

Standard and Syllabus for UPSC Geologists' Examination

Standard and Syllabus

The standard of the paper in General English will be such as may be expected of a science graduate. The papers on geological subjects will be approximately of the M.Sc. degree standard of an Indian University and questions will generally be set to test the candidate's grasp of the fundamentals in each subject.

There will be no practical examination in any of the subjects.

(1) General English

Candidate will be required to write a short Essay in English. Other questions will be designed to test their under-standing of English and workmanlike use of words.

(2) GEOLOGY - PAPER I

Section A : Geomorphology and Remote Sensing.

Basic principles. Weathering and soils, Mass wasting. Influence of climate on processes. Concept of erosion cycles. Geomorphology of fluvial tracts, arid zones, coastal regions, 'Karst' landscapes and glaciated ranges. Geomorphic mapping, slope analysis and drainage basin analysis. Applications of geomorphology in mineral prospecting, civil engineering, hydrology and environmental studies. Topographical maps. Geomorphology of India.

Concepts and principles of aerial photography and photogrammetry, satellite remote sensing — data products and their interpretation. Digital image processing. Remote sensing in landform and land use mapping, structural mapping, hydrogeological studies and mineral exploration. Global and Indian Space Missions. Geographic Information System (GIS) — principles and applications.

Section B : Structural Geology

Principles of geological mapping and map reading, projection diagrams. Stress-strain relationships of elastic, plastic and viscous materials. Measurement of strain in deformed rocks. Behaviour of minerals and rocks under deformation conditions. Structural analysis of folds, cleavages, lineations, joints and faults. Superposed deformation. Mechanism of folding and faulting. Time-relationship between crystallization and deformation. Unconformities and basement-cover relations. Structural behaviour of igneous rocks, diapirs and salt domes. Introduction to petrofabrics.

Section C : Geotectonics

Earth and the solar system, Meteorites and other extra-terrestrial materials, Planetary evolution of the earth and its internal structure. Heterogeneity of the earth's crust. Major tectonic

features of the Oceanic and Continental crust. Continental drift — geological and geophysical evidence, mechanics, objections, present status. Gravity and magnetic anomalies at Mid-ocean ridges, deep sea trenches, continental shield areas and mountain chains. Palaeomagnetism. Seafloor spreading and Plate Tectonics. Island arcs, Oceanic islands and volcanic arcs. Isostasy, orogeny and epeirogeny. Seismic belts of the earth. Seismicity and plate movements. Geodynamics of the Indian plate.

Section D : Stratigraphy

Nomenclature and the modern stratigraphic code. Radioisotopes and measuring geological time. Geological time-scale. Stratigraphic procedures of correlation of unfossiliferous rocks. Precambrian stratigraphy of India. Stratigraphy of the Palaeozoic, Mesozoic and Cenozoic formations of India. Gondwana system and Gondwanaland. Rise of the Himalaya and evolution of Siwalik basin. Deccan Volcanics. Quaternary Stratigraphy. Rock record, palaeoclimates and palaeogeography.

Section E : Palaeontology

Fossil record and geological time-scale. Morphology and time-ranges of fossil groups. Evolutionary changes in molluscs and mammals in geological time. Principles of evolution. Use of species and genera of foraminifera and echinodermata in biostratigraphic correlation. Siwalik vertebrate fauna and Gondwana flora, evidence of life in Precambrian times, different microfossil groups and their distribution in India.

(3) GEOLOGY - PAPER II

Section A : Mineralogy

Physical, chemical and crystallographic characteristics of common rock forming silicate mineral groups. Structural classification of silicates. Common minerals of igneous and metamorphic rocks. Minerals of the carbonate, phosphate, sulphide and halide groups.

Optical properties of common rock forming silicate minerals, uniaxial and biaxial minerals. Extinction angles, pleochroism, birefringence of minerals and their relation with mineral composition. Twinned crystals. Dispersion. The U-stage.

Section B : Igneous and Metamorphic Petrology

Forms, textures and structures of igneous rocks. Silicate melt equilibria, binary and ternary phase diagrams. Petrology and geotectonic evolution of granites, basalts, andesites and alkaline rocks. Petrology of gabbros, kimberlites, anorthosites and carbonatites. Origin of primary basic magmas.

Textures and structures of metamorphic rocks. Regional and contact metamorphism of pelitic and impure calcareous rocks. Mineral assemblages and P/T conditions. Experimental and thermodynamic appraisal of metamorphic reactions. Characteristics of different grades and

facies of metamorphism. Metasomatism and granitization, migmatites. Plate tectonics and metamorphic zones. Paired metamorphic belts.

Section C : Sedimentology

Provenance and diagenesis of sediments. Sedimentary textures. Framework matrix and cement of terrigenous sediments. Definition, measurement and interpretation of grain size. Elements of hydraulics. Primary structures, palaeocurrent analysis. Biogenic and chemical sedimentary structures. Sedimentary environment and facies. Facies modelling for marine, non-marine and mixed sediments. Tectonics and sedimentation. Classification and definition of sedimentary basins, Sedimentary basins of India. Cyclic sediments. Seismic and sequence stratigraphy. Purpose and scope of basin analysis. Structure contours and isopach maps.

Section D : Geochemistry

Earth in relation to the solar system and universe, cosmic abundance of elements. Composition of the planets and meteorites. Structure and composition of earth and distribution of elements. Trace elements. Elementary crystal chemistry and thermodynamics. Introduction to isotope geochemistry. Geochemistry of hydrosphere, biosphere and atmosphere. Geochemical cycle and principles of geochemical prospecting.

Section E : Environmental Geology

Concepts and principles. Natural hazards — preventive/precautionary measures — floods, landslides, earthquakes, river and coastal erosion. Impact assessment of anthropogenic activities such as urbanization, open cast mining and quarrying, river-valley projects, disposal of industrial and radio-active waste, excess withdrawal of ground water, use of fertilizers, dumping of ores, mine waste and fly-ash. Organic and inorganic contamination of ground water and their remedial measures. Soil degradation and remedial measures. Environment protection — legislative measures in India.

(4) GEOLOGY - PAPER III

Section A : Indian mineral deposits and mineral economics

Occurrence and distribution in India of metalliferous deposits — base metals, iron, manganese, aluminium, chromium, nickel, gold, silver, molybdenum. Indian deposits of non-metals — mica, asbestos, barytes, gypsum, graphite, apatite and beryl. Gemstones, refractory minerals, abrasives and minerals used in glass, fertilizer, paint, ceramic and cement industries. Building stones. Phosphorite deposits. Placer deposits, rare earth minerals.

Strategic, critical and essential minerals. India's status in mineral production. Changing patterns of mineral consumption. National Mineral Policy. Mineral Concession Rules. Marine mineral resources and Law of Sea.

Section B : Ore genesis

Ore deposits and ore minerals. Magmatic processes of mineralisation. Porphyry, skarn and hydrothermal mineralisation. Fluid inclusion studies. Mineralisation associated with — (i) ultramafic, mafic and acidic rocks, (ii) greenstone belts, (iii) komatiites, anorthosites and kimberlites and (iv) submarine volcanism. Magma-related mineralisation through geological time. Stratiform and stratabound ores. Ores and metamorphism — cause and effect relations.

Section C : Mineral exploration

Methods of surface and subsurface exploration, prospecting for economic minerals — drilling, sampling and assaying. Geophysical techniques — gravity, electrical, magnetic, airborne and seismic. Geomorphological and remote sensing techniques. Geobotanical and geochemical methods. Borehole logging and surveys for deviation.

Section D : Geology of fuels

Definition, origin of coal. Stratigraphy of coal measures. Fundamentals of coal petrology, peat, lignite, bituminous and anthracite coal. Microscopic constituents of coal. Industrial application of coal petrology. Indian coal deposits. Diagenesis of organic materials.

Origin, migration and entrapment of natural hydrocarbons. Characters of source and reservoir rocks. Structural, stratigraphic and mixed traps. Techniques of exploration. Geographical and geological distributions of onshore and offshore petroliferous basins of India.

Mineralogy and geochemistry of radioactive minerals. Instrumental techniques of detection and measurement of radioactivity. Radioactive methods for prospecting and assaying of mineral deposits. Distribution of radioactive minerals in India. Radioactive methods in petroleum exploration — well logging techniques. Nuclear waste disposal — geological constraints.

Section E : Engineering geology

Mechanical properties of rocks and soils. Geological investigations for river valley projects — Dams and reservoirs; tunnels — types, methods and problems. Bridges — types and foundation problems. Shoreline engineering. Landslides — classification, causes, prevention and rehabilitation. Concrete aggregates — sources, alkali-aggregate reaction. Aseismic designing — seismicity in India and earthquake-resistant structures. Problems of groundwater in engineering projects. Geotechnical case studies of major projects in India.

(5) HYDROGEOLOGY**Section A: Origin, occurrence and distribution of water.**

Origin of water: meteoric, juvenile, magmatic and sea waters, Hydrologic cycle: precipitation, runoff, infiltration and evapotranspiration, Hydrographs. Subsurface movement and vertical distribution of groundwater, Springs, Classification of aquifers, Concepts of drainage basin and groundwater basin. hydrological properties of rocks — specific yield, specific retention,

porosity, hydraulic conductivity, transmissivity, storage coefficient, water table fluctuations – causative factors, concept of barometric and tidal efficiencies, water table contour maps, Classification of rocks with respect to their water bearing characteristics, Hydro-stratigraphic units, Groundwater provinces of India, Hydrogeology of and Zones of India, wet lands.

Section B: Well hydraulics and well design

Theory of groundwater flow, Darcy's Law and its applications, determination of permeability in laboratory and in field, Types of wells, drilling methods, construction, design, development and maintenance of wells, specific capacity and its determination. Unconfined, confined, steady, unsteady and radial flow conditions, Pumps tests – methods, data analysis and interpretation for hydrogeologic boundaries, Evaluation of aquifer parameters using Thiem, Theis, Jacob and Walton methods, Groundwater modeling – numerical and electrical models.

Section C: Groundwater chemistry

Groundwater quality – physical and chemical properties of water, quality criteria for different uses, graphical presentation of water quality data, groundwater quality in different provinces of India – problems of arsenic and fluoride, Saline water intrusion in coastal and other aquifers and its prevention, Radioisotopes in hydrogeological studies, Groundwater contamination.

Section D: Groundwater exploration

Geological – lithological and structural mapping, fracture trace analysis, Hydrogeological – lithological classification with respect of hydrologic properties, Hydraulic continuity in relation to geologic structures, Location of springs Remote sensing – hydrogeomorphic mapping of the terrain using different images of different satellite missions, lineament mapping, shallow groundwater potential zone mapping using satellite images, Surface geophysical methods – seismic, gravity, geo-electrical and magnetic, Subsurface geophysical methods – well logging for delineation of aquifers and estimation of water quality.

Section E: Groundwater problems and management.

Groundwater problems related to foundation work, mining, canals and tunnels, Problems of over exploitation and groundwater mining. Groundwater development in urban areas and rain water harvesting, Artificial recharge methods, Groundwater problems in arid regions and remediation. Groundwater balance and methods of estimation. Groundwater legislation. Sustainability criteria and managing renewable and nonrenewable groundwater resources.
