

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 mineral, 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 which control 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 and 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 and 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, their 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 with special reference to economic mineral deposits in Pakistan.  
Origin, occurrence, and depositional environments of coal; coal Constitution and kinds of coals. 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 impact on the environment with special reference to Pakistan.

### SUGGESTED READINGS

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	Moore, 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. & Moore, 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

S.No.	Title	Author
25.	Geophysical Methods in Geology	Sharma, P.V
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.	Petrology: Igneous, Sedimentary, & Metamorphic	Blatt, H., Tracy, R. & Owens, D
31.	Metamorphic Petrology	Turner, F.J.,
32.	Sequence Stratigraphy	Emery, D. & Myers, K.J.,
33.	Elements of Petroleum Geology	Richard C. Selley,
34.	Petroleum Geology	North, F.K.,
35.	Geology of Pakistan	Bender, F.K. & Raza, H.A.,
36.	Engineering Geology: Principles and Practice	David George Price, Michael de Freitas
37.	Engineering Geology	F G Bell
38.	Fundamentals of Engineering Geology	Bell, F.A.G.,
39.	Environmental Geology	Montgomery, C.W.,
40.	Geology of Himalaya, Karakoram, Hindukush in Pakistan	Tahirkheli, R.A.K.,
41.	Geology of Pakistan	Bender, F.K. & Raza,
42.	Stratigraphy and Historical Geology of Pakistan	Kazmi, A.H and Abbasi, I.A
43.	Economic Geology: Principles and Practice	Walter L. Pohl
44.	Directory of Mineral Deposits of Pakistan	Zaki, A.,
45.	An Introduction to Ore Geology	Evans, A.M.,
46.	Metallogeny and Mineral Deposits of Pakistan	Kazmi, A.H. & Abbas, S.G.,
47.	Introduction to Mineral Exploration	Moon, C.J., Whateley, M.K.G. and Evans, A.M.
48.	Energy Resources	Brown and Skipsy
49.	Pakistan Energy Yearbook 2012	Ministry of Petroleum and Natural Resources Hydrocarbon Development Institute of Pakistan. Islamabad