

Paper: Geology (100 Marks)

Part-I (50-marks)

I. Introduction to Physical Geology

Introduction and scope of geology, its importance and relationship with other sciences; Earth as a member of the solar system: its origin, age, composition and internal structure; Introduction to rocks and minerals; Weathering and erosion; Isostasy; Geological Time Scale.

II. Stratigraphy and Paleontology

Principles of stratigraphy; Laws of superposition and faunal succession; Geological time scale with divisions; Classification and nomenclature of stratigraphic units: lithostratigraphic units, biostratigraphic units and chronostratigraphic units.

Introduction to fossils and their significance; Modes of fossilization; Study of morphology, range and broad classification of major invertebrate phyla; Introduction to micro fossils; Introduction to Paleobotany; Introduction and classification of major vertebrates; Introduction to micropaleontology

III. Mineralogy

Classification of minerals; Study of internal structure; Polymorphism and isomorphism; Paragenesis; Physical and optical properties of the common silicate and non-silicate mineral groups; Introduction to crystallography: elements of symmetry, study; normal classes of crystallographic systems.

IV. Structural Geology and Tectonics

Stress-strain concepts; factors controlling the mechanical behavior of materials; Folds; Faults; Joints; Foliation: terminology, classification and relationship with bedding; Lineation; Unconformity.

Plate tectonics theory; Geological evidences for continental drift; Sea-floor spreading; Oceanic ridges; Continental rifts; Intra-oceanic islands; Hot spot and Mantle plumes; Wilson Cycle; Tectonic framework of Pakistan.

V. Petrology and Petrography

Introduction, classification and description of sedimentary rocks; origin; transportation and deposition of sediments; Texture of sedimentary rocks; Sedimentary structures, their classification, morphology and significance; Composition, origin, differentiation and evolution of magma; Classification of igneous rocks; Mode of occurrences and types of extrusive rocks; Texture and structure of igneous rocks; Introduction to metamorphism; Types of metamorphism; Grades, zones and facies of metamorphism; Metamorphic diffusion and differentiation; Metamorphism in relation to Plate Tectonics; Differentiation between metamorphism and metasomatism.

Introduction to Polarizing Microscope; Optical properties of opaque and non-opaque minerals in plane polarized light and under crossed nicol including metallic under reflected light; Description of optical properties of common rock forming minerals.

Part-II (50-marks)

I. *Introduction to Geophysics*

Definition and relation of geophysics with other sciences; Classification and brief description of various branches of geophysics such as seismology, geomagnetism, geoelectricity, tectonophysics, gravimetry, geo-thermy and geodesy; Introduction to various geophysical techniques for exploration of mineral deposits, oil and gas, subsurface water and engineering works.

II. *Sequence Stratigraphy*

Introduction: history, concept and significance of sequence stratigraphy; Data sources: seismic reflections, outcrops, well logs, core and seismic facies; Sea level changes: their causes and effects, accommodation, eustatic and relative sea curve; Hierarchy of sequence stratigraphic elements; Types of sequences and systems tracts.

III. *Petroleum Geology*

The nature and classification of petroleum hydrocarbons, their origin, migration and accumulation; Source sediments, reservoir rocks and trapping mechanism for oil and gas; Prospecting and exploration of oil and gas; Reservoir: characteristics, drive mechanism, energy and pressure maintenance; Secondary and enhanced recovery; Introduction to Sedimentary Basins of Pakistan.

IV. *Engineering and Environmental Geology*

Rock and soil mechanics and its application in civil engineering; Rock mass characteristics; Geotechnical studies of rocks and soils; Geological factors and strength of rocks; Study of geological factors in relation to the construction of buildings' foundations, roads, highways, tunnels, dams and bridges; Application of geophysical methods for site investigation; Construction materials; Mass movement: their causes and prevention.

Introduction to environmental geology; Management of natural resources; Global climatic changes; Environmental controls for erosion, desertification and coastal degradation; Geological hazards such as floods, landslides, earthquakes, tsunamis, volcanoes, glaciers and shoreline processes; Remedial measures; Clean sources of energy; Industrial pollution, solid and liquid waste disposal, Introduction to environmental impact assessment and initial environmental examination.

V. *Mineral and Energy Resources*

Introduction of geological exploration/prospecting. Brief description of hydrocarbons, coal, gemstones, copper, lead, zinc, iron, gold, chromite, manganese, salt, gypsum, bauxite, sulphur, barite, fluorite, clays, phosphorite, building and dimension stones; Industrial rocks and minerals; Radioactive minerals and rocks; Special reference to economic mineral deposits in Pakistan.

Origin, occurrence, and depositional environments of coal; Coal constitution and its kinds; Coal rank, grade and calorific value; Coal deposits of Pakistan with reference to Thar Coal; Geothermal energy resources of Pakistan.

VI. *Economic and Applied Geology*

Metallic and Non-metallic mineral resources of Pakistan; Mineral-based industries. Overview of

Recodec Copper; Radioactive minerals and their occurrences in Pakistan; Gemstones of Pakistan.

Geology of Reservoirs, dams, highways and tunnels; Major natural hazards and their impacts on the environment with special reference to Pakistan.

SUGGESTED READING

| S.No. | Title | Author |
|-------|---|--|
| 1. | Physical Geology | Charles Plummer, David McGeary, Diane Carlson, |
| 2. | Physical Geology | Charles (Carlos) Plummer, Diane Carlson |
| 3. | Principles of Physical Geology | Holmes, A |
| 4. | Principles of Paleontology | Raup, D.M. & Stanley, S.M |
| 5. | Vertebrate Paleontology | Romer, A.S |
| 6. | Invertebrate Paleontology and Evolution | Clakson, E.N.K |
| 7. | Stratigraphy of Pakistan | Shah, S.M.I. |
| 8. | Principles of Sedimentology and Stratigraphy | Boggs, S |
| 9. | Stratigraphy and Historical Geology of Pakistan | Kazmi, A.H and Abbasi, I.A |
| 10. | Igneous and Metamorphic Petrology | Best, M.G., |
| 11. | Introduction to Optical Mineralogy | Nesse, W.D |
| 12. | An Atlas of Minerals in Thin Section | Schulze, D.J., |
| 13. | Minerals and Rocks | Klein, C., |
| 14. | Mineral Characterisation and Processing | Mohapatra, B.K., Misra, V |
| 15. | Principles of Mineralogy | William. H.B., |
| 16. | Mineralogy | Perkins, D |
| 17. | Plate Tectonics – Geodynamics | Moores, E.M. & Twiss, R.J |
| 18. | Structural Geology of Rocks and Regions | George H. Davis, Stephen J. Reynolds, Charles F. Kluth |
| 19. | Structural Geology | Twiss, R.J. & Moores, E.M., |
| 20. | Carbonate Sedimentology | Tucker, M.E. & Wright, V.P |
| 21. | Applied Sedimentology | Selly, R.C., |
| 22. | Petrology of Sedimentary Rocks | Boggs Jr. S |
| 23. | Sedimentary Rocks | Pettijohn, F.J |
| 24. | Introduction to Applied Geophysics | Burger R.H., Sheehan, A. & Jones, C |
| 25. | Geophysical Methods in Geology | Sharma, P.V |

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| 26. | The Solid Earth: An Introduction to Global Geophysics | Fowler, CMR |
| 27. | Igneous and Metamorphic Petrology | Best, M.G |
| 28. | Petrology: Igneous, Sedimentary, & Metamorphic | Blatt, H., Tracy, R.& Owens, D |
| 29. | Igneous and Metamorphic Petrology | Best, M.G., |
| 30. | Metamorphic Petrology | Turner, F.J., |
| 31. | Sequence Stratigraphy | Emery, D. & Myers, K.J., |
| 32. | Elements of Petroleum Geology | Richard C. Selley, |
| 33. | Petroleum Geology | North, F.K., |
| 34. | Geology of Pakistan | Bender, F.K. & Raza, H.A., |
| 35. | Engineering Geology: Principles and Practice | David George Price, Michael de Freitas |
| 36. | Engineering Geology | F G Bell |
| 37. | Fundamentals of Engineering Geology | Bell, F.A.G., |
| 38. | Environmental Geology | Montgomery, C.W., |
| 39. | Geology of Himalaya, Karakoram, Hindukush in Pakistan | Tahirkheli, R.A.K., |
| 40. | Geology of Pakistan | Bender, F.K. & Raza, |
| 41. | Stratigraphy and Historical Geology of Pakistan | Kazmi, A.H and Abbasi, I.A |
| 42. | Economic Geology: Principles and Practice | Walter L. Pohl |
| 43. | Directory of Mineral Deposits of Pakistan | Zaki, A., |
| 44. | An Introduction to Ore Geology | Evans, A.M., |
| 45. | Metallogeny and Mineral Deposits of Pakistan | Kazmi, A.H. & Abbas, S.G., |
| 46. | Introduction to Mineral Exploration | Moon, C.J., Whateley, M.K.G. and Evans, A.M. |

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| 47. | Energy Resources | Brown and Skipsy |
| 48. | Pakistan Energy Yearbook 2012 | Ministry of Petroleum and Natural Resources Hydrocarbon Development Institute of Pakistan. Islamabad |