



Benha university
Faculty of science
Geology Dept.
19 / 1 / 2019

Examination of Metamorphic petrology (337 G) for
the third level students (Special Geology), Jan. 2019.

Third Level
Special Geology
Metamorphic Petrology (337 G)
Time: Two Hours

Answer the following questions.

1- Complete the following sentences (1-31) using the given words (Note: each word can only be used once)? (31 Marks)

metasomatism 4	solid-solid reaction 16	garnet mica schist 23	mica schist 22	solid-solid net- transfer 10	decarbonation reaction 14	cation exchange reaction 12
slate 20	decreasing temperature 27	divariant reactions 15	Hornfels 28	dynamic metamorphism 2	phyllite 21	isograd 6
blueschist 7	contact metamorphic aureole 18	amphibolites 8	migmatite 3	pseudomorph	migmatite 25	dehydration reactions 13
andalusite	calcite-dolomite	biotite 30	chlorite 31	hydration/ dehydration reactions	folded unmetamorphose sedimentary rock 19	solid-solid phase transformation 9
solid-solid reaction 17	contact 26	polymorph 5	gneiss 24	oxidation- reduction reaction 11	granoblastic 1	silliminite 29
gneiss	oxidation- reduction reaction					

1- Given some Determine whether each of the statements below is true or false. correct false one if any. (20 Marks)

- 1- A **granoblastic** is the texture of fine-grained, equidimensional or randomly-oriented crystals, formed in response to heating without applied stress.
- 2- **dynamic metamorphism** describes metamorphism in which the dominant processes involve deformation and recrystallisation rather than temperature change.
- 3- The term **migmatite** describes mixed rocks, partly metamorphic and partly igneous in appearance, commonly formed by partial melting.
- 4- The metamorphic process involving mass transfer and change of bulk chemical composition is **metasomatism**.
- 5- **polymorph** is the mineral which has the same chemical composition as another, but differs from it in crystal structure.
- 6- **isograd** could be defined as a line on the ground joining points of equal metamorphic grade.
- 7- **blueschist** is a rock consisting dominantly of sodic amphibole.
- 8- Most **amphibolites** are predominantly black rocks with up to 30% white plagioclase.

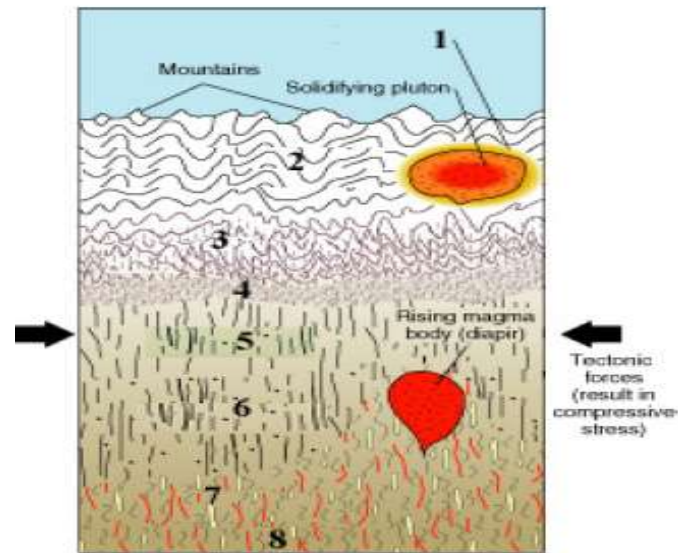
- 9- The reaction involves the transform of andalusite to silliminite include only rearrangement of the mineral structure without matter transfer is best describe **solid-solid phase transformation** (choose type of reaction)
- 10- If minerals contain volatiles, the volatiles must be conserved in the reaction so that no fluid phase is generated or consumed like Talc + Enstatite = Anthophyllite is best describe **solid-solid net-transfer**.

For points 11-17; match the reaction on the left column with the suitable metamorphic reaction type from upward choice list?

No.	Reaction	Type of metamorphic reaction
11-	$\text{Biotite} + \text{O}_2 \rightarrow \text{K-Feldspars} + \text{Magnetite} + \text{H}_2\text{O}$	oxidation-reduction reaction
12-	$\text{Fe-Garnet} + \text{Mg-Biotite} \rightarrow \text{Fe-Biotite} + \text{Mg-Garnet}$	cation exchange reaction
13-	$\text{Chlorite} + \text{Muscovite} \rightarrow \text{Orthoclase} + \text{Andalusite} + \text{H}_2\text{O}\uparrow$	dehydration reactions
14-	$\text{Calcite} + \text{Quartz} \rightarrow \text{Wallstonite} + \text{CO}_2\uparrow$	decarbonation reaction
15-	$\text{Muscovite} + \text{Quartz} \rightarrow \text{K-Feldspars} + \text{Silliminite} + \text{H}_2\text{O}\uparrow$	divariant reactions
16-	$\text{Graphite} \leftrightarrow \text{Diamond}$	solid-solid reaction
17-	$\text{Albite} \leftrightarrow \text{jadite} + \text{quartz}$	solid-solid reaction

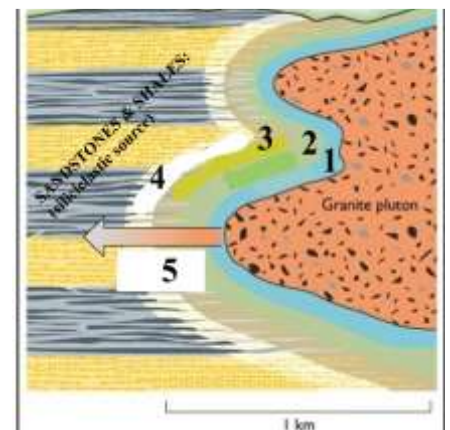
For points 18-25; match the number of the metamorphic zone on the given figure at right with their appropriate metamorphic rock from upward choice list?

- 18- **contact metamorphic aureole** could be found in metamorphic zone 1.
- 19- **folded unmetamorphosed sedimentary rocks** could be found in metamorphic zone 2.
- 20- **Slate** could be found in metamorphic zone 3.
- 21- **Phyllite** could be found in metamorphic zone 4.
- 22- **mica schist** could be found in metamorphic zone 5.
- 23- **garnet mica schist** could be found in metamorphic zone 6.
- 24- **Gneiss** could be found in metamorphic zone 7.
- 25- **Migmatite** could be found in metamorphic zone 8.



2- Using the illustration shown below, please answer the following questions (26-31). (6 marks)

- 26- The type of metamorphism described by this illustration is **contact metamorphism**.
- 27- The trend that defined by 5 could named **decreasing temperature**
- 28- The metamorphic rock that formed in one 1 may be named **hornfels**
- 29- The metamorphic mineral characterized zone 2 may be **silliminite**
- 30- The metamorphic mineral characterized zone 3 may be **biotite**
- 31- The metamorphic mineral characterized zone 4 may be named **chlorite**



3- In the illustration shown below, Please answer the following questions (32-34). (3 Marks)

32- The lines (A), (B) and (C) represents what type of pressure temperature series.

(A) High P/T series

(B) Medium P/T series

(C) Low P/T series

33- Write the missing name of metamorphic facies from (1-8).

1. Zeolite Facies
2. Prehnite-Pumpellyite Facies
3. Greenschist Facies
4. Amphibolite Facies
5. Granulite Facies
6. Eclogite Facies
7. Blueschist facies
8. Facies of contact metamorphism.

34- What is the metamorphic facies associated with geotherms around cooling magma?

Facies of contact metamorphism.

4- For questions (35-39), this is a conventional ACF diagram on which are plotted five rock compositions. (5 Marks)

35- Which rock is the amphibolite?

3

36- Which rock is the cordierite-sillimanite gneiss?

1

37- Which rock is the metaperidotite?

5

38- Which rock is the metagreywacke?

4

39- Which is the grossular-diopside-wollastonite rock?

2

5- For questions (40-44) this is a P-T diagram which P-T field representing the following facies. (5 Marks)

40- Pyroxene-hornfels facies.

10

41- The facies in which the galucophane mineral occurs.

1

42- The appropriate facies for a metabasic rock consisting of albite + epidote + chlorite + actinolite.

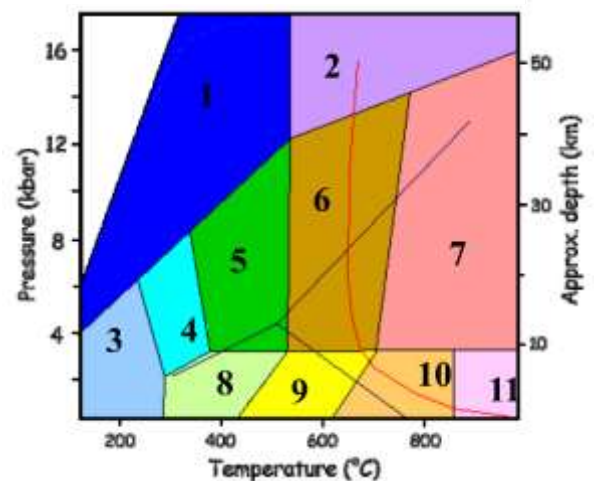
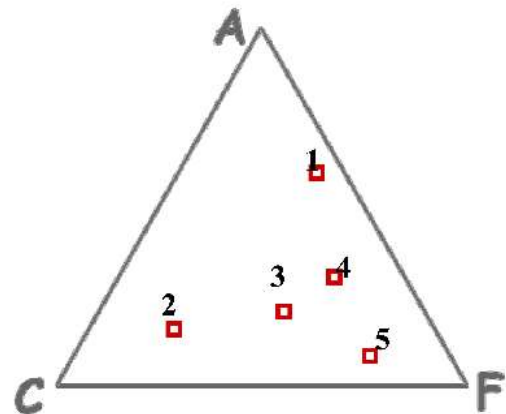
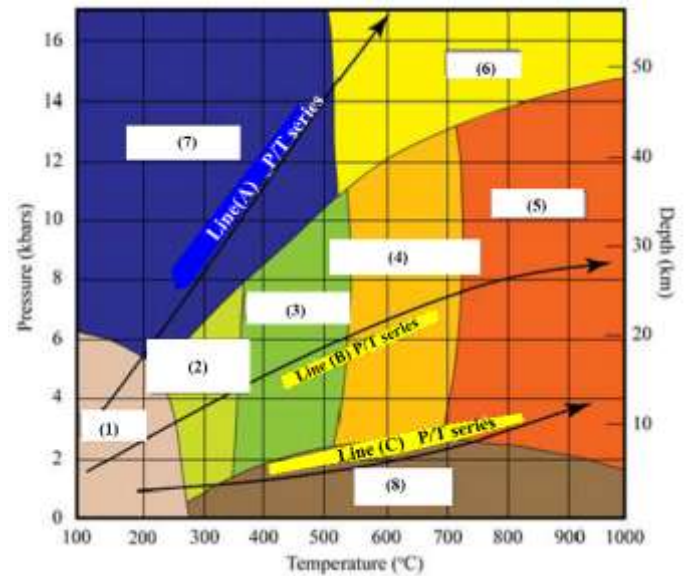
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43- Facies for a metapelitic rock with the assemblage garnet + cordierite + K-feldspar + quartz.

7

44- Facies for a calcareous rock with the assemblage tremolite + calcite + quartz, given also that an adjacent outcrop consists of kyanite-biotite schist.

6

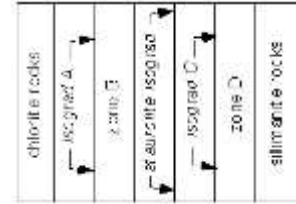


6- Choose the best answers for the following?

(11 Marks)

45- Isograd A is the _____ isograd

- a) amphibole
- b) muscovite
- c) **biotite**
- d) garnet

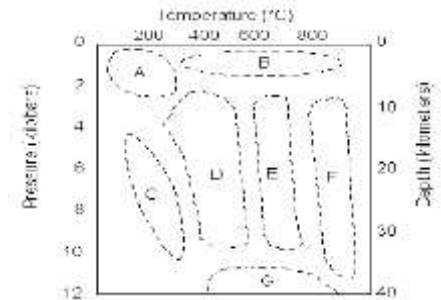


46- Zone D should contain which of the following minerals?

- a) amphibole
- b) sillimanite
- c) calcite
- d) **kyanite**

47- For the given P-T diagram What metamorphic facies occurs at temperatures of 400°C and pressures of 6 kilobars?

- a) **greenschist**
- b) hornfels
- c) granulite
- d) zeolite



48- Which pressure-temperature regime represents the eclogite facies?

- a) area A
- b) area C
- c) area E
- d) **area G**

With all my best wishes
Dr. Moustafa M. Mogahed