to trap gases causing violent explosive eruptions. Along the deeper end of a subduction zone is where basaltic volcanism occurs. Basaltic volcanism on the Earth caused sheild volcanoes to form where as on the moon it results in lunar maria to form. Both of these geological products are a result of basaltic magma and its properties. //



QUESTION THREE: GLOBAL SEA LEVEL RISE

Cyclic sea-level changes have affected our planet over hundreds of thousands of years.

Discuss the causes of global warming and its effect on sea level.

In your answer, you should also consider potential changes in:

- thermohaline circulation
- albedo effect
- solubility of carbon dioxide.

The impact humans are having on the global climate has been unanimously agreed on, and we are beginning to see the impact sea level rise is having on Earth. The oceans play a crucial role in maintaing stable global climate, and the human impact on the carbon cycle has run-off effects on ocean systems which put the global system at in jeopardy. Humans are speeding up the carbon cycle. In particular, extracting and fracing carbon from rock and prematurely pumping thousands of tones of carbon dioxide into the atmosphere as a by-product of internal combustion. The Earth's natural global warming and cooling follow 100,000 year cycles. These are known as Milankovic Cycles and are a result of the slight eccentricity of the earths orbit around the sun. Contempory figures show that CO_2 concentrations prematurly risen and as such directly impact sea level rise. As mentioned, the ocean circulation globally is a crucial factor in maintaing stable global climates. A key part of the ocean system is the

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thermohaline circulation. Thermohaline circulation is driven by a combination of temperature and salinity in the ocean. In high latitudes such as the poles there is no thermocline as the water is isothermal. That is to say that the water is uniformaly cold from the surface to the seabed and the primary cause of water plunging is levels of salinity. Water that is high in salinity is heavier than water without salinity (freshwater), and saline, cold water will plunge to the bottom below less saline colums. Sea ice in high latitudes floats because it is fresh water, and increased rates of global warming has the potental to cause the fresh ice to melt, as fresh ice becomes ~~more~~ less dense ~~as~~ which melts. Subject to increases in surrounding air and sea temperature. Increasing temperatures and decreasing has the potential to cause a thermocline to develop essentially creating a 'barrier' between the surface layer and deep laye of the ocean. This will have catastrophic effects on the global climate as the entire thermohaline circulation breaks down as there is no plunging of cold, saline water at the poles. The breakdown of the thermohaline circulation prevents the oceans from moderating the earths global climate, and cold polar waters will not move to equatorial regions causing continued heating in the tropical regions of the earth. Furthermore, the breakdown

of thermohaline circulation prevents nutrients from deep water 'midright' zones from getting to the surface, causing the death of surface dwelling marine eco-systems. In addition to the breakdown of the thermohaline circulation increased heating causing ice sheets to melt increase the amount of insolation the Earth absorbs. Ice has a high albedo (0.9), meaning that 90% of the incident energy is reflected back off the ice sheet and 10% is absorbed as heat. As ice sheets melt, there is less surface area and as such lowers the albedo, as the albedo of an object is a measure of the reflectivity of its surface. Ice that melts becomes open water, which has a very low albedo (0.06) as 94% of the Suns insolation is absorbed as heat and only 6% is reflected. Increased rates of ice sheets melting causes a run off effect causing exponential heating as increased melting of ice sheets causes higher levels of absorbtion of solar flux which in turn increases melting of remaining ice even further. The lower albedo results in warmer oceans due to the increased levels of absorbtion and as a result cause the water to have decrease in density and expand, which causes global sea level rise on the global scale as a result

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of increased levels of warming. The addition of increased levels of CO_2 in the atmosphere causes global ocean acidification. Carbon dioxide in the atmosphere is absorbed into the oceans and forms carboxilic acid which in large quantities lowers the average pH of the ocean. Acidic waters discourage phytoplankton from doing photosynthesis and like the albedo effect, has a run off consequences on the Earths global climate. More increased levels of carboxilic acid in the ocean will reduce the level of solubility of carbon dioxide in the ocean. The combination of these effects as a result of increased human activity have catastrophic consequences, especially for costal comunities who are subject to the impact of sea level rise. Furthermore the effects humans are having puts a large imbalance on the carbon cycle which impacts the ocean system which in turn impacts the atmospheric system. The result of global warming is primarily sea level rise and catastrophic, violent weather events that put human life at an increased risk. The run off effect that human carbon dioxide emmisions are having on the planet makes it ever more difficult to control the effects of CO_2 concentrations increasing in the atmosphere and have disasterous consequences.