Name:_____ Geosphere Time Allotted: 30 minutes

Key: (*) = none, one, or more than one answer possible (e.g. Answer: A, D, and E)

1. Given enough heat and pressure, migmatite, a rock intermediate between metamorphic and igneous rock, can be formed. What mineral is one most likely to find in this rock?

a) Olivine
b) Kyanite
c) Chlorite
d) Sillimanite

2. The D'' layer is a region in the lower mantle roughly 200 km in thickness. Indicate all of the following statements that are true of this region. (*)

a) A p-wave generated by tectonic activity would increase in velocity after traveling through the D'' region.
b) The D'' layer likely has highly felsic materials.
c) Perovskites ($CaTiO_3$) in the region likely have a sheet-like crystal structure.
d) The D'' layer likely contains significant, free-flowing magma convection cells.

3. Two-hundred million years ago, basaltic magma intruded sandstone beds in Northeastern New Jersey forming the Palisades, a prime example of fractional crystallization. Which of the following observations would you expect to find in the Palisades? (*)

a) Basal beds of basalt, with the remaining space filled with igneous rock that has Na-rich plagioclase feldspar on the bottom and Ca-rich on top.
b) A large mass of granite with small, dispersed accumulations of olivine crystals throughout, flanked on the top and bottom by beds of quartzite and basalt.
c) A large mass of olivine-rich basalt, flanked on the top and bottom by quartz-, orthoclase-, and muscovite-rich granite.
d) A large mass of plagioclase feldspar with Ca-rich layers on the bottom and Na-rich on top, flanked on the top and bottom by beds of basalt.
e) Basal layers of granite, with the remaining space filled with igneous rock rich in olivine, pyroxene, and Ca-rich plagioclase feldspar.

4. Which of the following statements concerning evaporites is false?

a) Seawater composition is similar worldwide, so evaporites are widespread.
b) Evaporite deposits typically form when small arms of the sea experience equal rates of replenishment by the ocean and rates of evaporation.
c) In a typical bedding sequence, carbonates and gypsum form first, halite next, and other sulfates, $MgCl_2$, and KCl form last.
d) Evaporites can form in non-marine environments.
e) The formation of phosphorite involves strong biosphere influences.

5. Which of the following statements concerning sedimentary basins is false?

a) Intense accumulation of sediments is the main cause of their subsidence.
b) Both convergent and divergent plate boundaries are associated with their formation.
c) They are sources for natural gas and oil.
d) They are characterized by negative accommodation space that increases over time.
e) The enlargement of sedimentary basins is created through positive feedback.

6. The Wilson Cycle describes the cyclic process of the opening and closing of ocean basins through tectonic activity. Order the following events according to this cycle.
(1) Sediment accumulates at passive margins.
(2) Accretion welds terrain onto continents.
(3) The continent undergoes rifting.
(4) Subduction creates volcanic mountain belts.
(5) Erosion dominates, thinning mountains.

a) 12345
b) 31425
c) 52413
d) 41532
e) 32541
f) 15243
g) 53124
h) 21453

7. Lithospheric processes from the Archean era were slightly different from modern-day tectonics. These differences are evidenced by komatiites, which are found only on Archean crusts. Which of the following statements is the most likely explanation for the connection between komatiites and Archean tectonic processes?

a) Komatiites contain high percentages of magnesium oxide, meaning they require a much higher melting temperature than in any other place found on Earth today. Higher temperatures equate to more vigorous mantle convection, which would result in thicker spreading centers and thin lithospheric flakes.
b) Tectonically metamorphosed komatiite, termed metakomatiite, is only found on lithosphere dated to the Archean era. This highly altered version of komatiite is only possible to have been formed during the intense orogenic episodes of the Archean era, combined with the ancient mineral-rich seas which contributed to drastic metamorphism by metasomatism.
c) Komatiites uniquely contain amorphous zircon crystals which date to the beginning of geologic time. The metamictization of these zircon crystals that caused the destruction of their crystal structure would have only been able to occur under Earth's early conditions of intense internal radiation, which in turn would have also caused intense mantle convection and rapid plate movement.
d) The thermal energy released from an extraterrestrial impact that marked the beginning of the Archean era caused Earth's mantle and crust to partially melt, leading to weak plates and intense mantle convection. The extraterrestrial object also deposited a global layer of iridium, which is highly concentrated in rare deposits of komatiite.

8. Which of the following statements concerning Karst topography is/are false? (*)

a) Extremophiles living in caves consume gypsum to form sulfuric acid, furthering the formation of sinkholes and caves.
b) Karst morphological features are not exclusively underground. Karst influences can dominate large-scale terrains, resulting in both sharp or rounded large-scale features.
c) High water tables are generally indicative of Karst topography. The ground's complete saturation with water accelerates the weathering of underground limestone.
d) Easy dissolution of limestone accommodates for high groundwater velocities, which in turn allow toxic groundwater pollutants to be effectively removed.
e) The evaporation of calcium carbonate-saturated groundwater is responsible for the formation of speleothems.

9. Indicate all of the following statements that could explain why the vast majority of high-grade metamorphic rocks exhumed to the surface do not undergo noticeable retrograde metamorphism? (*)

a) H_2O and CO_2 removed in prograde metamorphism are required to form hydrous minerals stable at Earth's surface.
b) Chemical reactions occur slowly at low temperatures.
c) High-grade index minerals are highly resistant to weathering and the overprinting by low-grade index minerals.

d) Volatiles removed in prograde metamorphism are required to catalyze the degradation of high-grade index minerals.
e) Many mineral-forming elements removed in prograde metamorphism are absent during the reformation of low-grade index minerals.

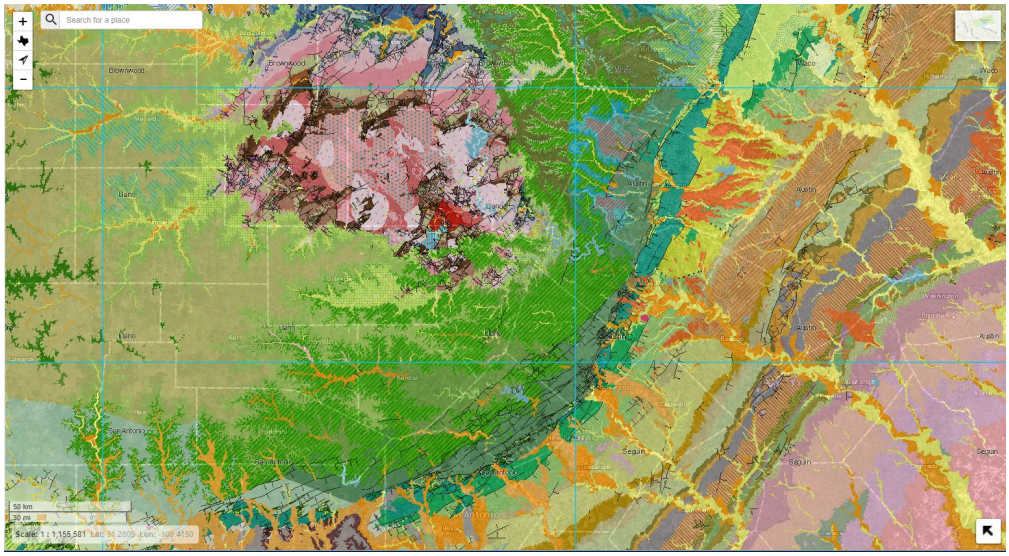
10. A geologist happens upon an assortment of galena, pyrite, and chalcopyrite while rockhounding (looking for rocks). What is the most likely geological setting of formation of these minerals?

a) Cooling magma
b) Marine (chemical) precipitation
c) Hydrothermal veins
d) Metamorphosed pelitic rocks
e) Metamorphosed calcareous rocks

11. Which of the following observations would suggest magma mixing? (*)

a) Pegmatitic igneous formations
b) Reverse zoning in minerals
c) Olivine crystals with Mg-rich cores and Fe-rich rims
d) Plagioclase crystals with Na-rich cores and Ca-rich rims
e) Glass inclusions
f) Phenocryst formation
g) Vugs of quartz within basalt

Consider the geological map of Central Texas below. Assume that the pink rocks in the upper left quadrant are pre-Cambrian granitic rocks, while everything else is Cretaceous limestone.



12. Using the figure above, indicate all of the following statements that are true. (*)

a) There is geologically recent extensive earthquake activity throughout the region.
b) The pink rock units represent an uplift.
c) The pink rock units represent an extinct shield volcano.
d) The faults to the east/southeast of the pink rock units are directly related to the uplifting of the pink rock units
e) The faults to the east/southeast of the pink rock units are the result of a deep, larger fault in the region
f) Elevation increases from West to East
g) Elevation increases from East to West
h) The faults to the east/southeast of the pink rock units act as barriers to surface water flow but not groundwater flow
j) The region to the east/southeast represent a disconformity

13. The crystalloblastic series is fairly important in determining a rock's origin. Indicate all of the following statements that are true. (*)

a) A rock with euhedral quartz and anhedral calcite is likely a metamorphic rock
b) A rock with euhedral muscovite and anhedral pyroxenes is likely a volcanic rock
c) Rutile has greater tendency to develop as euhedral compared to garnet
d) Rutile tends to form porphyroblasts

14. Which of the following sedimentary rocks would you usually NOT find in a lacustrine environment?

a) Siltstone
b) Shale
c) Travertine
d) Quartz sandstone

15. Which of the following statements regarding oil and natural gas formation is/are true? (*)

a) Natural gas will only develop between 2 and 5 km below the Earth's surface. Below this window, crude oil/raw petroleum is formed.
b) Crude oil is similar to natural gas but it is composed of simpler hydrocarbons.
c) The low densities of oil and natural gas cause both of them to float atop the water in permeable rock formations.
d) Both oil and natural gas are trapped underground by salt dome traps and impermeable shales which keep them in a hydrocarbon reservoir.

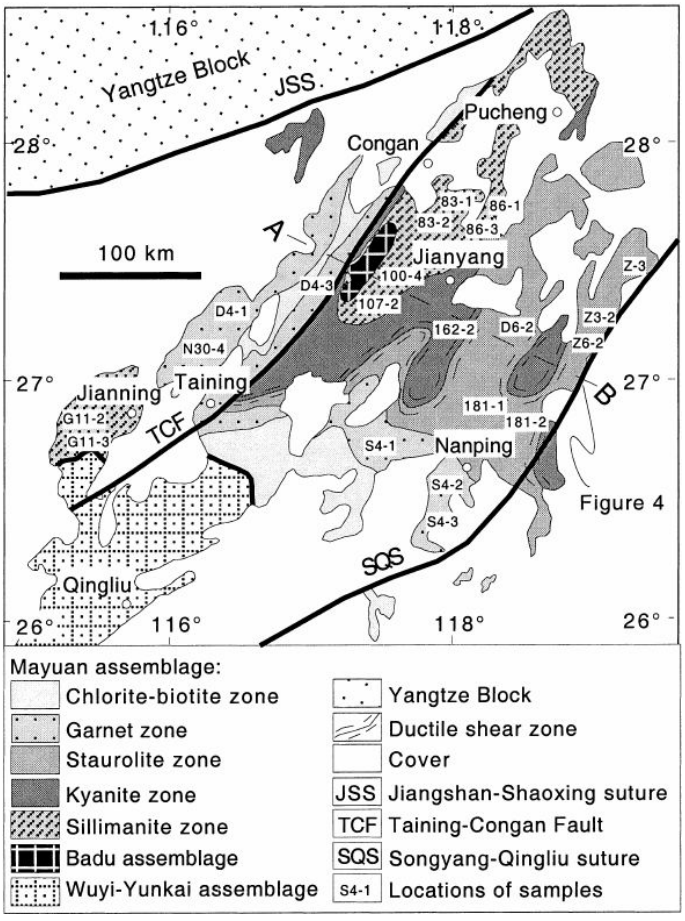
16. A lack of seafloor production, continents moving together, and largely aragonite seas are all characteristics of which phase of the supercontinent cycle?

a) Icehouse world, our current state
b) Icehouse world, our past state
c) Greenhouse world, our current state
d) Greenhouse world, our past state

17. Which of the following relations between surface erosion and plate tectonics is/are true? (*)

a) There is no evidence for relations between surface erosion and plate tectonics.
b) Higher rates of surface erosion correlates to higher rates of subduction.
c) Higher rates of surface erosion correlates to more stable subduction.
d) Higher rates of surface erosion may transform a passive margin into an active margin.
e) Higher rates of surface erosion correlates to the formation of more viscous magmas.

Consider the isograd below. Answer #Q18-19 using the figure below.



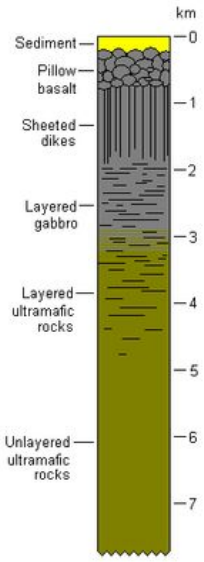
18. Using the figure above, indicate the most likely candidate for a gneiss-rich zone.

a) Qingliu
b) Jianyang
c) Nanping
d) D4-3
e) Along the SQS

19. Indicate the most likely candidate for the dominant geological process in this region.

a) Tensional forces
b) Compressional forces
c) Shear forces
d) Igneous intrusion
e) Jointing

Consider the figure below.



20. Which of the following is the most likely formation environment for this profile?

a) Around a hydrothermal vent
b) In the middle of the Canadian shield
c) Surrounding a batholith
d) Above the Mariana Trench
e) Around the Mid-Atlantic Ridge