Earth Systems 3209

Sample Exam Answer Key Part II

Total = 25 %

76. The process of segregation occurred in relation to Earth; however, this process did not occur in relation to the recently discovered planet.

Segregation occurs following the melting of a planet's interior. Based on density and gravity, the high density materials sink towards the planet's center and the low density materials float or rise towards the planet's surface.

Segregation did not occur on the recently discovered planet since low density silicate minerals were discovered deep below its surface and high density nickel and iron were found near its surface. Also, the recently discovered planet was one solid mass in contrast to Earth, which is structured into solid, liquid, and plastic-like layers.

- **1 % for indicating that, unlike Earth, the recently discovered planet did not experience the process of segregation.**
- **1 % for providing evidence that the recently discovered planet did not experience segregation since the high density materials is near the surface and not the center and vice versa for the low density materials. Segregation could not occur without melting and therefore, liquid and plastic-like states of matter.**

77 a) The number of experienced half-lives can be determined by taking the age of the sample and dividing by the constant half-life value of the radioactive parent isotope.

- **1 % for 2139 Ma ÷ 713 Ma, which equals 3 experienced half-lives.**

Since the sample originally contained 260 grams of radioactive parent isotope and since it is now known that it experienced 3 half-lives, then the amount of radioactive parent isotope presently in the sample can be determined.

- **1 % for 260 ÷ 2 (3 times), which equals 32.5 grams. It could also be shown as 260 ÷ 2 = 130, 130 ÷ 2 = 65, and 65 ÷ 2 = 32.5.**

77 b) The idea can be supported by the concept of uniformitarianism. Uniformitarianism explains that the same geologic processes that were occurring on Earth in the past are still occurring today and will continue to occur in the geologic future.

Earth has experienced the formation and destruction of supercontinents in the geologic past and since those same processes are still occurring today and will continue to occur in the future, then it can be concluded that there will once again be another supercontinent.

- 1 % for identifying the concept as uniformitarianism.
- 1 % for explaining the concept of uniformitarianism.
- 1 % for establishing the relationship between the idea of past and future supercontinents and the concept of uniformitarianism.

78 a) Weathering and erosion are processes comprising the rock cycle. Sedimentary rocks on Earth's surface can be affected by these processes. Over 40 % of the sedimentary rocks on Earth's surface are younger than 100 million years since adequate time has not occurred for them to be completely weathered and eroded. Sedimentary rocks over 100 million years would not exist as a high percentage since most would have been destroyed by the processes of weathering and erosion over a longer amount of geologic time.

Sedimentary rocks older than 100 million years could have had a greater opportunity to be melted back to a molten state whereby the process of crystallization could have turned it into an igneous rock. The likelihood is higher that sedimentary rocks younger than 100 million years would not have had the opportunity, as a result of an increased amount of time, to experience the processes of melting and crystallization.

Sedimentary rocks older than 100 million years could have had a greater opportunity to be affected by heat, pressure, and hot chemical fluids, and turned into metamorphic rocks. This would occur if the sedimentary rocks were buried in a mountainous region or came into close contact with hot molten, and therefore subjected to metamorphic conditions. The likelihood is higher that sedimentary rocks younger than 100 million years would not have had the opportunity to experience metamorphic conditions.

- 1 % each and two reasons are required for 2 % in total.
- Answers could vary as there are three options within the rock cycle.

78 b) (i) Muscovite mica and potassium feldspar are minerals that occur in both granite and rhyolite rocks (i.e. felsic rocks). Granite originates from slow cooling magma in contrast to rhyolite, which cools quickly from lava. Since the term magma was used in the question, then granite is the correct answer.

- **1 % for stating granite.**

78 b) (ii) Olivine, pyroxene, and calcium-rich plagioclase feldspar are minerals that occur in both gabbro and basalt rocks (i.e. mafic rocks). Basalt originates from fast cooling lava in contrast to gabbro, which cools slowly from magma. Since the term lava was used in the question, then basalt is the correct answer.

- **1 % for stating basalt.**

78 c) See the table below:

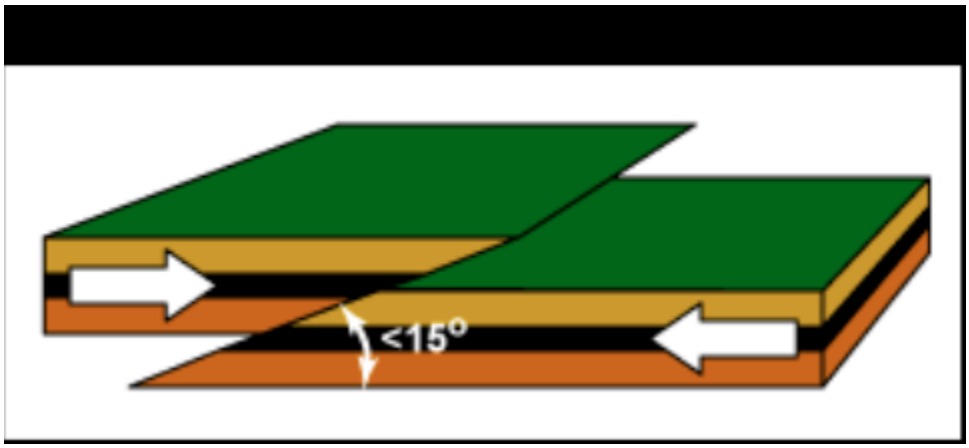
Silicate	Carbonate	Oxide
Fe_2SiO_4	$CaCO_3$	Fe_3O_4
SiO_2	$CaMg(CO_3)_2$	Al_2O_3

- **0.5 % for each correctly placed chemical formulae for a total of 3 %.**

79 a) Thrust faults occur at convergent plate boundaries due to compressional forces that cause the hanging walls to move upward in relation to the foot walls that move downward. Thrust faults can be defined as a sub-type of reverse faults; however, thrust faults have low angles , whereas reverse faults have higher angles.

The illustration of the thrust fault would need to demonstrate: i) the correct relative motion of the hanging wall and footwall; ii) the low angle of the fault; and, iii) arrows indicating compressional forces.

An example of a thrust fault with a low angle is shown below:



- **1 % for the illustration of the thrust fault including the correctly labeled parts (i.e. compressional forces (arrows), low angle fault line, and hanging wall up/footwall down).**

- **1 % for indicating that thrust faults form and/or exist at convergent plate boundaries are characterized by compressional forces.**

79 b) When a plate sub ducts (or sinks) beneath another plate in a compressional (i.e. convergent plate boundary) environment it becomes subjected to high heat and pressure conditions (due to increased depth), which can actually melt the subducting plate leading to the formation of magma chambers. These chambers, due to differences in density between the magma and surrounding rock, move upward towards the surface where they come into contact with cooler pre-existing rocks. As a result, these rocks can get baked or undergo contact metamorphism

The compressional forces can cause any pre-existing rocks in the convergent plate boundary region to be deformed as a result of increasing pressures. It can also cause any pre-existing rocks in the region to become buried leading to increasing temperatures. Such increased pressures and temperatures, in combination with hot chemical fluids in the ground, can cause the pre-existing rocks to undergo regional metamorphism. This often occurs when a continental shelf, which is adjacent to a continent, becomes compressed.

- **1 % for explaining the relationship between the process of subduction at a convergent plate boundary and the process of contact metamorphism, which is caused by one or more ascending magma chambers.**

- **1 % for explaining the relationship between the process of subduction at a convergent plate boundary and the process of regional metamorphism, which is related to regional mountain building.**

79 c) The Theory of Continental Drift was strengthened by several pieces of evidence that includes, but is not limited to:

i) jigsaw fit of the continents proving that continents move and/or "drift" and that previous to the present continental arrangement there was an existing supercontinent;

ii) fossil correlation between present-day continents indicating that species lived and were fossilized on a supercontinent that later split apart into smaller "drifting" continents;

iii) folded mountains and shield rocks belonging to present-day continents line up with those on other present-day continents once the reconstruction of a supercontinent has been completed;

iv) over human time, global positioning equipment (e.g. GPS) can be used to prove that continents are slowly, but surely moving and/or drifting; and

v) paleoclimatic evidence on present-day continents, as coal deposits and glaciers, match up proving that there was once a supercontinent on Earth and that continents have since been moving and/or "drifting".

- **1 % each and two pieces of evidence needed to be provided for a total of 2 %**

80. a) The rocks that were encountered with increasing drill depth were shale, conglomerate, and shale.

Shale is an example of a cap rock, conglomerate is an example of a reservoir rock, and shale is also an example of a source rock.

The description of the geology of the area seems plausible for the formation and trapping of petroleum.

Water in the reservoir rock can also be explained. First, there may not have been any organic matter rapidly buried within the source rock. As a result of no organic matter (i.e. kerogen), there was nothing to mature into petroleum to migrate to the reservoir rock and the trap.

Secondly, despite the geology indicating possible cap, reservoir, and source rocks, there was no indication of an actual discovered trap type. Without a trap, the petroleum could have been dispersed throughout the reservoir rock and therefore there would not have been a deposit of petroleum to strike by drilling.

Thirdly, it is possible that there was organic matter that eventually became petroleum; however, during migration through the reservoir rock and into the trap, it could have leaked out. For example, there could have been a fracture, fault, or crack in the cap rock and the petroleum, which is lower in density than water, could have been first to slowly leak out of the trap.

Fourthly, the hole may have been drilled through the correct geology; however, it may not have been drilled in the correct location or on the correct angle and as a result, it may have missed the petroleum in the absolute top of the trap, but instead encountered the water that structurally sits below the petroleum.

- **1 % each and two reasons had to be explained for a total of 2 %.**

80 b) Letter C represents the only location along the river where a placer deposit would most likely form.

In a meandering river, current velocities differ from inside of turns to outside of turns. The current velocity of water is slower on the inside of turns and faster on the outside of turns. The only letter that corresponds to slower moving water and/or low velocity water is C.

Placer deposits usually involve high density and/or heavy materials, for example, gold. Because it takes energy and/or high velocity (fast-moving) water to transport gold, then it is only appropriate to look for gold along areas of a river (e.g. location C) where the energy and/or current velocity is low.

- **1 % for identifying letter C as the correct location for the formation of a placer deposit.**
- **1 % for making the connections between areas of slow-moving water in meandering rivers, high density or heavy materials, and formation of placer deposits.**