## Part I

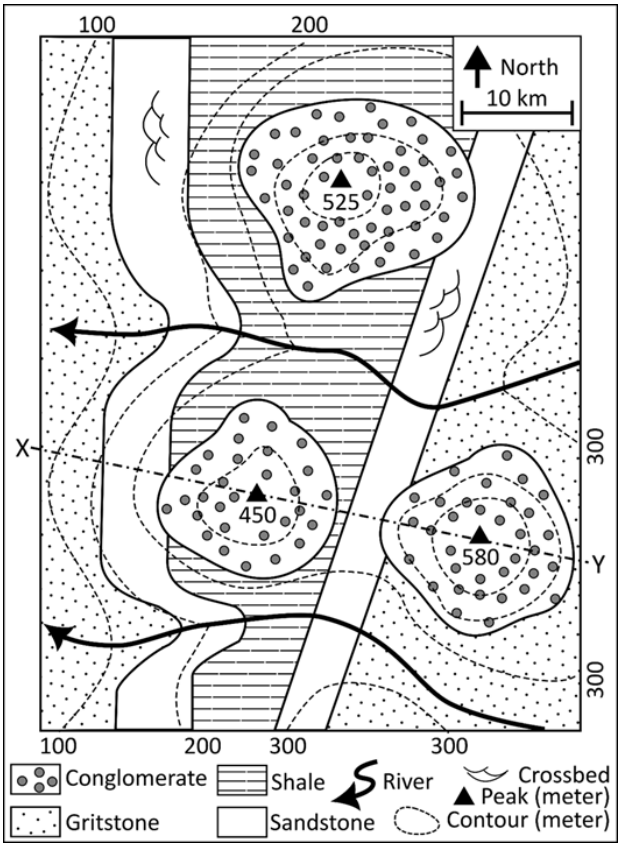
1. Interpret the given geological map and answer the following:

   (a) Explain the deformational structure of the sandstone bed.

   (b) What is the nature of contact between the conglomerate and the other beds?

   (c) Arrange the four rock types, given in the map, in their correct stratigraphic order.

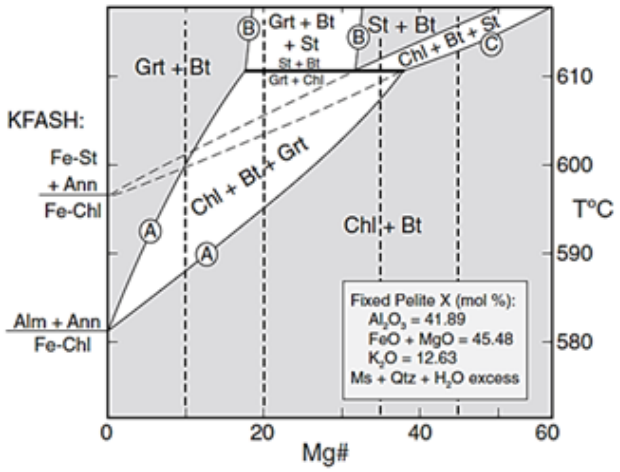
   (d) Draw a profile section along the XY line. When drawing the beds and contacts, the amount of inclination need not to be precise. $[5 + 5 + 5 + 10 = 25]$



## Part II: 5 questions 8 marks each

2. Explain how amphibole and feldspar compositions are useful in constraining the metamorphic facies conditions of metabasic rocks.

3. During field work, you find a mica-schist in which there are millimetre-centimeter thick layers that contain either garnet, or staurolite, or both, or neither. Explain with the help of the given figure how this heterogeneity can develop during metamorphism.




4. The $\delta^{13}C$ value of atmospheric $CO_2$ is -8‰. For carbonate sediments, $\delta^{13}C$ varies from +5‰ to -1‰. However, plants have $\delta^{13}C$ values ranging from -15‰ to -35‰. Explain why.

5. Explain morphology of a gastropod with suitable diagram and comment on its classification.

6. Write a short note on "K-T Mass Extinction" and its effect on the Global diversity of Marine Invertebrates.

**Part III: 5 questions 4 marks each: Justify your answer**

7. What kind of transient geothermal gradient characterizes subduction zone metamorphism?

   (a) High-P, high-T

   (b) High-P, low-moderate-T

   (c) Low-moderate-P; high-T

   (d) Low-moderate-P; Low-moderate-T

8. Metasedimentary rock in an area is folded, defined by the compositional banding in the rock. The attitude of the two limbs the fold are: 65°/70°→NW and 65°/30°→SE. What is the attitude of the axial plane of the fold?

   (a) 65°/70°→NW

   (b) 65°/80°→SE

   (c) 65°/80°→NW

   (d) 65°/70°→SE

9. Consider the univariant metamorphic reaction Albite = Jadeite + Quartz. What is the minimum number of chemical components required to describe the composition of all the phases?

   (a) 2 (b) 3 (c) 4 (d) 5

10. Which of the following is the evolution of sutural pattern of ammonite with time ?

    (a) Orthoceratitic – nautilitic – goniatitic – ceratitic – ammonitic

    (b) Orthoceratitic – goniatitic – nautilitic – ammonitic – ceratitic

(c) Orthoceratitic – nautilitic – ceratitic – goniatitic – ammonitic

(d) Orthoceratitic – goniatitic –ceratitic – nautilitic – ammonitic

11. Kutch Basin is famous for:

(a) Triassic ammonites

(b) Cretaceous gastropods

(c) Jurassic ammonites

(d) Jurassic gastropods

**Part IV: 15 questions with 1 mark each**

12. Spinel in a metapelitic rock has a composition of $(Fe_{0.35}Mg_{0.35}Zn_{0.30})Al_3O_4$. What is the $X_{Mg}$ value of the spinel?

(a) 0.30 (b) 0.50 (c) 0.25 (d) 0.75

13. The peak metamorphic pressure-temperatures constrained from a metabasic granulite are 800°C at 14 kbar. What is the transient geothermal gradient of the subduction zone?

(a) 17°C/km (b) 20°C/km (c) 23°C/km (d) 26°C/km

14. In the AKF ternary plot of mineral assemblages, the apex "A" represents:

(a) A = $Al_2O_3$ / ( $Na_2O$ + $K_2O$ + CaO )

(b) A = $Al_2O_3$ – $K_2O$

(c) A = $Al_2O_3$ – $Na_2O$ – $K_2O$ – CaO

(d) A = $Al_2O_3$ – $3K_2O$

15. A metamorphic rock comprises the assemblage grossular garnet-clinopyroxene-anorthitic plagioclase. What kind of rock is this?

    (a) Meta-basic rock

    (b) Meta-calcsilicate rock

    (c) Meta-pelitic rock

    (d) Meta-ultrabasic rock

16. Which of the following minerals forms at the highest temperature in closed system calcite marbles?

    (a) Wollastonite

    (b) Tremolite

    (c) Diopside

    (d) Forsterite

17. The typical metamorphic mineral assemblage of an amphibolite facies metapelite is:

    (a) amphibole + muscovite + biotite + quartz + plagioclase

    (b) chlorite + muscovite + biotite + quartz + orthoclase

    (c) chlorite + muscovite + biotite + quartz + plagioclase

    (d) chlorite + sillimanite + biotite + quartz + plagioclase

18. An oblique slip fault suggests:

    (a) tension forces only

    (b) compression forces only

    (c) shear forces only

    (d) shear forces combined with compressional and tensional forces

19. Which of the following boundaries approximately represent the Great Oxygenation Event (GOE) in the Earth's History?

    (a) Proterozoic-Paleozoic

    (b) Cretaceous-Tertiary

    (c) Archean-Proterozoic

    (d) Cambrian-Ordovician

20. The texture in a graphic granite represent which of the following stages of crystallization in the albite-silica binary system?

    (a) At liquidus in the albite rich composition

    (b) At liquidus in the silica rich composition

    (c) At the eutectic point

    (d) At the temperature below the eutectic point

21. A crystal that has two perpendicular and oblique crystallographic axes belongs to which of the following crystal systems?

    (a) Tetragonal

    (b) Orthorhombic

    (c) Monoclinic

    (d) Triclinic

22. If the type specimens of a species are lost, the new type specimens of the species are known as:

    (a) Paratype

    (b) Plesiotype

    (c) Neotype

    (d) Lectotype

23. Which group of fossils is used for biostratigraphic subdivision of Jurassic periods?

    (a) Trilobites

    (b) Foraminifera

    (c) Brachiopods

    (d) Cephalopods

24. Which one is the index trilobite fossil of Lower Cambrian of India?

    (a) Redlichia noetlingi

    (b) Redlichia advialis

    (c) Redlichaspis finalis

    (d) None of the above

25. Which one has two identical cardinal teeth, below umbo?

    (a) Unio

    (b) Spondylus

    (c) Pecten

    (d) None of the above

26. When the last whorl of a gastropod specimen completely encloses all the earlier whorls, is known as:

    (a) Involute

    (b) Epivolute

    (c) Envolute

    (d) Convolute