

# **Syllabus for M.Sc Applied Geology Entrance Examination**

## **EARTH SYSTEMS & PROCESSES**

Earth Systems: Geosphere – Atmosphere, Hydrosphere, Lithosphere, Biosphere. Atmosphere – Structure and Composition, Temperature structure of atmosphere, Troposphere, Stratosphere, Mesosphere and Thermosphere. Hydrosphere – Origin of earth's water, Reservoirs in the hydrosphere, World oceans, Glaciers, ice caps and ice sheets. Biosphere – Life's beginning. Solar system: Planets, Meteorites, Comets, Asteroids. Origin of earth - Big bang theory, Nebular hypothesis, Planetesimal hypothesis, Gaseous tidal hypothesis and Gas dust cloud hypothesis. Age of earth - Determination of Earth's age, radioactive methods, Non-radioactive methods. Earthquakes-magnitude and intensity, properties of seismic waves. Origin, distribution and prediction of earthquakes. Major earthquakes in India & world. Study of Earth's interior by using seismic waves. Volcanoes; Types-distribution -products-causes-effects and prediction. Mountains – Origin, types and distribution. Basic concepts of Isostasy and Geosynclines. Weathering and erosion – Types of weathering and products. Mass movements- Types of movements. Landslides-causes, effects and remedial measures.

## **DYNAMIC GEOLOGY**

Running water as a geological agent: Development of a typical stream-Drainage system-consequent and subsequent streams - Drainage basin- Drainage pattern-Geological work of stream, erosional and depositional fluvial landforms, Concept of base level, Peneplanation, Monadnocks, Stream terrace, Rejuvenation, knick Point, Entrenched meanders. **Underground** water: occurrence, zone of aeration & saturation, Water table, Perched water table, porosity, permeability, Aquifers- confined and unconfined, aquicludes, aquitard and aquifuge. Artesian wells, Geyser and springs. Erosional and depositional landscapes produced by action of ground water. Origin of limestone caverns-Stalactite and stalagmites. Karst topography. Geological work of wind. Erosional and depositional landforms. . Loess, types of dunes, Pediplanation, playas and inselbergs. Formation of deserts. Glaciers- Formation of glaciers- Types- Movements-Erosional and depositional landforms, Glacier landforms, glacial ages. Oceans and Seas: Waves, tides and currents. Geological work of oceans. Classification of shore line, Shore line types, description of continental margins, Continental shelf-Continental slopes-submarine canyons- sea mount-Guyots, mid-oceanic ridges, trenches. Coral reefs – types and origin.

## **CRYSTALLOGRAPHY**

Definition of crystal – morphological characters of crystal – faces – forms – edges solid angles Interfacial angle. Contact Goniometer and its use. Symmetry elements – crystallographic axes – crystal notation – parameter system of Weiss and Miller indices – axial ratio – laws of crystallography – the law of constancy of symmetry, the law of constancy of interfacial angles and the law of rational indices. Classification of crystals into systems and classes - Holohedral, Hemihedral, Hemimorphic and Enantiomorphic forms in crystals. Elementary knowledge of spherical and stereographic projections. study of the symmetry elements, and forms of the Normal, pyritohedral, tetrahedral and plagioclase classes of cubic system with special reference

to well developed crystals of Galena, Spinel, Garnet, Fluorite, Diamond, Pyrite, Tetrahedrite, Boracite and cuprite. Study of symmetry elements and forms of Normal, Hemimorphic, Tripyramidal,

Pyramidal Hemimorphic, Sphenoidal and Trapezohedral classes of Tetragonal system with special reference to well developed crystals of zircon, Rutile, Cassiterite, Vesuvianite, Apophyllite, Sheelite, Meionite, Wulfenite and Chalcopyrite. Study of the symmetry elements and forms of Normal, Hemimorphic, Tripyramidal, Pyramidal hemimorphic, Trapezohedral, Rhombohedral, Rhombohedral Hemimorphic, Trirhomboidal and Trapezohedral classes of Hexagonal system with special reference to well developed crystals of Beryl, Zincite, Apatite, Calcite, Corundum, Tourmaline, Phenacite and Quartz. Study of the symmetry elements and forms of the Normal, Hemimorphic and Sphenoidal classes of Orthorhombic system with special reference to well developed crystals of Barite, olivine topaz, staurolite, Sulphur, Calamine, Struvite and Epsomite. Study of the symmetry elements and forms of the Normal classes of the Monoclinic and Triclinic systems with special reference to well developed crystals of Gypsum, Orthoclase, Albite, Augite, Axinite and Kyanite. Twin crystals – Definitions – Effects of Twinning – laws of twinning – composition plane, twinning plane and twinning axis, indices of twins – simple and repeated (polysynthetic twins), contact and penetration twins: secondary twins. Study of twin laws pertaining to the following crystals – Fluorite (spinel law), Pyrite (iron cross twin). Rutile (geniculate), Calcite, Quartz (Brazil laws), Aragonite (mimetic twin), Staurolite (cruciform), Gypsum, Augite and Feldspars (Carlsbad, Baveno, Manebach,

## **MINERALOGY**

Definition of Mineral and Mineraloid – Scope and aim of Mineralogy. Chemical elements and periodic Table - Bonding of atoms – Metallic, Covalent, Ionic and Vander Walls Bonding in Minerals. Structure and classification of silicates. Compositional variation and coupled ionic substitution, Isomorphism, Polymorphism, Pseudomorphism, solid solution and ex-solution in minerals. Physical properties of minerals depending upon cohesion and elasticity, specific gravity, light, heat, electricity, magnetism and the senses. Determination of specific gravity of minerals- Joly's spring balance and Walker's steelyard methods. Nature of light – Ordinary and polarized light – Refraction and reflection. Refractive index, Critical angle and Total internal reflection. Double refraction - Plane polarization by Reflection, Plane polarization by Refraction, Nicol Prism - Plane polarization by absorption, Polaroid. Petrological microscope and its parts – Optical accessories, their construction and uses – Quartz wedge (Determination of order of Interference Colour), – Gypsum plate and Mica plate (Determination of Fast and Slow vibration directions) Optical classification of minerals. Optical properties of isotropic and anisotropic minerals observed under parallel and crossed Nicols. Differences between Isotropic and anisotropic minerals. Definition of extinction, Types of extinction, Extinction angles and their determination, and uses – Characters of Uniaxial and biaxial minerals – Optic axis and optic axial angle – Acute and Obtuse Bisectrix – Optic sign of Uniaxial and Biaxial minerals – Uniaxial and Biaxial Indicatrix - Sign of elongation - Optical anomalies. Mineralogy, Structure, Chemistry, Optical and Physical properties, Modes of occurrence and uses of the following groups of minerals: Olivine, Garnet, Epidote, Aluminium silicates, Pyroxene, Amphiboles, Mica, Chlorite, Feldspars, Feldspathoids and Zeolites. Mineralogy, Structure, Chemistry, Optical and Physical properties, Modes of occurrences and industrial uses of the following minerals: Polymorph and varieties of Quartz, Scapolite, Cordierite, Talc, Serpentine, Steatite, Calcite,

Dolomite, Topaz, Staurolite, Beryl, Tourmaline, Fluorite, Apatite, Zircon, Rutile, Sphene and Corundum.

### **STRATIGRAPHY & INDIAN GEOLOGY**

Laws of Stratigraphy; concept of uniformitarianism, law of order of super position, law of faunal succession, law of original horizontality, law of cross cutting relationship, physical and biological criteria of correlation and homotaxis. Facies and facial changes-litho and bio facies.

Time scale; standard stratigraphic time scale-Indian geological time scale, imperfections in geological records- breaks in stratigraphic records: unconformity, non-sequences, diastems.

Stratigraphic classification: Biostratigraphy, lithostratigraphy, chronostratigraphy. Physiographic divisions of India-major Stratigraphic divisions of India, Early Precambrian Stratigraphy: Sargur supra crustals, Granulite succession of south India, Dharwar Supergroup- Aravalli Supergroup.

Late Precambrian Stratigraphy: Delhi Supergroup, Cudappah Supergroup, Vindhyan Super group. Brief study of Singhbhum craton, Sausar and Sakoli group

Paleozoic Stratigraphy: Distribution of Paleozoic rocks in India, Cambrian of Salt Range, Age of Saline Series, Upper Carboniferous and Permian rocks of Salt Range, Paleozoic rocks of Kashmir Valley, Paleozoic rocks of Spiti Valley, Paleozoic rocks of Peninsular India,

Mesozoic Stratigraphy: The Depositional Environment-distribution-life-classification and economic importance of Gondwana formations of India, Coastal Gondwana of India, Gondwana formations of Tamilnadu, Triassic of Spiti – The Lilang System, Jurassic of Kutch, Cretaceous of Tiruchirapalli – Pondicherry – Bagh Beds, Deccan traps : distribution , structure , Lameta beds – infratrapean and intertrapean beds, age of the Deccan traps. Cenozoic Stratigraphy:

Comprehensive account of the geological events took place during Cenozoic Era in India, rise of Himalayas, stratigraphy of Siwalik system, fauna and flora of Siwaliks, Tertiary rocks of Assam, Karewa formation, Tertiary rocks of Tamilnadu, Tertiary rocks of Kerala, Pleistocene Glaciation – Cenozoic oil bearing formations of India.

### **PALAEONTOLOGY**

Definition of Palaeontology – organic world- Animal Kingdom – classification of animals – Habitates and Habits of animals. Definition of fossils – nature and modes of preservation of fossils : Unaltered hard parts : Altered hard parts : Petrification, permineralisation, carbonisation, recrystallisation, silicification , mould, casts, tracks , trails, borings, uses of fossils – stratigraphic indicators – climatic indicators- indicators of palaeogeography – indicators of evolution and migration of life forms – indicators of new deposits of coal and petroleum – life through ages.

Phylum protozoa – Order: Foraminifera: General morphology – chitinous test – septa, arrangement of chambers, suture, aperture , dimorphism – classification , geological history and stratigraphic importance. An outline of the uses and applications of Micro palaeontology. Phylum coelenterata – class Anthozoa – zoological features – General morphology: corallum, corallite , theca , chambers, septa, fossula, columella, septal developments, classification – tabulate corals – Rugose corals evolution geological distribution – stratigraphic importance.

Sub phylum Hemichordata – class Graptozoa: order Dendroidea and Graptoloidea – general morphology , rhabdosome, stipe , theca , common canal , nema , virgula , sicularia , angle of divergence, central disc, uniserial, biserial, classification, geological distribution and stratigraphic importance. Phylum mollusca: Class Pelecypoda:- General characters – umbo, Hinge line – ligament – lunule and escutcheon – adductor impressions, pallial line, pallial sinus, dental patterns, ornamentation, classification, geological history. Class Gasteropoda:- General

morphology, shell forms, whorl, spire, spiral angle, suture, aperture, columella, umbilicus, peristome, aperture, (Holostomatus and siphonostomatus) – types of coiling – Dextral and sinistral – ornamentation, classification and geological history.

Class Cephalopoda:- General morphology, siphuncle, septa, septal necks, connecting rings, chambers, suture lines, (Nautilitic, Goniatitic, Ceratitic and Ammonitic) – shell forms – ornamentation – classification evolution, geological history- morphology of a Belemnite shell.

Phylum Brachiopoda:- General morphology, umbo, hinge line, pedicle opening, delthyrium, deltidium pseudo deltidium – Brachial skeleton – morphometric details, ornamentation, classification, geological history. Phylum Echinodermata: - Class Echinoidea:- General morphology, periproct, apical system (Anus, ocular plates, Genetal plates, madriporic plates), corona (Ambulacra, inter ambulacra) – peristome – Regular and irregular echinoids – classification – geological history. Class crinoidea:- General morphology, calyx, dorsal cup, (Radicals, basals, intrabasals), arms, stem, classification, geological history. Class Blastoidea: - General morphology – calyx, dorsal cup (Basals, radials, deltoids, ambulacra). Brachioles, cicatrix, geological history. Phylum Arthropoda:- Class – Trilobita- General morphology: Cephalon: glabella, facial suture, free cheek, fixed cheek, genal angle, genal spine, cranidium; thorax – pygidium – classification – geological history. A brief outline of the classification of vertebrates. A short account of Devonian fishes, Mesozoic Reptiles, Siwalik mammals. General classification of plant kingdom – plant fossils from India – A brief account of the following plant fossils :- Glossopteris, Gangamopteris, Ptilophyllum, Calamites, Lepidodendron and Sigillaria.

## **STRUCTURAL GEOLOGY & GEO TECTONICS**

Introduction to Structural Geology. Methods for representing relief features; contours, topographic and geologic maps- their preparation and uses, geological surface and their attitudes- Dip and strike- trend of outcrops- rules of V – relation between true dip and apparent dip-width of outcrops; true thickness and vertical thickness and their mutual relation. Uses of clinometers and Brunton compass. Rock deformation-uniform pressure- differential pressure- stress and strain, types of stress-type of strain -stress strain diagram. Stages of deformation, mechanism of elastic, plastic and brittle deformation. Folds: Geometry and elements of folded surface-classification-descriptive study of different types of folds- recognition in the field and on the maps. Fault: Definition, terminology, classification, description and recognition in the field and on the map. Joints: Definition, classification, descriptive study and geological significance of joints. Foliation and lineation- primary and secondary and their types. Unconformities: Definition, and types, significance and recognition in the field and on the maps. overlaps-overlaps and offlaps, outlier and inlier. Plate tectonics: Basic concepts and definition. Types of plate margins. Important character of plate margins- divergent, convergent and transform plate margins. Triple junctions, Benioff zones, plate tectonic models for the origin of mountain belts. Island arcs, rift valleys, mid oceanic ridges, oceanic trenches, transitional faults and shield areas. A review of various tectonic hypotheses: Continental drift, Sea floor spreading, polar wandering, paleomagnetism, mantle plumes, hot spots. Tectonics of Indian subcontinent: Major structural trends in the peninsular India, Indoganggetic and extra peninsula.

## **ECONOMIC GEOLOGY**

Historical development of economic Geology. Geochemical distribution of elements. Materials of mineral deposits – ore minerals, gangue minerals, tenor and grade of ores, ore shoots and bonanzas. Classification of mineral deposits. Outline of Lindgren's and Bateman's classification-

Syngenetic and epigenetic deposits. Controls of ore localization – structural, stratigraphic, physical and chemical. Brief study of metallogenic epochs and provinces – geologic thermometers.

Magmatic processes. – mode of formation – Early magmatic processes and deposits, disseminations, segregations and injections – Late magmatic processes and deposits – Residual liquid segregation and injection – immiscible liquid segregation and injection – sublimation. Contact Metasomatic processes – the process and effects – resulting mineral deposits. Hydrothermal processes – principles – Factors affecting deposition – wall rock alteration – minerals sequence – cavity filling deposits Fissure veins, shear – zone, stock-work, saddle reef, ladder vein, fold cracks, breccia filling, solution cavities, pore space and vesicular filling – replacement deposits- process and deposits – criteria of replacement. Sedimentary processes and cycles – principles involved in sedimentation – cycles of Iron and manganese, weathering processes – principles- Residual concentration process and deposits – mechanical concentration principles – eluvial, alluvial, beach and eolian placers. Oxidation and supergene sulphide enrichment – solution and deposition in the zone of oxidation – secondary sulphide enrichments – Gossans and capping. Metamorphic processes – Formation of Graphite, Asbestos, Talc, Soapstone and Sillimanite group of minerals. Diagnostic physical properties, chemical composition, uses, modes of occurrence and distribution in India of the following:

- 1) Economic Minerals- Gold, Silver, Copper, Lead, Zinc, Iron, Manganese, Chromium, Tin, Aluminium
- 2) Radioactive metals - Thorium, Uranium, Titanium.
- 3) Industrial Minerals- Asbestos, Barite, Graphite, Gypsum and Mica.
- 4) Abrasives- Diamond, Corundum, Emery garnet, Abrasive sand, Tripoli, Pumice, Sand feldspar, Limestone, Clay, Talc etc.
- 5) Refractories- fireclay, graphite, Dolomite and sillimanite group of minerals, diaspore, pyrophyllite, zircon etc
- 6) Ceramic minerals- Clay, Feldspar, Wollastonite,
- 7) Gemstones.

Fossil fuels – coal and lignite – uses, classification, constitution, origin and distribution in India. Petroleum- composition, uses, theories of origin, oil traps, and important oil fields of India. A brief account of mineral deposits in Kerala. Significance of minerals in National Economy. Strategic, critical and essential minerals.

## **IGNEOUS PETROLOGY**

Definition of Petrology – Earth zones. Composition and constitution of magmas – Primary and Parental Magmas. Forms of Intrusive igneous rocks: Concordant forms - Sill, Laccolith, Lopolith and Phacolith, Discordant forms - Dykes, Cone Sheets, Volcanic neck, Ring dyke, Batholiths, Stocks, Bosses and bysmaliths. Forms of Extrusive igneous rocks: Lava flows, Pyroclastic deposits - Agglomerate, Lapilli, volcanic ash and volcanic froth. Structures vesicular and Amygdaloidal structures – block lava – Ropy lava – pillow structure – flow structure – sheet joints- mural jointing – columnar jointing – rift and grain. Textures: Definition and description - crystallinity: crystallites and microlites – Devitrification – Granularity – shapes of crystals , mutual relations – Equigranular textures: allotriomorphic hypidimorphic, Panidiomorphic. inequigranular Textures: porphyritic and Intergrowth texture – Trachytic texture – Intergrowth texture strctures orbicular structure Spherulitic structure – Perlitic fracture. , Directive textures, Overgrowth textures, Reaction textures - Micro Structures Classification: bases of classification

– Genetic classification – classification based on colour index – based on the proportion of Alkali to plagioclase feldspars – based on silica saturation – based on alumina saturation – A short account of CIPW classification, Normative minerals, salic and femic groups – Merits and defects of CIPW classification – Tyrrel's tabular classification – IUGS classification Crystallization of Unicomponent magma – Crystallization and petrogenetic significance of Binary magmas: Diopside – Anorthite Eutectic system, Albite – Anorthite Solid-Solution system, Forsterite – Silica incongruent melting system and Ternary system (Ab–An–Di). Reaction principle and Bowen's reaction series - Causes for the diversity of Igneous rocks – Magmatic Differentiation: Fractional Crystallization, Liquid immiscibility, Assimilation - Short notes on: Consanguinity, Variation diagrams and petrographic provinces. Study of Texture, Mineralogy, Classification, and Modes of occurrence of Granite, Granodiorite, Syenite, Diorite, Gabbro with their hypabyssal and volcanic equivalents. Petrographic characters and origin of Pegmatites, Lamprophyres, Alkaline rocks, Dunite, Peridotite and Anorthosites.

### **SEDIMENTARY & METAMORPHIC PETROLOGY**

Sedimentary process: disintegration & decomposition of rocks – transportation – deposition – diagenesis. A broad classification of sedimentary rocks into residual, mechanical, chemical and organic Groups. Structures of sedimentary rocks – mechanical, chemical and organic structures. Textures of sedimentary rocks – clastic and non – clastic textures. Residual deposits – terra rossa, clay, laterite and bauxite and soils. Mechanical deposits – rudaceous, arenaceous and argillaceous groups. Heavy minerals in sand and sandstones. A descriptive study of Conglomerate, Breccia, Sandstones and Shales. Chemical deposits – siliceous, carbonaceous, ferruginous and salt deposits. organic deposits – calcareous, siliceous, phosphatic, ferruginous and carbonaceous deposits. A brief study of Flint, Chert, Siderite, Gypsum, Rock Salt, Caliche, Guano and Kiesellgher. Descriptive study of different types of calcareous and carbonaceous deposits. Definition of metamorphism – Agents and kinds of metamorphism – facies, zones and grades of metamorphism – metamorphic structures and textures. cataclastic metamorphism and its products. Retrograde metamorphism. Thermal metamorphism of pelitic sediments, pure and impure calcareous rocks. A brief study of Breccia, Flaser, Mylonite, Hornfels, Marble, Ophicalcite. Dynamothermal metamorphism of pelitic sediments. plutonic metamorphism petrography and origin of charnockites – metamorphic differentiation – pneumatolitic and injection metamorphism – anatexis and palingenesis. Brief study of Slate, Phyllite, Quartzite, Schist. Gneiss, Granulite, Leptynite, Charnockite, Eclogite, Amphibolite, Schorl, Adinole, Lit-Par- Lit – gneiss and Migmatite.