Civil Services (Main) Examination, 2013

GEOLOGY
(Paper II)

Time Allowed : Three Hours **Maximum Marks : 250**

QUESTION PAPER SPECIFIC INSTRUCTIONS

(Please read each of the following instructions carefully before attempting questions)

There are EIGHT questions divided in two Sections.
Candidate has to attempt FIVE questions in all.
Question Nos. 1 and 5 are compulsory and out of the remaining, any THREE are to be attempted choosing at least ONE question from each Section.
The number of marks carried by a question/part is indicated against it.
Wherever any assumptions are made for answering a question, they must be clearly indicated.
Word limit in questions, wherever specified, should be adhered to.
Attempts of questions shall be counted in sequential order. Unless struck off, attempt of a question shall be counted even if attempted partly. Any page or portion of the page left blank in the Question-cum-Answer Booklet must be clearly struck off.

SECTION 'A'

1. Attempt the following questions with suitable sketches wherever necessary. **10×5=50**

(a) Explain how the radius ratio of cation to anion influences coordination in minerals. Cite examples of two common coordination in rock forming minerals.

(b) Define the Gibbs phase rule and calculate the variance of the assemblage containing enstatite + forsterite + Mg-spinel + Mg-cordierite + corundum in the appropriate chemical system.

(c) With suitable examples, enumerate the essential difference between regional dynamothermal metamorphism and contact metamorphism.

(d) Explain why in any igneous rock, primary forsterite and quartz cannot stably coexist.

(e) Describe the critical differences between porosity and permeability. Add a note on how these two properties of sediments are determined.

2. (a) With theoretical details, discuss (i) optical indicatrix, and (ii) determination of sign of elongation of uniaxial minerals. **15**

(b) With suitable examples, discuss the causes behind and effects of (i) pleochroism and (ii) birefringence in minerals. **15**

(c) Derive Bragg's law for X-ray diffraction. Calculate the inter-planar spacing in a crystal for a plane that gives a sharp reflection at $2\theta=50$ for CuKα radiation ($\lambda=1.5418$ Å) in a powder X-ray diffraction experiment. **20**

3. (a) Thin sections of three basaltic rocks contain (i) phenocrysts of Ca-rich plagioclase in diopside matrix, (ii) phenocrysts of diopside in Ca-rich plagioclase matrix, and (iii) coexisting phenocrysts of both Ca-rich plagioclase and diopside. On the basis of phase diagram in the diopside-anorthite system, describe the initial melt composition and temperatures, along with crystallization behavior of the above rocks. **20**

(b) By suitable reactions, discuss various mineralogical and mineral-chemical changes that take place during metamorphism of a basaltic rock at the greenschist-amphibolite facies transition. **15**

(c) In a P-T diagram show the domains of various metamorphic facies and briefly explain these facies. **15**

English version compiled from published transcriptions and cross-checked across sources; not a facsimile of the official UPSC question paper.

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4. **(a)** What are turbidites? With a neat sketch, show different units of a Bouma cycle and the flow regimes under which they are formed. **15**

(b) With neat sketches, describe the primary depositional sedimentary structures, with emphasis on their application in determining paleocurrent directions. **15**

(c) With the help of a neat sketch, briefly discuss the classification of sandstone. What is the general tectonic environment in which quartz arenites are found? **20**

SECTION 'B'

5. Attempt the following questions with suitable sketches wherever necessary.

10×5=50

(a) Describe the relationship between average crustal abundance of metals and their content in ore deposits. Add a brief note on tonnage, grade and cut-off grade of ore deposits.

(b) What are the sources for the formation of coal and petroleum deposits? Briefly discuss the process of coalification.

(c) Briefly enumerate the various sampling methods in mineral exploration and mining.

(d) From the first and the second laws of thermodynamics and assuming reversible process, derive the expression $dU=TdS-PdV$; where U, S, T, P and V respectively stand for internal energy, entropy, temperature, pressure and volume.

(e) Discuss the various causes and environmental impacts of acid mine drainage.

6. **(a)** Explain the ore forming processes that result in chromite and Ni-Cu sulphide deposits hosted by ultramafic rocks. **15**

(b) With schematic sketches, show and elucidate the zones of hydrothermal alteration in a porphyry copper deposit, emphasizing their mineralogy and temperature of alteration. Explain why the ore zone is localized at the boundary between two specific alteration zones. **15**

(c) Mark the location of following mineral and coal deposits in the outline map of India and write a brief description of each of these deposits: (i) Khetri copper belt, (ii) Hutti gold deposit, (iii) Jharia coal field, and (iv) Nellore mica belt.

[Figure: Small blank outline map of India in a rectangular frame (tick marks along the frame edges), showing only the national outline with Sri Lanka, the Andaman and Nicobar Islands and the Lakshadweep islands, and a short unlabelled scale bar at the lower left; no places, symbols or labels are marked on it]

20

7. **(a)** Explain how ore concentrates are produced from run-off mine by mineral beneficiation, with the help of examples of two different beneficiation processes. **15**

(b) With suitable examples, define indicator and pathfinder elements in geo-chemical prospecting. Discuss mobility of elements in near surface environment. **20**

(c) Compare and contrast the corrections used in gravity and magnetic methods of mineral prospecting. **15**

8. **(a)** Discuss the mineralogical and chemical compositions of various meteorites, with a note on how meteorites furnish evidence about planetary interiors. **15**

(b) Discuss the effects of river flooding and response to flood hazards. **15**

(c) Explain the role of water in slope stability and add a note on types of slope failure. **20**

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