Assessment Schedule – 2013

Scholarship Earth and Space Science (93104)

Evidence Statement

Q	Evidence	1–2	3–4	5–6	7–8
1	**Key points** Shows good understanding and integration of key parts of the carbon cycle with reference to relevant parts of NZ and surrounding ocean (including the Southern Ocean). A good range of these points should be in the answer: - CO_2 is dynamically exchanged between the atmosphere and the ocean. - Cold stormy water as is found around much of NZ and this, and the Southern Ocean, dissolves more CO_2 than warm water. - Phytoplankton use CO_2 in photosynthesis to form food which is consumed by other organisms. - Plankton and other marine organisms die and fall to the ocean floor (marine snow) and their carbon is added to the sediment. - CO_2 in the ocean forms carbonic acid with water which then dissociates into hydrogen carbonate and carbonate ions. - Carbonate ions aid in the formation of calcium carbonate by physical and biological means. These are deposited on the ocean floor, adding to the sediment. - Carbonate and dissolved CO_2 is taken deep into the ocean by down-welling and can stay in the depths for 1000s of years. - The thermohaline current, a major branch of which runs past NZ, circulates dissolved CO_2. - Phytoplankton and other marine mammals form calcium carbonate platelets or shells. When they die, the platelets or shells drop to the bottom of the ocean and become part of the marine sediment. - Sediment accumulation happens all around NZ but especially on the continental shelf, eg off the east coast of the North Island. - Marine sediment is very carbon rich because of organic debris. - Land sediment is eroded from the land by water, ice and plant and animal action. - High country such as the Southern Alps are eroded especially fast, and sediment transported via water and gravity, eg by braided rivers, to the	• Very little understanding of the carbon cycle at this level with only some development of ideas. • The carbon cycle is not specifically related to New Zealand.	• Shows some understanding of the carbon cycle with some logical development of ideas. • Some synthesis and integration of the processes. • The carbon cycle is related to New Zealand.	• Understanding of the underlying earth and space science showing logical development, clarity and precision of ideas. • Good links of carbon cycle with New Zealand features • Good analysis, synthesis and integration of the processes exhibiting well developed understanding of the context.	• Thorough understanding of the underlying earth and space science showing logical development, clarity and precision of ideas. • Excellent understanding of the role of New Zealand in the global carbon cycle. • 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.

	ocean. - Ocean currents transport the carbon rich sediment around the coast and beyond, eg up into the Kermadec trench, before it is deposited on the ocean floor or on the sides of canyons such as the Kaikoura Canyon and the Cook Strait canyons. - Collapse of canyon walls causes sediment to travel for up to several 100 km before being deposited. - Volcanic eruptions, both on land (TVZ) and underwater (Kermadec volcanoes), contribute ash to sediment deposits as well as carbon dioxide into the air. - All sediment eventually becomes rock because of compression of layers of sediment and compaction and cementation (dissolved minerals cement particles together). - Rock made from calcium carbonate becomes limestone, a major carbon sink. Limestone formations are a common feature of New Zealand landscapes. - If limestone is metamorphosed, (subjected to heat and pressure), marble is formed – a very long term storage of carbon. - Limestone subducted melts when magma is formed, releasing carbon dioxide as a gas when volcanic eruptions occur. - CO_2 will be transported around the globe by atmospheric currents, and much of it will be dissolved back into the ocean. Other relevant points will also be considered. The carbon cycle is able to maintain a stable temperature range and regulate the climate by: • An increase of carbon dioxide in the atmosphere increases the temperature, because it acts as a greenhouse gas, trapping heat. • More heat means that more water will evaporate from the oceans, and the additional precipitation will remove CO_2 from the atmosphere, moderating the greenhouse effect and cooling the planet. • If the planet cools too much, less water will evaporate and there will be less precipitation to remove CO_2; the CO_2 will build up, warming the planet.				

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2	**Key points** • The presence of carbon dioxide in the atmosphere and / or the presence of obvious volcanic shaped features show that there was once active volcanism. • Mars volcanoes are so big possibly because of either lack of plate movement or very slow plate movement which gives plenty of time for the volcanoes to grow very large, eg Olympus Mons. • The three volcanoes of the Tharsis Montes or the Elysium volcanoes are in a straight line and so could have been formed from either: - plate movement over a hot spot (Earth feature is the Hawaiian volcanoes or seamounts off NE coast of NI) - subduction forming a line of volcanoes, because of magma is formed at a certain depth, (Earth feature line of volcanoes in Kermadecs or TVZ). • In the early days of the formation of Mars, it may have been warm enough for water to be liquid and to lubricate tectonics. • The Valles Marineris is very straight and looks like a rift valley which would indicate the movement apart of tectonic plates. (Note: Any very straight long line on a planet will be a tectonic feature because water always creates curved valleys). • The Valles Marineris is oriented to the magnetic map. • The magnetic map indicates a divergent plate boundary/ spreading apart of plates (*sea floor spreading acceptable ONLY if this term is accurately explained or qualified)*. • The alternating bands of magnetism in the rocks are similar to alternating bands found on the ocean floor, eg in the Atlantic. • Alternating magnetism in rocks probably formed when the planet was still cooling at the beginning of its life. New crust came up from the mantle and the (basalt) rock would have solidified taking on the magnetism of the time. Therefore, the core must have been much hotter and old crust would have cycled downwards. • The Valles Marineris has what appears to be a strike-slip fault running along it – possibly a large transform fault. Earth feature – Alpine Fault. • The central segment of the Valles Marineris shows that the sides of an old impact basin are offset by 150 km showing movement along the fault. • The strike-slip fault could be a later feature overlying the divergent plate	• Very little understanding of the underlying earth and space science with only some development of ideas.	• Shows some understanding of the underlying earth and space science with some logical development of ideas. • Some analysis and critical thinking.	• Understanding of the underlying earth and space science showing logical development, clarity and precision of ideas. • Good analysis, critical thinking and application to complex situation.	• Thorough understanding of the underlying earth and space science showing logical development, clarity and precision of ideas. • Sophisticated analysis, critical thinking and application to complex situation showing perception and insight. • Reflection on the answer resulting in extrapolation. • All aspects of answer expressed with convincing communication.

	movement because of the evidence from the impact basin. • Any good argument as to why there probably is not tectonics on Mars today is acceptable, as long as it is developing the given ideas, eg magnetism in rocks shows that there was once a molten core which could have set up convection currents. **Extra evidence that can be gathered:** • Collection and examination of rocks to show the type of volcanism, type of rocks, magnetism in the rocks, and existence of rocks and minerals that are formed when tectonic plates interact. • Seismometers could be placed to detect ground movement, especially in the Valles Marineris. • Observation of either side of a chosen canyon to see if there is relative movement. • Continuation of the search for more evidence of water.				

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3	*NOTE: All statements need to be qualified, eg C-14 is used for dating organic material.* *Any statements on ice-cores are only relevant if is used as back-up or cross-correlation with other evidence.* **Key points** • The geological record could be dated by: - radio isotopes, eg C-14, which are used for dating organic matter up to about 50,000 years old - dating the layers above and below, below being older, above being younger - using tree ring data (by counting rings and using rings showing unusual thickness or thinness as markers) - using sediment core data using something like volcanic ash (the chemical composition of which is unique to each volcanic eruption). • Distinctive markers would be anything that is worldwide in the geological record such as plastic, radioactive isotopes from atomic tests, PCBs, CFCs, aluminium, nitrates. • Each marker stated would need an explanation saying why it is a marker, eg plastic because it is non-biodegradable, aluminium because it would be found made up into an artefact such as an aluminium can • Markers where you don't expect them, eg plastics in ocean sediments. • Evidence of wide-spread extinctions in the fossil record. • Widespread distribution of species: - would act as another distinctive marker especially if organisms are found well away from their place of origin - widespread species, such as domesticated animals, would prove evidence of large human settlements - pollen from agricultural crops would also act as markers - Sediment could contain a lot of human artefacts - unexpected chemicals not usually found in sediment from natural causes - the wide distribution of certain species may disturb the geological record because the wide distribution would not be because of sea level	• Very little understanding of the underlying earth and space science with only some development of ideas.	• Shows some understanding of the underlying earth and space science with some logical development of ideas. • Some analysis and critical thinking.	• Understanding of the underlying earth and space science showing logical development, clarity and precision of ideas. • Good analysis, critical thinking and application to complex situation.	• Thorough understanding of the underlying earth and space science showing logical development, clarity and precision of ideas. • Sophisticated analysis, critical thinking and application to complex situation showing perception and insight. • Reflection on the answer resulting in extrapolation. • All aspects of answer expressed with convincing communication.

	falls or land bridges for example, but because of other reasons such as domestication by humans. • Sediment layers from natural causes could show signs of rapid climate change, such as changes in stable isotope ratio or in species such as temperature sensitive marine species. • Marine species directly on top of land species in the fossil record or marine sediment in a previously inland site, indicating sea-level rises. • Evidence of ocean acidification such as widespread extinction of coral reefs, and damage or thinning to coral, shellfish shells and phytoplankton platelets in the fossil record. • Any relevant cross correlation of evidence, eg C-14 or stable isotope records, which might cross-correlate with evidence of rapid sea level rises and/or marine species changes. **Note:** CFCs do NOT affect climate change; there is no link between the ozone hole and climate change.				