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SCHOLARSHIP

NZQA | Mana Tohu Mātauranga o Aotearoa
New Zealand Qualifications Authority

Scholarship 2025
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.

Do not write in any cross-hatched area (▨). This area may be cut off when the booklet is marked.

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

QUESTION ONE: VOLCANOES UNDER THE ICE

Explore the stages and features of a glaciovolcanic eruption. As there is considerable ongoing ice loss in the region, consider the long- and short-term implications for volcanism in Antarctica.

In Antartica there are many volcanos and two active volcanos along and near the west Antartic Rift sgstem which is seen in figure 1. These volcanos ~~are~~ situated along the west Antartic rift system are sitting along the techtonic plate boundary of the east & west Antartic plates. These plates are pulling appart causing a divergent plate boundary. This divergent plate boundary can cause the earths crust to be streached thin and the depth of it decreses. This mean it provides less pressur onto the mantle really it easier for magma to make its way up and though the crust to erupt and become an active volcano. At divergent plate boundarys the magma that comes through the crust tends to be basaltic magma as it is not travely though the crust for a long time and picking up other types of rocks and elements to create different types of magma, however if it did it could form andesite or rhyolite magma. For basaltic magma to travle though cracks in the crust caused by the diverged plate boundary it would create a relitivly calm and not too vigorous eruption. This is due to the ~~the~~ features of basaltic magma.

Basaltic magma has relatively low silica content causing it to be very runny and have a low viscosity. This does not allow it to trap much gas which therefore does not expand and create a vigorous eruption when it breaks to the surface. Although of this, the heat from the volcanos activity melts the ice caps about it to create some water. When the ice above is thick it will slightly melt however it can easily be drained out the side seen in figure 2, but when there is thin ice above the volcano the ice can be melted into water but it can't escape as easily with drainage. ~~This means when there is thick ice~~ When the basaltic magma which is very hot erupts out the vent and meets cold water, this difference in temprature causes a huge vigorous phreatomagmatic eruption where the magma and the cold water rips the pieces of magma apart into ash & other small chunks erupts and can creates a pyroclastic flow when then settles until there is no more water and the ~~retained~~ basaltic magma leftover erupts out and runs down the sides. When there is thin ice, and more water a phreatomagmatic eruption is more likely to occour due to the melty ice building up over the vent, whereas when there is a thick ice cap over the volcano and less melted ice, a phreatomagmatic eruption is less likely to occur and the thickness and pressure of the thick ice causing the magma to not be able to erupt out of the vent as easily and eruptions are less likely to occour. E

Due to the faster moving and melting of the glaciers

in Antartica, reducing in thickness by more than 1 meter per year, vigorous phreatomagmatic eruptions are more likely to occour, in the short term. As the ↑increase heat from ocean currents due to climate chang is the largest factor causing sea ice melting, this can cause different long and short term effects on the volcanism in Antartica. Humans are constantly emitting greenhouse gasses into the atmosphere which absorb and trap radiation and heat in the atmosper causing the Earths surface temprature to constantly warm up, all over the world. This causes water at the equator to warm up more which can be transported to the poles and Antartica via deep ocean currents such as thermohaline currents. thermohaline currents are originally caused by downwelling at the poles due to cold and salty water creating high dursity water that downwellings move from mixed layer into deep layer and travels along the ocean floor ~~where~~ until it reaches something which causes it to upwell. ~~It~~ Water from the mid latitudes & equator are consequently pulled along to the poles & Antartica to replace this downwelled water. Due to climate change and humans worsening the greenhouse effect, this water pulled along to Antartica is constantly getting warmer. This causes less sea ice & glaciers to form, and instead causes them to melt. This will decrease the pressure on the crust and volcanos under the ice caps ~~erupt~~ erupt, it easier for them to erupt and mixing volcanism in Antartica in the short term. This could cause ash clouds to be produced which can cause ash to end up

in the atmosphere which can also be harmfull. This melting of sea ice and increased volcanism could remove some species habitats and in extreme cases cause species to become extinct in ~~the~~ due to the short term - effects. However the long term effects can be different. Due to the waters in antartica to be warming up, this can cause the original downwelling at Antartica to stop and ice water is no longer dense enough to downwell. this will therefore stop the thermohaline current completely and cool water will not be ~~transported~~ to the equator & warmer water will not be trasported to the poles, stopping one of the oceans main ways of thermoregulation. The waters at Antartica will then no longer receive warmth & heat from the equator and will cool down forming more ice. If the thermohaline current gets permanently shut off even more and more ice will form which can cause the lower part of the earth to possibly go into another ice age in the long term. But if could also start downwelling and the thermohaline current pace up again which could therefore act as a positive feedback loop with constant ice melting and forming cycles. In the long term if the thermohaline current permanently shuts off the volcanism in the Antartic region could completely stop due to thick ice caps forming, but if the thermohaline current stops, then starts again, it can cause alternating periods of no volcanism when ice caps are thick, and periods of high volcanism where the ice caps are thin.

QUESTION TWO: WARMING OCEAN

Explore how shifts in the Subtropical Front have led to the warming of the ocean by the Chatham Rise. In your answer, consider oceanic and atmospheric processes. Furthermore, discuss what effects a continuation of the shift in the Subtropical Front would have on the marine biodiversity and fisheries on the Chatham Rise.

The subtropical front is where the cold fresh water from the southern ocean meets the warm salty water from the subtropics. This subtropical front used to be just north of the chatham rise, however is moving south and currently is just on the chatham rise, and in future will be further south than it is seen in Figure 3. this causes differences in ocean salinity and temprature at the chatham rise and changes the nutrients and food it brings to support a marine ecosystem. Due to global warming from human emission of greenhouse gasses into the atmosphere which trap radiation and heat causing the earths surface & oceans to warm up, The stronger westerlie winds have effected the currents which bring warm subtropical water to NZ as well as them moving further south causing the subtropical front to move further south. The southern ocean however has not been effected by warmer water being brought to it causing it to remain cold. However the increase in temprature of the waters near NZ cause the temprature difference and gradient to increase at the subtropical front. Since the warmer water is mixing with the cool water, the net temprature will be warmer than previously. This creates the ocean at chatham rise to

be warmer. The south pasific gyre which is a surface current brings the warm water from the equater to NZ. This gyre forms due to trade winds transporting surface water with them. Due to Ekman transport and coriolis, the water in the southern hemisphere is deflected to the left and causes the anti-clockwise south pasific gyre. Due to the heating of the earth and the equater constantly being heated due to having an 90° angle of incletion it gets very warm causing the hadley circulation cells to form stronger as warm air constantly rises. This can cause stronger winds which transport more warm water via the gyre to NZ causing its ocean to warm up more, increasing the temp of the subtropical front over the chatham rise. the ENSO climate cycle also effects the temp of this water. During La Niña events when warmer water is transported from central & eastern pasific to NZ this further heats the subtropical front. During a La niña event the winds westerlies weaken and smaller winds from high to low pressure strengthen in the opposite direction. This caused more water to be pushed from the east pasific to NZ warming the chatham rise.

~~Due to the increased warmth of the~~ The subtropical front ~~chatham rise~~, the water ~~also~~ ~~is cooler~~ ~~but~~ becomes further south due to the westerlie winds also moving south, which causes it to meet the cooler water from the polus lower then the

chatham rise. This means the water does not meet at the chatham rise and it is not provided with the cool, nutrient rich water which provides the essential food & nutrients for phytoplankton ~~and~~ and for other layer marine organisms to thrive. The water from the poles is delivered to the subtropical front via the Antartic circumpolar current where downwelling & upwelling occours to collect nutrients & food from the ocean floor at the bottom of the deep layer and brings them up to NZ via upwelling. This provides an amazing ~~set~~ set of nutrients for marine ecosystems to be established and thrive. However since the subtropical front has moved south, the nutrients are no longer provided to the chatham rise. This means the marine ecosystem will start to fail and collapse, destroying the food web and causing many species ~~including~~ including fish to die out. This means that the NZ fisheries will loose over 60% of their nations total fish catch as the location is the primary fishery area and it will no longer be able to catch fish due to the collapse in the ecosystem. This will result in fish not

being caught, and sold, causing economic destress as fish markets and shops do not gain fresh produce and cannot sell anything, not making money and losing jobs. As well as this fisheries will not catch fish and will cost money and people will loose jobs really in a huge economy change in NZ. However due to the constant monitoring of this change through satelites, and argo floats the changes can be measured and the cold nutrient rich water can be located where fisheries can change their fishing locations. Scientists should constantly monitor it and due to the information from the Argo floats that there is warm salty water all the way down to the bottom of the seafloor it can be seen that no water from poles is being transported there. ~~which~~ The argo floats info can help to predict the future change of the subtropical front to inform fisheries and people so they can plan in advance to ensure fisheries can still catch fish where the narrow ecosystem will have moved to, which will be further south seen in figure 3.

QUESTION THREE: SEASONS IN OUR SOLAR SYSTEM

Analyse how seasons on Mars, Uranus, and Neptune would be different to those on Earth by comparing eccentricity, length of orbit, distance from the Sun, and axial tilt. Additionally, evaluate the role that solar radiation plays in the planets' seasons.

In our solar system there are ~~many~~ different planets which have different extremetres of seasons and lengths of seasons. For seasons to occour a planet needs an axial tilt which allows one side of the planet to be tilted towards / away from the sun at different times within its orbit.

Mars has an axial tilt similar to Earths, only differing by 1.5°. This axial tilt means that ~~the~~ at different times throughout its orbit the northern hemisphere will be tilted towards the sun and the southern hemisphere tilted away and at other times the northern hemisphere will be tilted away and the southern hemisphere tilted towards. when the hemosphere is tilted towards the sun it will be in summer and when tilted away will be in winter, seen in figure 1.

~~Mars has a greater distance from~~ Mars, Uranus, and Neptune all have a greater distance from ~~the~~ the Sun than Earth does. This means that the solar radiation providing heat to the planet will be less intense. Due to this their ~~summer~~ summer season will also be less intense

and not as hot, however earth does not have much eccentricity of its orbit so is roughly the same distance away from the sun at all times. Neptune also has a very small eccentricity so will be similar to earth, however Mars has a rather large eccentricity and Uranus has a medium eccentricity. When in perihelion and the planet is the closest to the sun in its orbit, the summer season will be very extreme and hotter than when in apehilion and farthest away from the sun? so less intense. This is due to the sun radiation providing heat having to travel a smaller distance and therefore not getting decreased and blocked. When in perehilion the winter will also be less intense and in apehelion it will be very intense & cold. The extremety of their seasons is compared to their other seasons. The difference between them. The length of the orbit also can change and effect the seasons on different planets. Earths orbit is 1.0 years and each season is $\frac{1}{4}$ of that so 3 months. This is due to each hemosphere tilted towards the sun for that long per year. However the other planets have different and larger lengths of their orbits. Mars' orbit is only 0.8 of a year longer than Earths so each season will be abit longer over its orbital time.

Uranus has a ~~very~~ 84.1 year orbit so each season lasts ~21 years. This means that ~~when~~ when ~~it~~ one homosphere is in summer it will constantly get lots of radiation and heat and will heat up more due to the constant and long period of time in summer. This is the same for its winter when it will get very cold for a very long time when furest away from the sun. Neptune has an even longer 165 year orbit which the effects will be the same as Uranus but more extreme. These can be seen in figure 2. the extremety of the seasons is compared to their other seasons. the differences between them. The information scientests received about Neptunes clouds being seen showing it enters spring is due to clouds having high albedo which means they have high reflectivity. Since they are getting brighter this shows that they are reflecting more light signifying they are getting hit by sunlight and radiating from the sun. ~~It~~ This shows how ~~the~~ Neptune is recently tilted towards the sun moving into spring and ten later on another $\frac{1}{4}$ of its orbit will be moving into summer. This evidence can be seen in figure 3.

~~the amount of ra~~

the amount of radiation also has

effect on the seasons where the ~~more~~ planets ~~far~~ closer to the sun receive more radiation. This effects the seasons as the more radiation received means the more heat received and the amount ~~the~~ each season can heat up due to the radiation received. This means that the closer to the sun the warmer the seasons are going to be when ~~not~~ ~~access~~ if there was no atmosphere ~~on~~ surrounding a planet. So Earths seasons should be the highest temperatures if it did not have an atmosphere however the atmosphere protect and block out some of the radiation from reaching the planet. The solar radiation received allows the planets to be in a certain temperature season if there was and atmosphere present. The amount of radiation the atmosphere/~~Earth~~ planet receives also allows ~~it~~ its brightness and darkness levels with seasons causing longer/shorter hours of light throughout one rotational period of the planet. The tilt & distance & eccentricity of the planet also causes the solar radiation to be towards a specific part of the planet being a hemisphere or side, and the intensity of the season compared to the other planets and the difference between a planets own seasons.

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Scholarship

Subject: Earth and Space Science

Standard: 93104

Total score: 16

Q	Score	Marker commentary
1	6	Candidate explained the features of a glaciovolcanic eruption in Antarctica with good discussion on effects of the thin ice on the magma. Furthermore, they have explored the short- and long-term impacts of volcanism in Antarctica. However, not enough details provided to be awarded an outstanding answer.
2	5	Candidate has explored how shifts in the Subtropical front would affect the Chatham Rise as well as considering oceanic and atmospheric processes. However, they have not covered this in sufficient detail to be awarded a 6.
3	5	Candidate has analysed how eccentricity and length of orbit can affect seasons on Earth, Mars and Uranus. However, the answer is not detailed enough to be awarded a 6.