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Geology 2051 Geologic Time, Assignment 1

PART A: Short Answer Questions

1. Name the mineral group for each of the following minerals

Mineral	Pyrolusite: MnO_2	Ankerite: $Ca(Fe,Mg,Mn)(CO_3)_2$	Garnet: $Mg_3Al_2Si_3O_{12}$	Barite: $BaSO_4$
Group	oxide	carbonate	silicate	sulphate

2. List the minerals that are likely to be present in the following intrusive igneous rocks, and name the volcanic rock with a similar composition.

Rock	Minerals typically present	Equivalent volcanic rock
granite	Quartz, K feldspar, sodium rich plagioclase, biotite, hornblende	rhyolite
Diorite	Plagioclase, hornblende (amphibole) pyroxene (augite)	andesite
Gabbro	Plagioclase, pyroxene (augite) olivine	basalt

3. A sandstone dominated by rounded quartz grains (less than 2% feldspar) would be a quartz sandstone (as opposed to arkose >25% feldspar) from a conglomerate (since it is rounded and not angular) of detrital sediment worn down during transportation. Cross bedding indicates deposition at an angle to the surface on sloping surface (downwind). Transportation may have been by water or wind with large beds forming by moving sediment and settlement from suspension.
4.

Rock	Texture/features	Mineral content
Mica schist	Distinct foliation, some minerals visible	Micas, chlorite, quartz, talc, hornblende, garnet, staurolite, graphite
Granite gneiss	Distinct foliation, coarse, layers often subparallel and discontinuous	Quartz, feldspare (K, Na) hornblende and biotite (small proportions), plagioclase

quartzite	Hard, dense, interlocking quartz grains, non-foliated sugary appearance with glassy lustre	quartz
Slate	Fine foliation, smooth breaks, crystals not visible to the eye	Clays, mica, chlorite

5. Thermal convection cells within the mantle are the mechanism that moves plates through seafloor spreading. Heat from within the Earth (as result of radioactive decay and leftover head from Earth's formation) is the driving force behind the convection currents in the outer core and mantle. Plates on the lithosphere move over the asthenosphere to separate or collide.
6. At the subduction zone, two plates collide and the leading edge of one plate is pushed under the other. The subducting plate moves into the asthenosphere, is heated, partially melted, and creates magma which is less dense than the surrounding mantle. When it rises to the surface it erupts in volcanic activity.
7. Explain the origins of the following geological time names

Cretaceous	Is named for beds of chalk (calcium carbonate deposits by shells of marine invertebrates) found in Western Europe. The actual word is from the Latin creta – "chalk"
Ediacaran	Is a period named after Ediacarahills in South Australia where fossils of Ediacara biota were found in 1946. They represent the earliest known complex multicellular organisms
Proterozoic	This name comes from Greek origin and means "earlier life". Protero – former, earlier, Zoic – animal, living being

8. The Carbon-14 dating method can be used for specimens up to 70,000 years old. Three examples of materials that can be dated by this method are: wood, burnt bones, and peat.
9. By noting changes in ring patterns one could note time frames where growth slows or stops, indicating climate change like drought or an ice age. The age of the oldest tree could be tracked to others in a non-glaciated area. The rings could show the last "healthy" year, and asymmetry could show a point when a tree was pushed over or damaged by glacial movement. New growth rings could indicate glacial retreat and climate warming.

PART B: Plate Tectonics – Continental Drift

1. City: Beijing, China (last name: Helmer)

Period	Latitude of Beijing
Late Cambrian (542-488 Ma)	30° S
Late Ordovician (487-444Ma)	20° S
Mid Silurian (443-416 Ma)	5° N
Late Devonian (415-359 Ma)	5° S
Early Carboniferous (358 Ma)	0° (*interesting shift from N-S-0)
Late Carboniferous (299 Ma)	23° N *(see bottom row)
Late Permean (298-251 Ma)	28° N
Triassic (250-200 Ma)	45° N
Jurassic (late) 199-146 Ma	45° N
Cretaceous (145-66 Ma)	42° N
Paleogene (middle Eocene Epoch) 56-34Ma	42° N
Neogene (23-2.6 Ma)	42° N
Quaternary (present)	39° N
*This seems to be when China appeared to divide into North and South China. Judging on location of present day Beijing, the latitude of North China was tracked.	

2. At the beginning of the Cambrian, Beijing (China) was located approximately 30 degrees south of the equator, connected to the supercontinent Gondwana. China was one of six continents during the Paleozoic era. By the late Ordovician period, Beijing (China) had separated from Gondwana in a northwest direction. The continent continued a northward movement in the mid Silurian period, situating it 5 degrees North of the equator. It was now approximately 55 degrees north of Gondwana and to the East of Kazakhstania. By the late Devonian China had drifted south of the equator by 5 degrees and rested at the equator by the early Carboniferous period. At this time it was now closer to Kazakhstania and more westward of Gondwana. There was major activity during the late Carboniferous period as the continent of China appeared to divide into North and South China. North China (comparable land mass where present day Beijing is located). North China (Beijing) drifted Northward to 23 degrees above the equator, bringing it in near contact with Kazakhstania. By the late Permean period Beijing is in close proximity to Sibera. The supercontinent of Pangaea had now begun to form , with Laurasia and Gondwana colliding. By the Triassic period, China

had drifted North, apparently due to a subduction zone of the plate to the Northeast of it. Beijing's movement was minimal during the Cretaceous and Peleogene eras, with the latitude of China remaining at approximately 42 degress North. During the Middle Eocene epoch, the continent of China was connected, within the larger continent of Asia, then located East of Europe, North of India and Australia, and NE of Africa. Present day Beijing is located at 39 degrees North and sits on the Eurasian plate. This plate is reportedly drifting North at a rate of approximately 2 centimeters per year.

3. The climate of Beijing may have had extremes during the Permean period because of the emerging Pangaea. The continent of China was on a similar latitude of Pangaea (28 N) so may have gone through the same intense heat and fluctuations between wet and dry. The supercontinents experienced extreme climates. Triassic continental climates were also hot and dry until the Jurassic period, when Beijing may have begun to experience more warm and humid climates like nearby Pangaea was reported to have. Since the elevation of Beijing is only 44 meters above sea level, it most likely would not have experienced the cold and snowfall that higher elevations did during the Cretaceous period did. From the Paleogene era to present day, Beijing did not change latitude much and has probably been experiencing similar conditions to the current times. Presently, Beijing is a humid continental climate with high humidity summers due to East Asian monsoons. Winters are cold, windy, and dry.

PART C: Geological Time

1. If 4570 MA is represented by one year, then March 20, 1970 is day 79 of 365.
2. The portion of that year that March 20 (day 79) represents is: 79/365 = 0.2164
3. The date in geological time represented by the above proportion is 0.2164 x 4570 = 988.9 Ma
4. My date represents the Precambrian Eon, early Neo Proterozoic Era (1000 – 542 Ma) specifically, the Tonian period (1000-850 Ma) This is the first geologic period of the Neo Proterozoic Era. During this time, rifting begins, leading up to the breakup of supercontinent Rodinia (located straddling the equator) that was formed in the late Stenian period, 1000Ma) The Tonian period leads up to the Cryogenian period that had the most severe glaciation where ice sheets reached the equator. With the oncoming cooling, there may have been large scale glacial events beginning since all the continents were bound together at one low latitude. This accelerated weather may have begun/increased ice formation as more CO_2 was absorbed into the atmosphere. With little CO_2 in the atmosphere, glaciers would form, possibly reflect solar radiation back into space, leading to even more glacial ice forming. Few fossils were found from this period. Those discovered were of soft-bodied organisms, possibly protocists.

PART D: Dating Exercise

1. With the info given so far, of layers a, b, c, and f (granite), layer a would be the oldest, followed by layer b (according to the Sedimentary Principle of Superposition) Layer c, according to the same principle, would be the next youngest. The Granite intrusion f would be the youngest of all layers according to the Principle of Cross Cutting Relationships, which states that an igneous intrusion or fault must be younger than the rocks it intrudes or displaces.

   According to the Potassium Argon decay curve graph, the granite samples are approximately 100 Ma. Since layer c has Paleocene aged plant fossils in it, it can be speculated that this layer is between 66-56 Ma, as this is the geological time represented by the Paleocene Epoch of the Paleogene Period.

   Layers a and b therefore must be older than approximately 100 MA since they were present before the intrusion of granite f. Layer c is not disturbed by the granite f, and is above a, and b so therefore is youngest of these four layers.

2. Assuming that the wood is the same age as sediment of layer e, the approximate age of layer e is 2300 years old.

   The problems with assuming the wood is the same age as the sediment are: We are assuming that the wood was deposited at the same time as the other sediments. The conditions under which the wood was deposited are unknown – there is a layer of ash underneath (layer d)-Was the wood transported by lava flow? Flood? Wind? Also, assuming that sediment layer e has more than one layer of sediment, where were the wood fragments found within this layer? According to the Principle of Superposition, the oldest part of this sediment layer would be at the bottom, so if the wood were found near the top, for example, it may be younger than the entire layer itself.

3. The ash layer d could be as young as 2300 years (top) and as old as 66 Ma (bottom). Methods of determining its age: Since layer e contains wood fragments, carbon dating could be used, especially if there was wood near the top, next to layer e (it would then be young enough for carbon dating to be effective). The lower, older part of the layer could be checked for any Paleocene fossils as found in layer c. If fossils were found, the layer could be near the older end of its spectrum. Potassium Argon method of dating the ash would perhaps be the most accurate, as it is used for fine grain volcanic rocks where no crystals can be separated.

PART E: Collecting and Describing Rock Samples

1. Rocks collected: Sample A-intrusive igneous, Sample B-metamorphic

2. SAMPLE A: Collected from area of the Nakalele Blowhole, Nakalele Point, West Maui, Hawaii, USA (between Mile Marker 38 and 39, Highway 30) The sample was collected from the cliff area above the blowhole, near the beginning of the "trail".

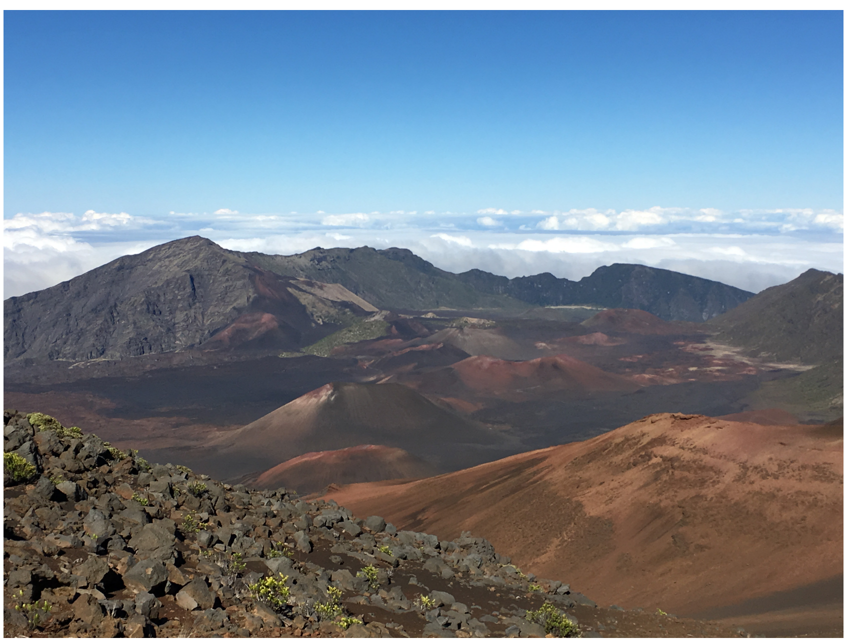
Nakalele Point, West Maui, above the Blowhole (area of sample A)

Two samples from the Nakalele Blowhole, (Sample A is on the left, behind the nickel)

(This is the Blowhole at Black Sand Beach, Wainanapanapa State Park, Maui USA-I was able to get closer to this one for a better photo)

SAMPLE B: Collected from the Haleakala Crater, Haleakala National Park, Maui, Hawaii, USA. Elevation: 10,000 feet (3048 meters) The sample was found along the trail that meanders through the crater. There are several cinder cones in the crater and the northwest and southeast corners of the depression have valleys that drain to the north and south coasts of Maui. The information plaque situated at the beginning of the trail states that the crater has been carved by erosion. The last eruption of Haleakala was reported in 1790 when lava erupted from two vents on the southwest rift zone. Lava flows reached the sea at Makena Beach.

Haleakala Crater, Haleakala State Park, Maui (rock sample retrieved from here)



Cinder cones in Haleakala Crater

3. SAMPLE A: has a rough texture and no apparent bedding or foliation. The majority of grain sizes range from 1.0mm – 1.5cm and are opaque. Grains range in colour from reddish brown, to black, to greyish. Possible minerals

present are basalt, (iron rich forms may be the red grains) feldspar, and olivine.

SAMPLE B: has a fairly rough texture with apparent horizontal foliation. No obvious individual crystals can be seen and rock breaks fairly easily into sheets (or pieces thereof). Minerals present may be micas, chlorite or clays.

4. SAMPLE A: Potential name-Rhyolite (volcanic equivalent of granite) This sample was most likely formed as the magma from a Maui volcano eruption cooled slowly below the surface. Since this rock was found at the surface near a blowhole, it may have been exposed by wind or water erosion, possible rifting during an eruption, or weathered and expelled by the blowhole. Since there are larger and smaller minerals present, this rock may have had two-stages of cooling. It is not porous and jagged as extrusive igneous rocks to indicate that it most likely cooled below the surface.

   SAMPLE B: Potential name-Slate. This sample was most likely formed as the volcanic ash from a Haleakala eruption was subject to heat at pressure over an extended period of time. Considering it was found in the surface area of a crater exposed by erosion, the sample would have been originally under the surface, covered over time by later lava flows. Exposure in this area would have happened over time as the wind and/or water exposed the underlying rocks.

5. INDIVIDUAL PHOTOS

SAMPLE A

SAMPLE B