Assessment Schedule – 2021

Scholarship Earth and Space Science (93104)

Evidence Statement

ONE

Evidence	1 – 2	3 – 4	5 – 6	7 - 8
Origin of the eroded rock and sediment and how it is transported to the sea The westerly winds blow across the Tasman Sea towards the west coast of the South Island. The winds pick up moisture coming across the ocean. When the winds meet the north-south-oriented Southern Alps, they are lifted up, which results in clouds forming and water vapour condensing into rain; orographic rainfall. Some of this rain will spill over into the rivers that are flowing to the east from the Southern Alps. This rain, and also the ice, erodes the rock of Southern Alps. The initially sharp pieces of rock are tumbled around in the rivers, resulting in particles of sediment being knocked off. The resulting river flows and deposition of sediments on the rise are sensitive to variations in westerly wind flow. There are links between wind strength, precipitation, flood frequency, and sediment accumulation which is reflected in the sediment cores. **Evidence that could be gathered and analysed to determine how often El Niño and La Niña events have occurred historically** A comparison of rock sediment over time and between lake cores enables the rate of erosion and weathering of certain rocks, such as those that make up the Southern Alps, to be worked out. The relative thickness of rock sediment layers may indicate the rate of weathering – a thicker layer indicating more erosion because of more rain due to the ENSO. **El Nino** During an El Niño, there are increased westerly winds which lead to a wetter west coast than a normal year. This increased rainfall in the western South Island would cause more erosion of the rocks in the Southern Alps, and a larger amount of sediment would be found in the bottom of the lake. In sediment cores, there would be increased sediment found during this period that would indicate an increase in rainfall. This is because the layers will be thicker due to the greater amount of erosion, and darker in colour due to the composition of the sediment. **La Nina** The opposite could be said for a La Niña; the trade winds increase during this	• Very little understanding of question with very little development of ideas. • Resource booklet copied only.	• Shows some understanding of question with only some development of ideas. • Some synthesis and integration of the processes.	• Good understanding of question with good development of ideas. • Good analysis, synthesis, and integration of the processes, exhibiting well developed understanding of the context. • Must show a good sense of geological time.	• Thorough understanding of question with excellent development of ideas. • Sophisticated analysis, synthesis, and integration of the processes, showing perception and insight applied to the context. • Reflection on the answer resulting in extrapolation. • All aspects of answer expressed with convincing communication. • Must show integration of ideas e.g. cycles.

period. This leads to less rainfall in the west than a normal year, which means that there is less sediment being eroded into the lake. This leads to lighter, thinner layers in the sediment core due to the lack of erosion and the composition of the resulting sediment. **Dating** Other evidence to note differences could come with the use of pollen, as vegetation changes with climate. So studying pollen samples could help determine past climatic conditions. The oldest sediments are at the bottom of the core and the youngest at the top – this sequential order gives a relative date for each layer. This would be used to note differences and how often they have occurred. More accurate dating of different layers can be gained from distinctive layers, such as volcanic ash from a known eruption, or dust particles from a specific known event, or C-14 dating of organic material. When these are compared with relative dating and C-14 dating, a chronological sequence for thousands of years can be determined. This would be very useful to form a timeline for the frequency of ENSO, going back up to 70 000 years. Due to the irregular nature of the ENSO, it is important to find historic data to allow its previous frequency to be figured out so that we can compare that to more recent times, and if there has been a change in pattern.				

TWO

Evidence	1 – 2	3 – 4	5 – 6	7 - 8
The Moon has a crust, mantle, and core. It may have a solid iron core surrounded by a softer, somewhat molten liquid iron outer core. Early in the Moon's history, the interior was molten enough to produce magma that erupted through the Moon's crust onto the surface, creating the volcanoes and 'seas' of lava flows. Over time, the magma cooled and solidified, ending volcanism on the Moon. Lava also burst from the crust when large enough asteroids broke through the surface. The surface is much higher on the farside, and the crust is typically much thicker there as well. The primary factors controlling volcanism on the Moon appear to be surface elevation and crustal thickness. Magmas originating at equipotential depths will have greater difficulty reaching the surface on the far side. Volcanism on the Moon differs in several ways from volcanism on the Earth: **Age** • Volcanism on the Earth is an ongoing process, as we have plate tectonics and hotspots. Many of Earth's volcanoes are quite young in geologic terms, often less than a few hundred thousand years old. **Asteroids** • The Moon's surface shows plenty of evidence of asteroids. Early in the formation of the solar system, there were a large number of asteroids and these bombarded the planets and moons as they were pulled in by gravity. These meteors impacted the surfaces on both sides of the Moon, and there is a lot of evidence of these on the far side of the Moon. However, as the crust is much thinner on the near side of the Moon, the meteors could have helped the magma come to the surface, whereas this is not likely the case on the far side of the Moon, where the crust is thicker. • There isn't much evidence for these on Earth, as plate tectonics and erosion has covered them up. Also, Earth has an atmosphere that helps to burn up these asteroids. The Moon does not have any of these elements and without a magnetic field or atmosphere to shield it, the Moon gets bombarded frequently by meteors.	• Very little understanding of question with very little development of ideas. • Resource booklet copied only.	• Shows some understanding of question with only some development of ideas. • Some synthesis and integration of the processes.	• Good understanding of question with good development of ideas. • Good analysis, synthesis, and integration of the processes, exhibiting well developed understanding of the context. • Must show a good sense of geological time.	• Thorough understanding of question with excellent development of ideas. • Sophisticated analysis, synthesis, and integration of the processes, showing perception and insight applied to the context. • Reflection on the answer resulting in extrapolation. • All aspects of answer expressed with convincing communication. • Must show integration of ideas, e.g. cycles.

Volcanism • The settings of mare volcanism reveal another major difference from volcanism on the Earth. Earth's volcanoes mostly occur along subduction boundaries, and can form long linear mountain chains. Hawaiian Islands are formed from a plate moving over a mantle hotspot. Also, basaltic magma can form cinder cones, shield volcanoes, and none of these are present on the Moon. In contrast, the maria typically occur in the bottoms of very large, very old impact craters. Thus, most of the maria are nearly circular in shape. **Gravity** • Lunar gravity is only one-sixth that of the Earth. This means that the forces driving lava flow are weaker on the Moon. Thus, the very flat and smooth mare surfaces imply that mare lavas were very fluid. They could both flow very easily and spread out over large areas. Also, the low gravity means that explosive eruptions can throw debris further on the Moon than on the Earth. Indeed, such eruptions on the Moon should spread lavas out into a broad flat layer, and not into the cone-shaped features seen on the Earth. This gives one reason for why large volcanoes are not seen on the Moon. **Water** • The Moon has essentially no dissolved water. The lunar maria are all completely dry. In contrast, water is one of the most common gases in Earth lavas. Water also plays a major role in driving violent eruptions on the Earth. Thus, the lack of lunar water should strongly affect lunar volcanism. In particular, without water, violent explosive eruptions are much less likely on the Moon. Instead, lavas should just flow smoothly and quietly out onto the surface.				

THREE

Evidence	1 – 2	3 – 4	5 – 6	7 - 8
Sea ice only contains fresh water, so the remaining salt stays in the ocean when seawater freezes to form sea ice. The remaining salt and the cold temperature result in dense brine that sinks and flows down the continental shelf to the bottom of the deep ocean (downwelling). Melting sea ice has no impact on sea level rise because it's already floating in the ocean. As oceans warm, the ice melts, but the total volume of water does not change. However, melting sea ice does contribute to climate change. This is because white sea ice has a high albedo. It has a highly reflective surface and reflects a large amount of sunlight. So when it melts, the dark open ocean now absorbs sunlight. This absorption heats up the ocean causing further melting of ice. Also, the warming ocean raises global temperatures, which in turn cause glaciers and ice sheets on land to melt further. This is an example of a positive climate feedback loop. Land ice is a larger contributor to sea level rise because the melted water is being added to the ocean. Antarctica has ice shelves as well as ice sheets, these sheets extend from the shelves and therefore add to sea level rise. The shelves act as a barrier stopping the glacial ice from reaching the ocean. The shelves are melting because they are being melted from underneath from a warming ocean. If the ice shelves melt, then they could release a large amount of melt water from the glaciers behind them, raising global sea levels. If all the sea and land ice melted in the world there would be a major effect on the thermohaline circulation. In the Northern Hemisphere, cold dense water sinks (North Atlantic Deep Water) and in the Southern Hemisphere cold dense water sinks at the South Pole (Antarctic Bottom Water) and drives the thermohaline current (THC), which distributes heat, nutrients and gases (not just water) through the other ocean basins. There are more consequences than just sea level rise due to land and sea ice melting. Differences in salinity and temperature impact global ocean circulation. These variations in ocean temperature and salinity can disrupt and threaten marine species that are dependent on the ocean due to the ocean being delicate to change. Any reduction in sea ice production also reduces brine production and the sinking of dense water to form the AABW and the NADW. This will result in the THC slowing down, and it will not be as efficient at distributing nutrients, gases and heat around the planet. The oceans help regulate the Earth's temperature. If the oceans warm, then the solubility of CO_2 will decrease. This means that there is more CO_2 in our atmosphere which can then trap IR from the Sun causing the planet to warm. As more of this happens, it will cause ice sheets to melt causing sea levels to rise.	• Very little understanding of question with very little development of ideas. • Resource booklet copied only.	• Shows some understanding of question with only some development of ideas. • Some synthesis and integration of the processes.	• Good understanding of question with good development of ideas. • Good analysis, synthesis, and integration of the processes, exhibiting well developed understanding of the context.	• Thorough understanding of question with excellent development of ideas. • Sophisticated analysis, synthesis and integration of the processes, showing perception and insight applied to the context. • Reflection on the answer resulting in extrapolation. • All aspects of answer expressed with convincing communication. • Must show integration of ideas e.g. cycles / feedback loops.

Of concern is the level of CO_2. As shown on the green line in the middle, it has fluctuated between about 180 – 280 ppm (parts per million) over this period of time. It moves very closely with temperature however there is a timelag and even CO_2 emissions are reduced or stopped then the temperature will still continue to increase. Now the level rapidly increased to 400 ppm; a 40% increase. This correlates with our emissions from burning fossil fuels, reduction of forest cover, and other factors. With our present warming trend, higher sea level is a major concern due to the catastrophe it would present to coastal cities and infrastructure globally. Large populations live in low lying areas which may become displaced. Also, large proportion of the world rely on fish as their primary protein source and this would be affected as the food chains would be disrupted. Because our warming is now happening a lot faster than previous periods of natural abrupt climate change, there is no way to accurately predict how many years it will take for enough ice to melt to raise the ocean that much.				

Cut Scores

Scholarship	Outstanding Scholarship
13 – 18	19 – 24