Global temperature

A Tectonic B Orbital C Deglacial/millennial D Historical

GEOSPHERE written test IESO 2011
Name_____
Country _____

1. Based on Ruddiman (2001), the global temperature fluctuation can be distinguished into four different time scales due to different mechanisms. Use the following figures provided. Which figure best shows the fluctuation of temperature in Antarctica ice core records during more than one interglacial phase.? _/1 pt
(A) Fig. A (B) Fig. B (C) Fig. C (D) Fig. D

2. Seafloor drilling and seismic analysis reveal a thick layer of salt at a certain depth in a very large part of the Mediterranean Sea. What can you conclude from these observations? _/0.5 pt

a) The Mediterranean Sea has an important economic value that has not been exploited yet.
b) There was a period when the Mediterranean Sea almost dried out.
c) The Mediterranean Sea is very young.
d) The Mediterranean Sea is a relic of the Tethys Sea.

3. In the field, you found an outcrop with three horizontal undeformed layers, one above the other. The lower unit is a layer of Dolomite, the middle layer is basalt, and the upper layer is Limestone . Which of the following observations would lead you to the conclusion that the basalt is a lava flow? _/1 pt

a) There are "baking signs" only in the lower part of the limestone layer.
b) There are "baking signs" in the lower part of the dolomite layer.
c) There are "baking signs" only in the upper part of the dolomite layer.
d) All of the above.

4. To which cycle of matter is Limestone connected? _/0,5 pt

a) Phosphorus cycle
b) Carbon cycle
c) Sulfur cycle
d) Nitrogen cycle

5. The reason that the magnetic anomaly stripes of the same age are wider in the Pacific ocean than the Atlantic Ocean is: _/0,5 pt

a) The rate of magmatic intrusions at the East Pacific Rise is faster than the rate of this process at the Mid-Atlantic Ridge.
b) The Mid-Atlantic Ridge is located exactly in the middle of the ocean and therefore the rate of the opening of the ridge is equal on both sides.
c) The Pacific Ocean is older than the Atlantic Ocean.
d) The ring of fire around the Pacific Ocean reduces the rate of reversals of the Earth's magnetic field.

**6.** During the last three billion years the main internal energy source of the Earth has been: _/0,5 pt

a) The pressure of columns of rock and ocean.
b) The friction that occurs at the plate boundaries.

c) Radioactive decay of isotopes.
d) The radiation of the sun.

7. In the Bottaccione Gorge, near Gubbio (Italy), there is an outcrop of interest. It contains a thin clay layer with significant geochemical anomalies such as high iridium concentrations. It is dated to an numerical age of 65.5 Ma. Which chronostratigraphic boundary corresponds to this layer?   _/1 pt.
a) Cretaceous/Tertiary
b) Lower Cretaceous/UpperCretaceous
c) Paleocene/Eocene
d) Cambrian/Pre-Cambrian

8. Use the two graphics below. On the left is a geologic map of a region where north is to the top of the map. On the right is a topographic section along line a to b. Contours are in meters. A structure is shown in grey.
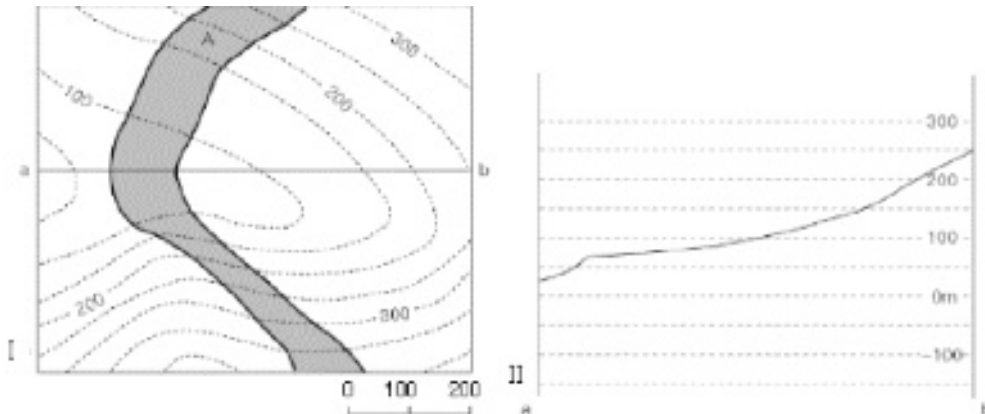
Which of the following is the true strike, dip and thickness of grey strata from the map? Please note that there are two methods used to show strike: quadrant method designated by (Q) and azimuth or magnetic bearing method designated by (A). The chart shows them both as Q and A. 2 pt .

choice	Strike	Dip (degrees)	Thickness (m.)
A	Q N-S A 180 degrees	45	70 to 75
B	Q S 60 degrees E A 120 degrees	45	90 to 100
C	Q E - W A 90 degrees	30	70 to 75
D	Q N-S A 180 degrees	30	90 to 100

9. Which one of the following minerals is used as a gem in jewelry, is used as an industrial abrasive, is a silicate, and has an isometric mineral symmetry. Circle the best answer above._/0,5 pt.

a.	quartz	b.	biotite	c.	Hornblende	d.	rutile	e.	garnet
f.	orthoclase	g.	calcite	h.	halite	i.	beryl	j.	diamond
k.	basalt	l.	gabbro	m.	andesite	n.	granite	o.	rhyolite
p.	shale	q.	marble	r.	slate	s.	chalk	t.	chert

10. The following stratigraphic sections show two cross sections which are located near each other. Symbols a and a' represent an igneous rock and b to e represent sedimentary rocks. Answer the following question. _/0,5 pt
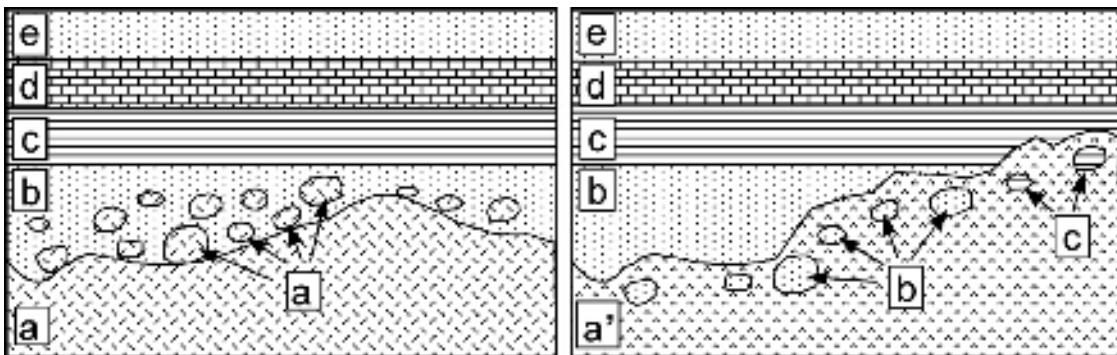
Which rock is older, a or a'? _____

11. The precipitation of which of the following minerals is regulated by the concentration of CO_2 in the solution?   _/0,5 pt.

5

a) halite;   b) gypsum;   c) apatite;   d) calcite;   e) opal;   f) barytes.

12. The following table shows explanation of rocks and their formation environment. Choose the one that has the correct relationship between formation environment and rock type. _/1 pt

	Rock name	Macroscopic observation	Formation environment
1	Limestone	Sand size grains, spherical to elliptical grain shape, bedded	In the crust several km below the surface
2	Granite	Fine grained, foliated, occurrence of light and dark grains together	In the crust where magma cools slowly
3	Basalt	Coarse to very coarse grained, dark color, occurrence of vesicles	Mid-oceanic ridge
4	Sandstone	Medium grained, parallel laminae or cross bedded	River or beach
5	Gneiss	Alternating dark and light bands, foliated, coarse grained	Contact zone between magma and surrounding rocks near surface

Correct answer: _____

 13. The following picture shows an outcrop of Paleozoic age deposited in the ocean. The strata largely consist of sand and shale layers. Answer the questions. _/1,5 pt (0,5 x 3)

(1) Which layer is sandstone and shale respectively in A and B?
    Shale: _____Sandstone: _____
(2) What is the depositional process of layer A and B?
   _____ is deposited by settling from suspension whereas _____ is deposited by turbidity current.
(3) Can you expect to find trilobite fossil from this outcrop? Yes/no   Answers:_____

14. The figure below is the stratigraphic section and paleomagnetic inclination in some area assuming the rocks were deposited from 180 million years to the present without deformation. The paleomagnetic inclination of rock in each layer is shown within a circle. The arrows indicate the direction of paleo-magnetization at the time of rock formation.
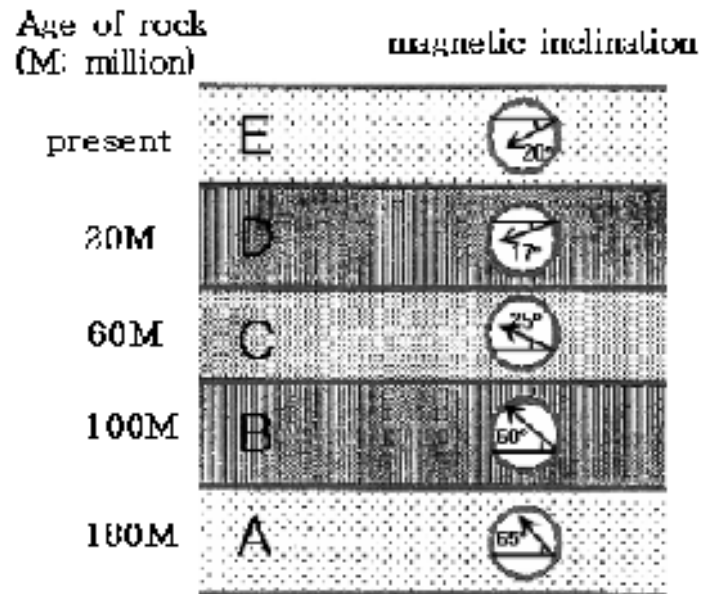

Calculate the average (south to north) velocity of the continent as it moved from position B to position E. Here, we assume that the latitude difference of one degree (1°) is equal to 110 km, and we suppose that paleomagnetic inclination is equal to twice the paleo-latitude. _/1 pt

A) 2.3 cm/yr
B) 4.4 cm/yr
C) 8.8 cm/yr
D) 9.7 cm/yr

IESO 2011

15. The figure below shows the soil texture of samples from five farms (A~E). The soil of which farm has the highest permeability? _/1 pt.
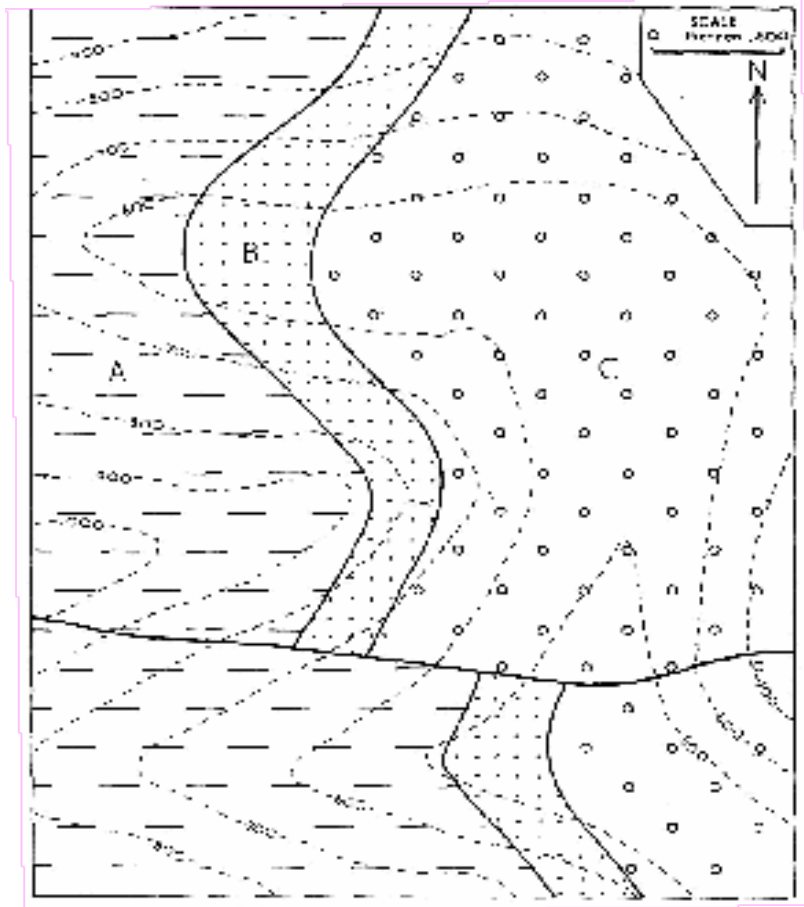(A) Farm A   (B) Farm B
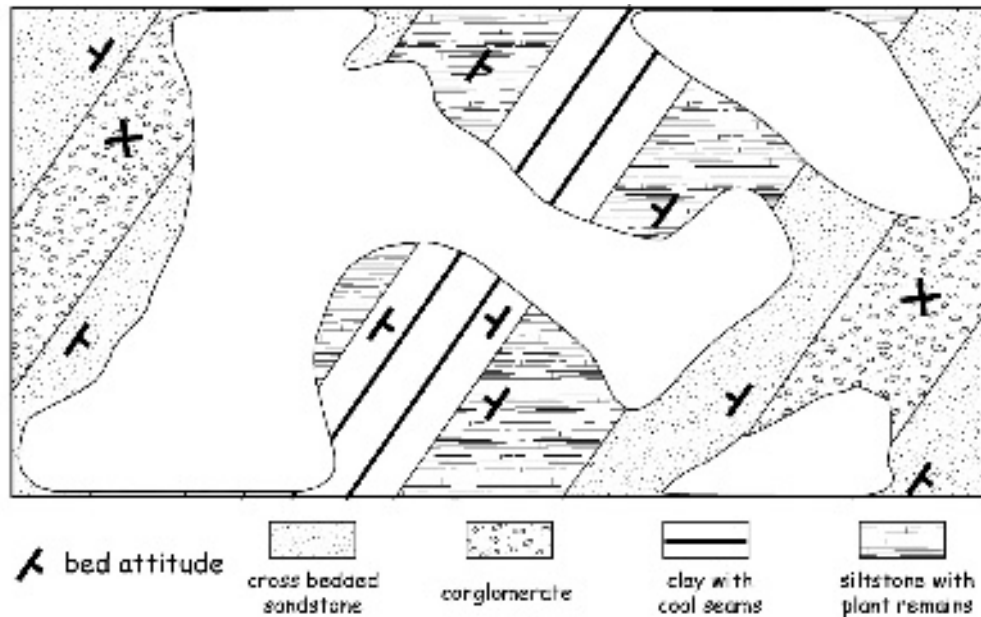(C) Farm C   (D) Farm D
(E)   Farm E

Clay

Sand   Silt
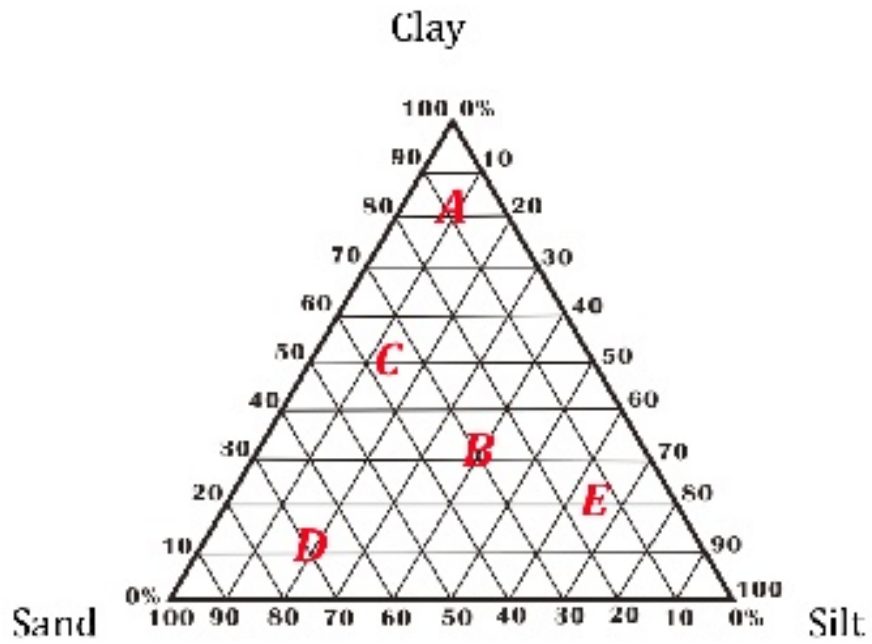
16. Which type of fault is shown in the geological map below? _/0,5 pt.

        a. normal

        b. inverse

   c. vertical

        d. obtuse

17a. Examine the map above. Which of the choices best describes the type of tectonic structures shown.   _/1 pt.

a) two anticlines with an intervening syncline
b) two synclines with an intervening anticline
c) a salt dome
d) flat stratigraphy

17b. Reconstruct the stratigraphy of the region shown above choosing among the following stratigraphic columns. _/0,5 pt.

a)   b)   c)   d)
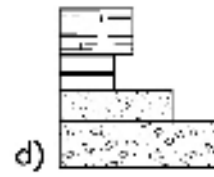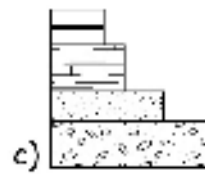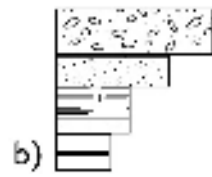
18. Trace fossils are the remnants of the activities of ancient animals. According to the patterns of trace fossils, geologists can infer the substrate condition, sedimentation rate, water flow energy, and paleoenvironment. Figure 9 is a trace fossil found in sandstone showing how an organism utilized the limited resource with high efficiency. What is the most likely environment to find this kind of trace fossil? _/1 pt.

(A)inter tidal flat (B) rivers or lakes (C) mountains (D) deep marine


9a. Trace fossil on sandstone. Scale bar is 1 cm   9b. Close up view of Fig. 9a. Each divide on the scale bar on the bottom is 1 mm.

Fig. 9

19. A student used a portable Global Positioning System (GPS) to record the coordinates of his positions. The signal and the receiving conditions were good during the measurement. After the student entering the coordinates he got into GoogleEarth, he noticed that the position drawn in GoogleEarth (GPS data) shifted hundred of meters away from the true location (True Loc). However, the relative positions among different locations measured in the same day were correct. Which of the following factors is the most likely cause of this problem? _/0,5 pt.

(A) influence by the ionosphere
(B) malfunction of the GPS
(C) sheltered from the buildings
(D) different coordinate systems
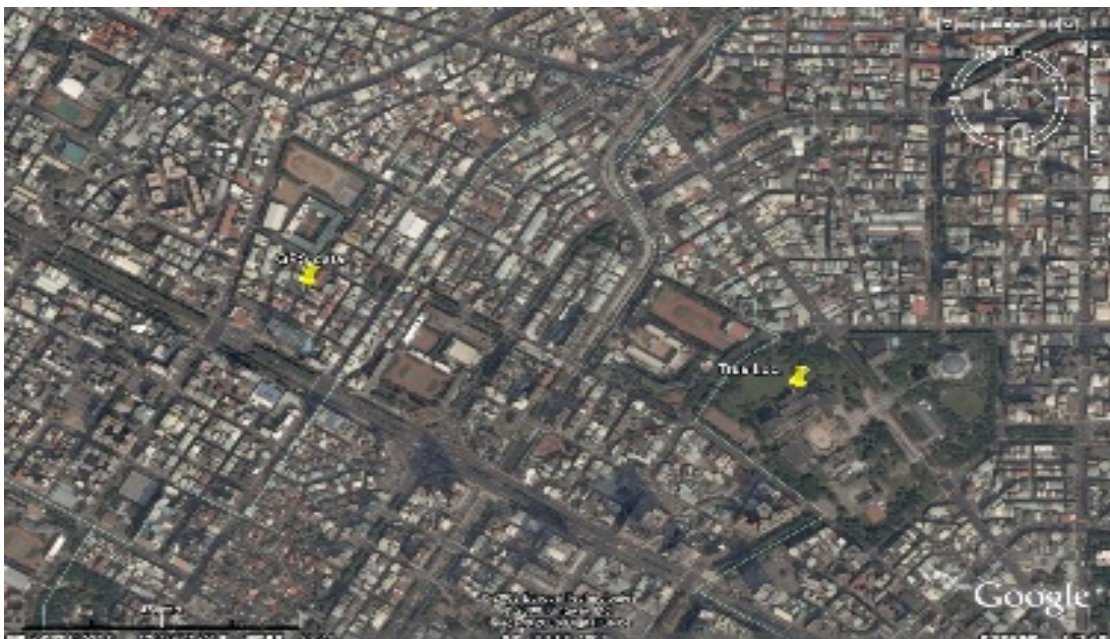
20. The baby mammoth fossil shown below was found in Siberia in 1977. The fossilization process it underwent is known as: _/0,5 pt.

a) carbonification
b) cryo-conservation
c) inclusion in amber
d) permineralization
e) pyritization
f) silicification

21.   This fossil shown above is: _/0,5 pt.

a) shark (chondrycthyan)
b) a bony fish (osteichthyan)
c) an amphibian (salamander)
d) a reptile (ichthyosaur)
e) a bird (penguin)
f) a mammal (cetacean)

22. Match all of the rock features/sedimentary structures on the left with all possible depositional environment found on the right.
_/1,5 pt.   (0,25 x 6)

Rock feature/Sedimentary structure   Depositional
environment

1 ___coal and siltstone with plant remains   a. shallow ephemeral lake

2 ___stromatolites and intraclastic limestone   b. quiet marine deep water

3 ___laminated evaporites   c. delta swamp

4 ___mud cracks   d. peri-glacial lake

5 ___varves   e. lagoon in arid climate

6 ___thin-bedded shales   f. carbonate tidal flat

23. Consider seismic waves which propagate at 4.5 km/s in the Earth crust.

a) What are the wavelengths associated to periods of T=0.1s, 1s and 100 s? _/0,5 pt.

| (a) | 250m, | 2.5 km | and | 250 km. |
(b)	450m,	4.5 km	and	450 km.
(c)	150m,	4.5 km	and	500 m.
(d)	750m,	7.5 km	and	750 km.

16

b) What are the periods and the frequencies associated to wavelengths of 1m, 1km, 100km ? _/ 1 pt.   (0,5 x 2)

periods:
(e)	0.00444 s,	4.4 s	and	444.4 s.
(f)	0.00034 s,	0.22 s	and	24.6 s.
(g)	0.00006 s,	0.06 s	and	60.0 s.
(h)	0.00022 s,	0.22 s	and	22.2 s.

frequencies:
(i)	4500 Hz,	4.5 Hz	and	0.045 Hz.
(j)	34 Hz,	24 Hz	and	44 Hz.
(k)	1200 Hz,	1.2 Hz	and	0.012 Hz.
(l)	22 Hz,	2.2 Hz	and	220 Hz.

P   S

Time(minute)

3:00   3:05   3:10 am
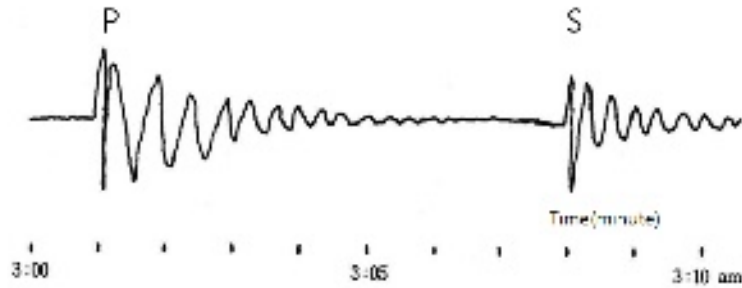
24. The figure above shows the observed seismogram at some earthquake observatory. Here, the velocity of P wave (Vp) and S wave (Vs) is 7km/sec and 4km/s, respectively. _/1,5 pt (0,5 x 3)

(a) How far the observatory is located from epicenter?

(b) What time the earthquake occurred?

(c) What time the first S wave arrive at the place 4000 km far from epicenter?

a)
(__) 3150 km
(__) 3920 km
(__) 4140 km

b)
(__) 2 h: 51 min: 40 sec;
(__) 2 h: 40 min: 33 sec;
(__) 3 h: 03 min: 22 sec.

c)
(__) 2 h: 55 min: 20 sec;
(__) 3 h: 22 min: 15 sec;
(__) 3 h: 08 min: 20 sec.

25. Volcanic eruption in a mid ocean ridge leads to matter and energy transformation between the following earth systems (choose the most complete option): _/1 pt

     a. From geosphere to atmosphere.
     b. From hydrosphere to geosphere.
     c. From geosphere to hydrosphere and then to biosphere.
   d. Only from geosphere to hydrosphere.

18

IESO 2011

26. Indicate the type of magma characteristically erupted at the following plate tectonics volcanic environments (the same magma type can occur in more than one environment). The choices are: Andesite, Basalt, Obsidian, and Rhyolite
_/ 1,5 pt.   (0,5 x 3)

· MidOceanic ridge
· Island arc
· Withinplate – Hot spots

27. Mark three of the following phenomena that are precursors of impending volcanic eruptions. _/ 0,5 pt.

a. Landslides
b. Anomalous seismicity
c. Heavy rains
d. Increase of temperature and chemical changes in fumarolic gases
e. Strong winds
f. Ground uplift

28. Looking closely at the figure representing the eruptive behavior of magmas depending on their chemical composition and their dissolved gas content.   0,5 pt.
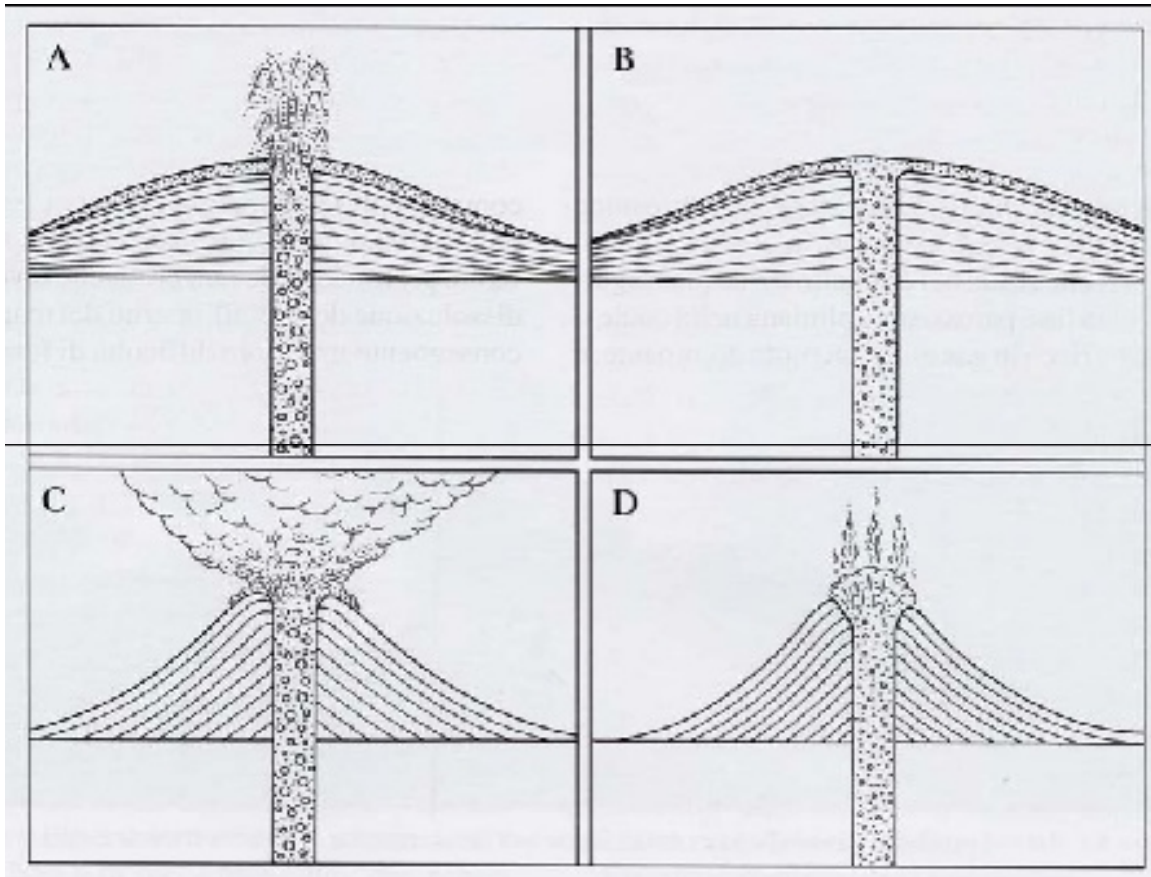
a Basic and de-gassed magma
b Basic magma rich in glass
c Acid magma rich in glass
d Acid and de-gassed magma

Figure A shows eruptive behavior from which type of magma?_____

Figure B shows eruptive behavior from which type of magma?_____

Figure C shows eruptive behavior from which type of magma?_____

Figure D shows eruptive behavior from which type of magma?_____

29. Michelangelo Buonarroti (1475-1564) was one of the greatest sculptors of the Renaissance. In this historical period, several discoveries and innovations in the field of art, science, and technology were made. Michelangelo carved his statues from the "Carrara marble" a very fine metamorphic rock characterized by a uniform white color, coming from quarries near the town of Carrara (Italy).

Which two of the following features are <u>NOT</u> associated with the formation of a marble? _/1 pt.

a) Marbles are formed by recrystallization of feldspars found in sandstones.
b) Marbles have a hardness of 6-7 on the Mohs scale of mineral hardness.
c) Marble is a metamorphic rock composed primarily of calcium carbonate ($CaCO_3$).
d) The color of marble depends on the presence of mineral impurities (such as clay, iron oxides etc)
e) Marble is a rock resulting from metamorphism of sedimentary carbonate rocks, such as limestone or dolomite rock.
f) Marble is a non-foliated metamorphic rock with a crystalline structure.

30. How is called this geological phenomenon? _/0.5 pt.

a) Volcanic chimney
b) meteor impact crater
c) rockfalls
d) sinkhole

31. The north – south trending Gulf of Aqaba is located along the south part of the Dead Sea and the Arava Rift valley. It is 15 km wide and active rift since the early Miocene. The rift valley is the north part of the Syrian-African tectonic system.

5000 BP, 3 meters, above sea level, 5000 years old marine terraces were found 3 meters above sea level along the east and the west margins of the gulf. These terraces are continuously mapped for several kilometers with a constant elevation. These terraces may represent: _/1 pt.

A.   More warm climate comparing to the Late Pleistocene climate
B.   Colder climate comparing to the recent climate
C.   Tectonic uplifting
D.   Remnants to high tide event

32. Tsunami waves can be generated by several natural phenomena. One of the most frequent cause are large subduction zone earthquakes, generated at the interface between two lithospheric converging plates where one of the two subduces beneath the other. Central Mediterranean tectonics is dominated by the slow relative converging motion of the African and European Plates. Italy sits on the converging plate margin, and its volcanic and seismic activity are related to this first order phenomena. In the central Mediterranean area subduction is continuously going on under Calabria in Southern Italy, and to the east under the island of Crete. Here, large subduction zone earthquakes occurred in historical times, such as in the A.D. 365 M 8+ earthquake, and generated widespread devastating tsunami waves that hit the coasts of North Africa, mainland Greece and Southern Italy.

Earthquake generated tsunamis are produced by the coseismic displacement of the sea bottom. The speed of a tsunami is directly correlated to the depth of the sea, i.e. it moves faster in deep waters and slow in shallower waters.

Early warning systems are fundamental for mitigating the tsunami hazard along the coasts, and are based on models of tsunami generating and of propagation.

Supposing that at 06:30 am UTC a large subduction zone earthquake hits the south-western coast of Crete, and knowing:

1) the equation of the speed of the tsunami waves
$$V = \sqrt{g * D}$$
where g is the gravitational costant (m/s2), and D is the depth of the water
2) the average depth of the Jonian Sea along the three sections shown in the map: Section A, 2000 m; Section B, 2500 m; and Section C, 3000 m.

Measure on the map the distance of the three sites from the earthquake epicenter and calculate the arrival time (UTC) of the waves at destination filling in the table. _/2 pt.

	Mean depth (m)	1-Mean speed (m/s)	2-Mean speed (km/h)	3-Distance (km)	4-Time to destination (h)	5-Arrival time (UTC)
Site A	2000					
Site B	2500					
Site C	3000					

On the basis of your calculation the three sites will be inundated in the following order:
1)   First Site A, then B and last C;
2)   First Site B, then C and last A;
3)   First Site C, then B and last A.
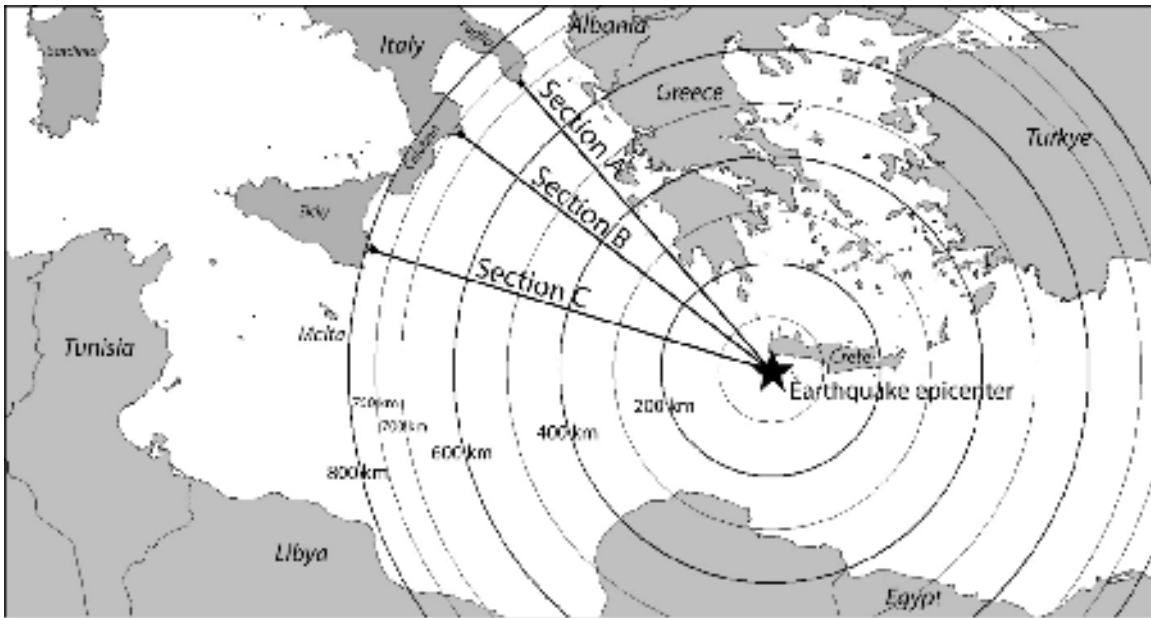
Map of the Central Mediterranean area, showing with the black star the epicenter of the subduction zone earthquake, and the trace of the three sections. Circles centered on the epicenter can be used to measure the distance.