Entrance Test Syllabus based on UG Syllabus for M. Sc Applied Geology (2023)

Unit-1. Fundamentals of Geology (4 Marks)

Introduction to the science of geology: Definition, branches, scope and importance, History of Geology; Modern theories about the origin of solar system; Origin of the Earth. Relation with other branches of sciences; Role of physics, chemistry and paleo-biology in the development of ideas about earth. Role of Physics in crystallography, gravity, geomagnetism, isostasy, earthquakes and microscopy. Role of Chemistry in chemical bonds, crystal chemistry, solution chemistry, chemical energetics.
Introduction to rocks and minerals: Rocks as natural mineral aggregates; types of rocks: igneous rocks; sedimentary rocks; metamorphic rocks. Preliminary knowledge about the most common rock forming and economic minerals. Structure of earth: physical properties. Surface relief of the earth. Exogenous and endogenous processes. Various Geospheres. Fundamental concepts: Catastrophism, uniformitarianism, cycle of erosion, and base level of erosion. Weathering: definition and types, agents of weathering. Products of weathering. Epeirogenesis and orogensis. Mountains and types. Volcanoes: types, distribution and eruptional features. Glaciers: Definition and types, snowline, glacial movements and crevasses. Geological work of glaciers: Erosion and deposition. Aeolian processes: erosional and depositional features.
Geological work of river: erosional and depositional features. Drainage patterns. Karst topography: Surface and sub-surface features. Structural landforms: Definition and types, Inversion of topography. Climate and landforms. Soils: Soil formation, Soil profiles. Oceans: Topography of sea floor. – Continental shelves, slope, abyssal plains, Ocean ridges and, submarine valleys, canyons, deep-sea trenches and guyots. Oceanic erosion and deposition. Coral reefs and types.

Unit-2. Mineralogy and Crystallography (4 Marks)

Mineralogy: Definition, scope and classification of silicate minerals and ore forming minerals.Scalar and vector properties of minerals. Moho's scale of hardness. Physical properties and modeof occurrence: Quartz, Feldspar, Mica, Amphibole, Pyroxene, Olivine, Garnet, Chlorite, andCarbonate. Optical Mineralogy: Polarizing microscope, mechanism of polarization andinterference of light, use of accessory plates. Elements of optics, isotopic medium, anisotropicmedium, refractive index, Snell's law of critical angle, Optical indicatrix: isotropic, uniaxial andbiaxial. Pleochroism and Birefringence. Optical properties of minerals under plane-polarized andcross-polarized light: Forms, cleavage, fractures and parting, refractive index and relief, Becke lineand its use.
Crystallography: Introduction, and Morphology of crystals: Face, edge and solid angle, interfacial angle and Law of constancy of interfacial angles. Description of Laws governing the crystallography. A brief idea of Symmetry and Lattice: Bravias Lattices, symmetry operations, Crystal Systems, crystal forms, crystal classes. Axial system and axial ratios. Parameter system of Weiss, Miller indices. Law of Rationality of indices. Translation vectors, planar and space lattices. Crystal growth and twining: Growth of crystals from melt and solutions, and twining in crystals: Types, causes and laws, Normal class of crystal systems. Crystal forms: Crystallized, crystalline, cryptocrystalline and amorphous. Crystal habit: elongated, tabular, flattened and equant. Description of form of crystalline and cryptocrystalline aggregates. Crystal chemistry: Dimorphism, polymorphism, pseudomorphism, isomorphism and solid solution.

Unit-3. Igneous Petrology(4 Marks)

Nature and scope of petrology: Difference between Petrography and petrogenesis. Structure of igneous rocks: Large structures- blocky lava, amygdaloidal lava, and vesicular structures, pillow structures, flow structures, sheet and platy structures, prismatic and columnar structures. Textures: Crystallinity,

granularity (phaneric and aphanitic), shapes of crystals, mutual relations of crystals, equigranular and unequigranular textures, porphyritic, poikilitic, opthitic, intersertal andintergranular textures, directive textures, intergrowth textures. Reaction textures. Reaction structures – corona and kelyphitic borders. Classification of igneous rocks: Principles of classification, CIPW classifications, IUGS classification and tabular classification. Nomenclature and description of common igneous rocks Composition and constitution of magma: Definition of magma, composition of magma, types of magma, physico-chemical constitution of magma, primary magma. Processes resulting in diversity in igneous rocks: Fractionation and differentiation–Gravity settling, filter-press differentiation, flow diffusion and gaseous transfer within magma; liquid immiscibility, mixing of magmas. Assimilation.

Unit-4. Metamorphic petrology and sedimentology(4 Marks)

Metamorphic rocks: Definition of metamorphism; Controls of metamorphism–bulk composition and motivating forces in metamorphism- heat, pressure and chemically active fluids. Types of metamorphism–Contact, cataclastic, regional. Metasomatism, anataxis, palingenesis, migmatization. Metamorphic facies. Metamorphic textures and structures. Sedimentary rocks: Process involved in formation of sedimentary rocks: erosion, transportation, deposition, diagenesis and lithification. Texture: size, roundness, sphericity, surface texture fabric, porosity and permeability. Gran size analysis, grade scale, sieving method: types, use and methods. Sedimentary Structures: Primary, secondary and biogenic. Major primary structures: cross bedding, cross lamination, horizontal bedding, graded bedding, sole marks, ripple marks, rain prints and dunes. Classification of clastic and non-clastic rocks: Rudaceous, Arenaceous, Argillaceous and calcareous.

Unit-5. Palaeontology and Stratigraphy(4 Marks)

Palaeontology: Origin and evolution of the life through ages; Geological time scale; Preliminary idea about faunal succession. Fossils, their characters, conditions necessary for fossilization; types of preservation and occurrence. Application of Paleontology. Evolution of Man, Horse &Elephant. Morphology characters, geological, geographical and stratigraphic distribution of the following: (1) Brachiopoda (2) Bivalvia (3) Gastropoda (4) Cephalopoda (5) Graptoloida (6) Anthozoa (7) Echinoidea (8) Trilobita. Introduction to micropaleontology and microfossils and their application. Elementary ideas aboutForaminifera, Ostracoda, Radiolarian and Conodonts. Elementary concept of vertebrate Paleontology with special reference to Siwaliks. Introduction to Paleobotany with special reference to Gondwana plant fossils. Extinction of organisms with special reference different hypothesis for the extinction of dinosaurs. Introduction to Palynology and its applications. Application of Paleontological data in paleogeographic reconstructions. Palaeontological evidence in favour of continental drift.Stratigraphy: introduction, nomenclature and Principles. Stratigraphic correlation; imperfection of geological record. Brief introduction to Precambrian rocks of India; Dharwar, Aravalli, Cuddapah, Vindhyan and Himalayas with special emphasis to the classification, distribution, lithology and economic deposits. Stratigraphy of Phanerozoic rocks with reference to the lithology and fossil content. Palaeozoic succession of Kashmir, Triassic of Spiti, Jurassic of Kuch, Cretaceous of Tiruchirappalli. Stratigraphy of Siwaliks and Karewas of Kashmir.

Unit-6. Geochemistry(4 Marks)

Introduction to geochemistry: Crystal chemistry-chemical bonds, coordination number, radius ratio, ionization potential, electro-negativity, atomic substitution, phase rule. Cosmic abundance of elements. Major element, trace elements and Rare earth elements, Large ion lithophile elements and High field strength elements. Gold Schmidt’s geochemical classification of elements. Geochemical characteristics of crust, mantle and core. Geochronology and age of Earth. Relative and absolute dating techniques for age

determination. Applications of stable isotopes to investigating volcanism (5), metamorphism and meteoric-hydrothermal systems. Concepts of mass-balance, mixing theory, and open and closed systems.

Unit-7. Geophysics and Seismology(4 Marks)

Introduction and scope of geophysics, Spheroidal shape of earth and Geoid, magnetic field of theearth, Paleomagnetism, Exploring Earth's interior with geophysical techniques. Applications ofgeophysics in mineral and energy resources exploration. Earth's thermal history: Heat conductionand heat flow. Thermal gradient of the earth. Convection currents-evidence and models.Gravitational Field: Concept, its variability with latitude, altitude, topography, and subsurfacedensity variations. Gravity instruments: Pendulum gravimeters, Ship borne measurements. Units ofgravity, gravity anomaly - definition, types (Free- air, Bouguer), local and regional concepts.Detection of cavities at engineering sites. Isostasy: Observation; Pratt and Airy schemes of theisostatic compensation, elastic crust on viscous mantle.

Seismology: Earthquake and Seismic waves, effects of seismic waves and damage to structuresand natural objects. Basic features of seismographs; Magnitude and intensity of an earthquake.Types of earthquakes: tectonic and volcanic. Induced seismicity, Neotectonics. Elastic reboundtheory - statement and geodetic evidence. Earthquake location: Focus, epicentre and hypocenter;Earthquake belts; Focal depth of earthquakes. Earthquake focal mechanisms - how these areobtained. Seismic wave reflection and refraction. Structure of the Earth: Crust, mantle; Outer core,inner core; wave speed and density distribution. Earthquake Prediction: Need, definition,possibility, results; Seismic gap theory.

Unit-8. Hydrogeology and Medical Geology (4 Marks)

Hydrosphere: Distribution of water: Saline water and fresh water. Forms and origin of water. Surface water (hydrology) and subsurface water (soil water and ground water). Porosity: Primary and secondary: specific yield and specific retention. Aquifer, aquitard, aquiclude, aquifuge. Types of aquifers: unconfined, confined and perched aquifers. Hydraulic conductivity and storativity. Darcy's Law, Understanding the transport and purification of water through Hydrological cycle. Physico-chemical quality of water (pH, EC, Ca, Mg, Na, K, Cl, HCO_3, SO_4, NO_3).

This course introduces students to the basic concepts of Medical Geology, interaction betweenabundances of elements and isotopes and the health of humans and plants. The public healtheffects of Earth materials and geological processes, medical impacts of water quality,biogeochemical interactions and nutrient anomalies, anthropogenic degradation of geologicalenvironments, application of geochemistry to environmental health issues, geospatial analysisas a tool in epidemiology, health hazards associated with volcanic eruptions, global dust fluxand respiratory problems, impacts of radon-arsenic-selenium-mercury-iodine, uranium onphysiological function, carcinogenic associations with coal and fibrous minerals,geological effects on animal health, and geophagy (human ingestion of soil materials as a dietarysupplement).

Unit-9. Structural geology (4 Marks)

Basic concepts of field geology: Maps–definition, topographic and geological maps. Dip andstrike of stratified rocks, True dip, apparent dip, plunge and pitch of linear structures. Outcroppatterns. True thickness and vertical thickness. Width of the outcrop, relation between truethickness and the width of outcrop. Criteria for distinction between normal and overturnedsequences: ripple marks, cross bedding, graded bedding, mud cracks, rain-imprints, Pillow lava,vesicular tops of lava beds, Relationship of cleavage with bedding, Paleontological methods. Folds: Definition and classification (geometrical); fold parameters/components. Unconformities:Definition, types of unconformities. Criteria for recognition of unconformities. Concordant pluton:sills, laccoliths, lopoliths, and phacoliths. Discordant pluton: dykes, volcanic vents, ring dykes.Joints- Morphology and classification (Geometrical). Foliation: Definition and classification;Schistosity, gneissosity, slaty cleavage. Lineation: Definition and classification, slickenside,mineral lineation Cleavage/ bedding intersections, pucker lineation, pitch and swell,

boudinage,quartz roding and mullion. Faults: Definition, terminology and classification (geometrical). Criteria for recognition of faults:discontinuity of structures, repetition and omission of strata, features characteristic of fault plane:slickenside, gouge, fault breccias, mylonites, silicification and mineralization, differences insedimentary facies. Physiographic criteria: scraps, triangular facets.

Unit-10. Plate tectonics(4 Marks)

Important concepts about Earth dynamics: outline description of Contraction, Expansion, Plate tectonic models. Plate tectonics - basic concepts and definitions, types of plate margins, important characters of plate margins. Mechanism of plate movement; Mantle plumes vis-à-vis island chains. Plate tectonics in relation to the distribution of seismic, volcanic and island arc belts. Plate tectonic models for the origin of mountain belts: Ocean-ocean, ocean-continent, Continent-Continent types of convergent boundaries. Northward movement of the Indian Plate and the origin and evolution of the Himalayas and its thrust belts. Seismicity of the Indian subcontinent.

Unit-11. Engineering and Environmental Geology(4 Marks)

Basics of Engineering Geology: Engineering properties and classification of rocks. Factors affectingengineering properties of rocks. Importance of geological studies to Engineers and significance ofgeological Investigations for civil engineering projects. Rock stability tests. Engineering properties ofsoils. Geology for Site selection and construction of roads, buildings, dams, bridges, Tunnels, andreservoirs. Mass movements. Earthquakes, Soil liquefaction, creep and seismic zones of India. Environmental Geology. Soils: soil formation, types of soils, soil degradation. Environmentalchanges due to influence of humans. Explain the causes of soil, air and water pollution. Surface processes and erosion. Deforestation and land degradation. Geology of Mineral Resources,Mineral Resources and the Environment. Minerals and Human Use, Waste disposal, WasteManagement and Geology.

Unit-12. Economic Geology(4 Marks)

Ore minerals and gangue. Concept of Metallogenic Epochs and provinces. Classification of minerals deposits – genetic and associational parameters. Magmatic deposits; Hydrothermal deposits with reference to: a) Porphyry copper deposit b) Vein deposits of tin and tungsten. Formation of pegmatite and pegmatite deposits in India. Oceanic mineral resources (manganese nodules). Ores formed by metamorphic processes.Supergene enrichment deposits. Placer & residual deposits. Mode of occurrence of followingminerals deposits in India: Banded iron formation, Gold, Thorium, Mica, Bauxite and Tungstendeposits. Origin of Petroleum – Organic versus inorganic theories, transformation of organic matter intopetroleum (geochemical aspects, pressure, temperature, depth of occurrence). Limiting conditionsof petroleum occurrence. Reservoir rocks – definition and types. Source rocks; definition andtypes. Migration and accumulation of petroleum: primary and secondary migration. Reservoir Traps, classification (structural, stratigraphic). Cap rocks – types. Coal; Introduction;Constituents of coal: Rank and grade of coal; Varieties of coal (physical and chemical characters);Origin of coal. Distribution of Coal in time and space.

Unit-13. Remote sensing and Societal Geology(4 Marks)

Remote sensing: Concept and foundation of RS (Electromagnetic spectrum, radiation laws). Overview of RS technology. Landsat, IRS, SPOT, MODIS. Introduction to Microwave remotesensing and its applications. Interaction of Electromagnetic waves with Earth surface features(water, soil, rocks, and vegetation). Photo-geology and its applications. Spectral behaviour of different soils. Mapping of soil – erodedand non-eroded soil and degraded lands. Application of remote sensing: geomorphologicalmapping, land use/land cover mapping. Introduction to GIS and its applications. Digital

terrainanalysis using DEM data: Path analysis, network applications and morphometry; Introduction toGIS models and modelling. Societal Geology: Fundamental concept (environment, population needs and planning). NaturalHazards: Landslides: Slope stability, causes of landslides, anthropogenic activity and landslides,prevention and correction of landslides. Landslide hazard mapping. Earthquakes; Scale of intensity related damage, preventive measures. Seismic hazard zonation.Floods: magnitude and frequency of floods, urbanization and flooding, nature and extent of floodhazard. Coastal hazards: tropical cyclones, tsunamis and coastal erosion.

Unit-14. Oceanography and Marine Geology(4 Marks)

Physical oceanography, ocean salinity, ocean currents, El-Nino-La Nino effect relation between climate and ocean in the Indian context, Exclusive economic zones and their economicpotential, Principles behind echo sounder and side scan sonar systems and seismicmethods, Physiographic divisions of oceans, Origin, stricter and evolution of Indian Oceanshelf and margins (estuaries, deltas, tidal flats). Approach to be interdisciplinary requiringintegration of biological, chemical, physical and geological processes. Past historical impact ofsea level changes, coastal erosion and conservation methods, Coastal Regulatory Zones.

Unit-15. Mining and Mineral Exploration (4 Marks)

Geology in mining industry, Tenor and Grade: definition, meaning and specification, mineral exploration: sequence and phases, methods of exploration, float ores and in situ ores, Gossan, Pits, Trenches and Boreholes, core drilling, equipment and accessories, Core drill sampling, core splitting, logging, storage, sludge, combining Assay returns from sludge and core. Calculation of Specific gravity, Porosity, Bulk density, compression factor, Sampling Principle, Methods, Size and quantity, Reduction, Errors, Sampling practices in open-cast mining.Categories of reserves, estimation of reserves, cross-sectional method, area of influence method, triangular method, and weighted volume estimate method, Classification of mining methods, Factors influencing choice of mining method, Open cast mining, Underground mining, Coal mining methods, Ore Dressing or Beneficiation, Brief outline of Mining Acts and Regulations in India, Conservation of mineral resources.

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