

DEPARTMENT OF GEOLOGY

MODULE CODE	GLG2B10
MODULE NAME	Structural Geology and Plate Tectonics
CAMPUS	APK
EXAM	NOVEMBER 2016

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External Moderator	
Duration	180 minutes
Marks	180

Number of pages	6 (including front page)
Instructions	Answer all the questions

Exam paper 16GLG2B10 - Section 1 - Structural geology (90 Marks)

1. Primary and non-primary structures

- a. Give the name of three primary structures. (6)
- b. Give the name of four non-primary structures. (8)

2. Stress and strain

- a. Give three examples of strain markers that can be used to quantify strain in a rock. (6)
- b. As an approximation, which type of strain will suffer a rotten tomato that you throw on a wall? (5)
- c. Define what mean stress means. (5)
- d. Define what effective stress means. (5)

3. Rheology

Are these statements **true** or **false**?

If the statement is **false**, give the **right answer**.

- a. The amount of elastic strain a rock can accommodate is usually higher than the amount of plastic strain. (3)
- b. Rocks are more brittle when deformed at relatively low strain rate. (3)
- c. Boudinage forms when an incompetent layer embedded in competent layers is affected by layer parallel stretching. (3)

4. Ductile deformation

- a. Explain by means of annotated sketches what a ptygmatic fold is. (5)
- b. What are the two most important variables affecting the wavelength of a single layer buckle fold. (8)

5. Brittle deformation

- a. By means of annotated drawings define what an *en echelon* tension gash array is. (8)
- b. What are conjugate faults and what are the angular relations between them and the principal stress axis σ_1 , σ_2 and σ_3 . (8)

6. Fabrics and shear zones

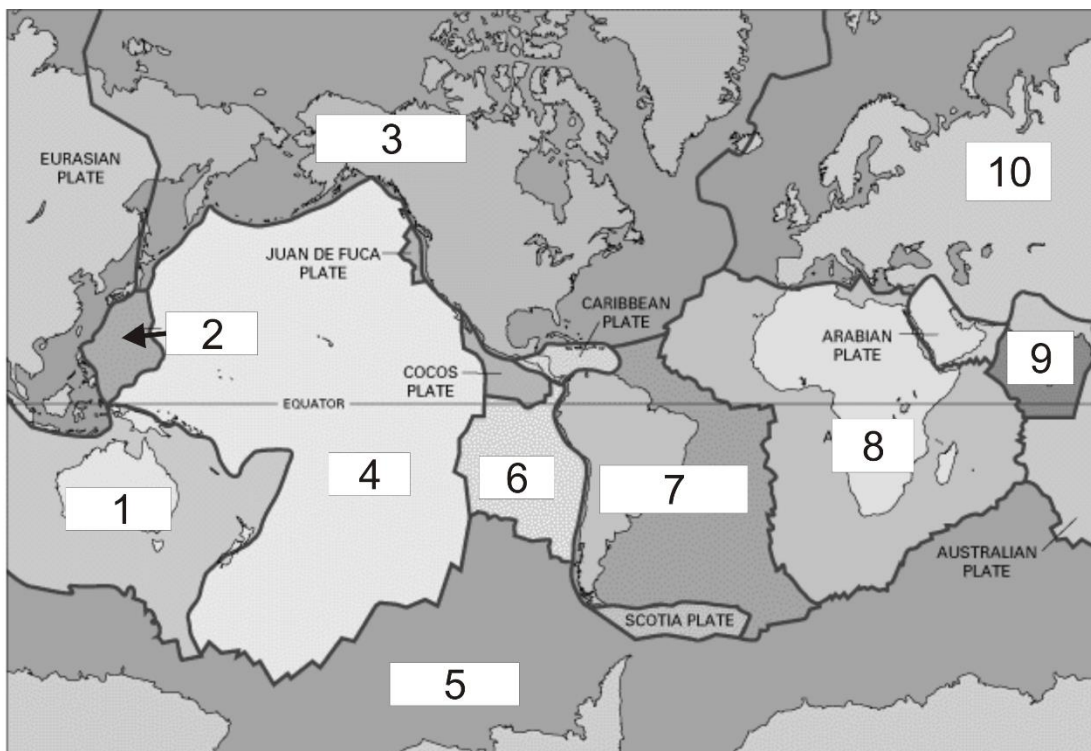
- a. Using sketches to help you, explain differences between crenulation cleavage and gneissic foliation. (6)
- b. By means of annotated diagrams, explain what the process of transposition is. (6)
- c. Give at least two different type of lineations typically formed during folding. (6)

Section 2: Plate Tectonics

Question 1:

- a) Provide the names of the tectonic plates as indicated by the numbers in the figure below (10 marks).
- b) Indicate the type of plate tectonic boundary between the following plates (choose between constructive, destructive or conservative plate boundary) (5 marks).

1. 6 and 7
2. 9 and 10
3. 4 and 6
4. 8 and 10
5. 4 and 1

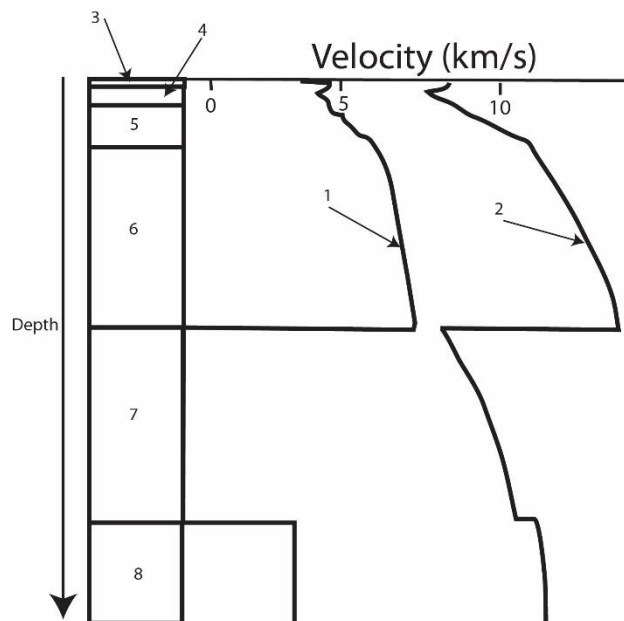


Question 2:

- a) San Andreas Fault (1)
- b) Baikal lakes (1)
- c) Lake Victoria, Lake Malawi and Lake Tanganyika (1)
- d) The Challenger Deep (1)
- e) Iceland (be careful, there are two here) (2)
- f) Everest, K2, Makalu and Lhotse (1)
- g) European Alps (1)
- h) Mount Saint Helens and Mount Rainier (1)
- i) Gulf of Aden (1)
- j) Islands of Hawaii (1)
- k) Islands of Japan (1)
- l) Alpine fault in New Zealand (1)
- m) Dead sea (1)

Question 3

Answer the questions related to the figure below (14).



- What does the figure represent? (2)
- What does the line marked as "1" represent? (2)
- What does the line marked as "2" represent? (2)
- Label the zones that make up the internal structure of the earth as indicated by numbers "3" to "8". (6 marks)
- Based on the figure, is zone "7" liquid or solid and state why. (2)

Question 4

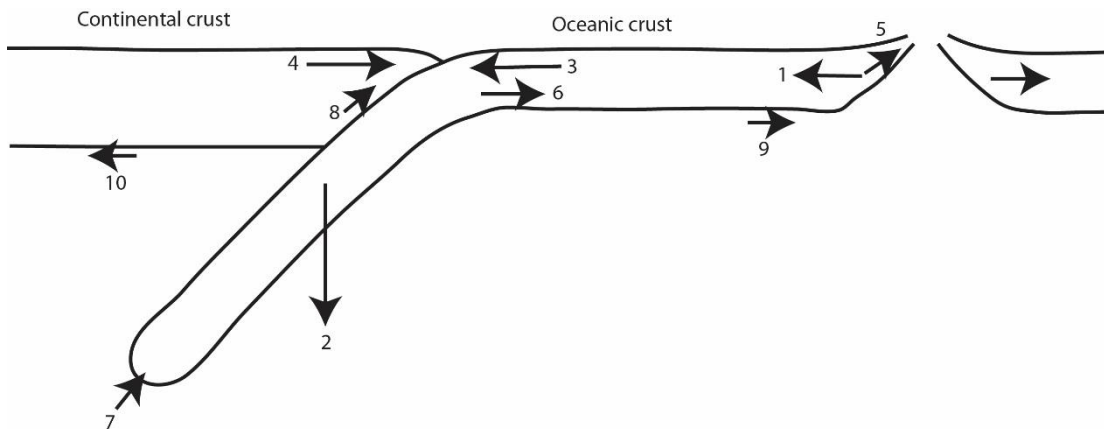
State whether the following is true or false (23):

- S waves are transmitted through the mantle and are therefore present in the Earth's core. (1)
- The mantle transitional zone can either be a mineral phase change or a fluid layer. (1)
- The Atlas Mountains is an example of a continental island arc. (1)
- The Rhine Graben is a mantle activated graben. (1)
- Gondwanaland was made up of Laurasia and Pangea. (1)
- The most destructive earthquakes are associated with mid oceanic spreading ridges. (1)
- Paleomagnetism can be used to indirectly age date sedimentary rocks. (1)
- The Edge Force mechanism model for convection cells driving plate tectonics is more effective in heat transfer than the Mantle Drag theory. (1)
- The heat flow in the crust increases with the age of the crust. (1)
- The average geothermal gradient across the upper 100km of depth of continental crust is 25 degrees Celsius per kilometre. (1)
- Large scale earthquakes occurring at shallow focal depths always result in the formation of a Tsunami. (1)
- The Paramagnetic minerals maintain their induced magnetism when removed from a magnetic field. (1)
- Gondwanaland broke up into the landmasses that we know today as Africa, South America, Antarctica, India, Asia and Madagascar. (1)

- n) Deep focal earthquakes typically occur along subduction zones.
- o) The Vine-Matthews hypothesis explains the formation of magnetic lineations present on the sea floor.
- p) Oceanic lithosphere is terminated horizontally by thrust faults.
- q) The Mesosphere is a weak layer that terminates at a depth of 700km.
- r) The crustal component of the Lithosphere can be oceanic and/or continental in nature.
- s) The study of climatic indicators in rocks can be used to infer paleo-longitude.
- t) The lithosphere is composed out of the crust, upper mantle and mantle transition zone. (1)
- u) Lithospheric components can be made up of mantle material. (1)
- v) The depth at which the asthenosphere starts is shallow beneath continental crust and deep below oceanic crust (1)
- w) The Lithosphere extends down to the outer core. (1)

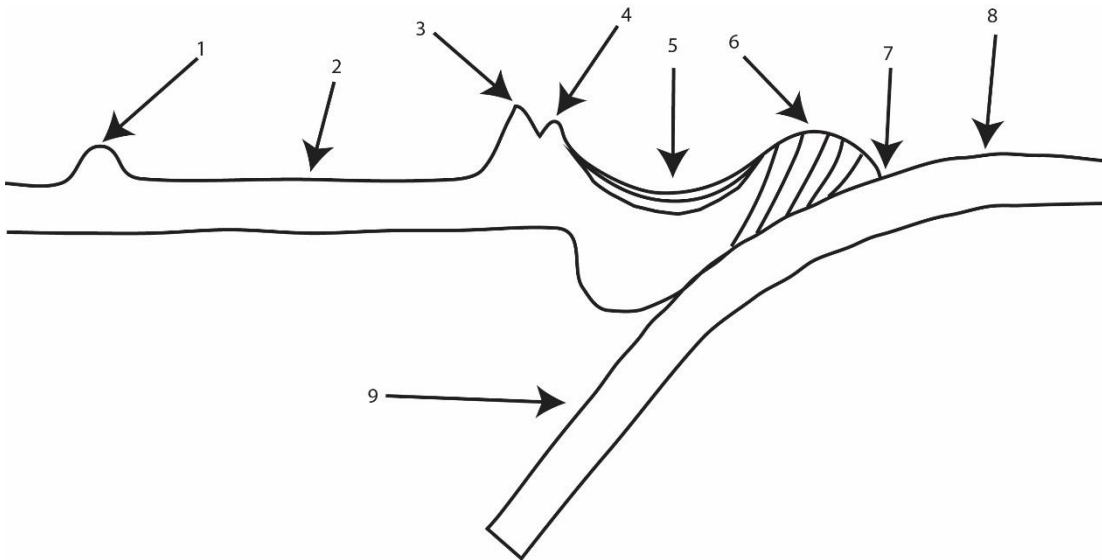
Question 5

Name the numbered forces that act in on tectonic plates in the following schematic. (10)



Question 6

- a) Name the numbered features in the schematic representation of a subduction zone as indicated below. (9)



- b) The feature numbered at "6" contain lines that represent fault planes. Are these fault planes formed as a result of normal or reverse faulting? (1)

Question 7

Name the 5 types of geological evidence that can be used to test a paleocontinental reconstruction. (5)