

SYLLABUS GEOLOGY

MINERALOGY

Concept of point group, space group, reciprocal lattice, diffraction and imaging. Concepts of crystal field theory and mineralogical spectroscopy. Lattice defects (point, line and planar). Physical, Electrical, magnetic and optical properties of minerals. Bonding and crystal structures of common oxides, sulphides, and silicates. Transformation of minerals - polymorphism, polytypism, and polysomatism. Solid solution and exsolution.

IGNEOUS AND METAMORPHIC PETROLOGY

Steady-state geotherms. Genesis, properties, emplacement and crystallization of magmas. Phase equilibrium studies of simple systems, effect of volatiles on melt equilibria. Magma mixing, mingling and immiscibility. Classification, texture and structures of Igneous rocks. Metamorphic Structures and Textures; Isograds and Facies. Mineral reactions with condensed phases, solid solutions, mixed volatile equilibria and thermobarometry. Metamorphism of pelites, mafic ultra-mafic rocks. Material transport during metamorphism. P-T-t path in regional metamorphic terrains, plate tectonics and metamorphism. Petrogenetic aspects of important rock suites of India, such as the Deccan Traps, layered intrusive complexes, anorthosites, carbonatites, charnockites, khondalites and gondites. Classification, texture and structure of Metamorphic rocks.

STRUCTURAL GEOLOGY AND GEOTECTONICS

Theory and strain. Behaviour of rocks under stress. Mohr circle. Different types of failure and sliding criteria. Geometry and mechanics of fracturing and conditions for reactivation of pre-existing discontinuities. Paleostress analyses. Common types of finite strain ellipsoids. Techniques of strain analysis. Progressive strain history and methods for its determination. Deformation mechanisms. Role of fluids in deformation processes. Geometry and analyses of brittle ductile and ductile shear zones. Sheath folds. Geometry and mechanics of development of folds, boudins, foliations and lineations. Fault-related folding. Gravity induced structures. Major tectonic features and associated structures, extensional-, compression-, and strike-slip-terrains and relevance to plate boundaries.

APPLIED PALEONTOLOGY

Theories of origin of life. Organic evolution - Punctuated Equilibrium and Phyletic Gradualism models. Mass extinctions and their causes. Application of fossil in age determination and correlation. Paleocology, Life habitats and various ecosystems, Paleobiogeography. Modes of preservation of fossils and taphonomic considerations. Type of microfossils. Environmental significance of fossils and trace fossils. Use of microfossils. Application of Micropalaeontology in hydrocarbon exploration. Oxygen and Carbon isotope studies of microfossils and their use in paleoceanographic and paleoclimatic interpretation. Important invertebrate fossils, vertebrate fossils, plant fossils and microfossils in Indian stratigraphy.

SEDIMENTOLOGY

Clastic sediments- gravel, sand and mud; biogenic, chemical and volcanogenic sediments. Classification of conglomerates, sandstones and mudstones, and carbonate rocks. Flow regimes and processes of sediment transport. Sedimentary textures and structures. Sedimentary facies and environments, reconstruction of paleoenvironments. Formation and evolution of sedimentary basins. Diagenesis of siliciclastic and carbonate rocks.

PHYSICAL GEOLOGY

Milky Way and the solar system. Modern theories on the origin of the Earth and other planetary bodies. Earth's orbital parameters, Kepler's laws of planetary motion, Geological Time Scale; Space and time scales of processes in the solid Earth, atmosphere and oceans. Age of the Earth. Basic principles of stratigraphy. Theories about the origin of life and the nature of fossil record. Earth's gravity and magnetic fields and its thermal structure: Geoid, spheroid; Isostasy. Physiography of the Earth; weathering, erosion, transportation and deposition of Earth's material; formation of soil, sediments and sedimentary rocks; energy balance of the Earth's surface processes; Basic concepts of seismology and internal structure of the Earth. Physico-chemical and seismic properties of Earth's interior. Behaviour of rocks under stress; Folds, joints and faults. Earthquakes - their causes and measurement. Interplate and intraplate seismicity. Paleomagnetism, sea floor spreading and plate tectonics. Development in geomorphology. Historical and process Geomorphology. Landforms in relation to climate, rock type, structure and tectonics. Processes - weathering, pedogenesis, mass movement, erosion, transportation and deposition. Geomorphic processes and landforms - fluvial, glacial, eolian, coastal and karst. River forms and processes - stream flow, stage-discharge relationship; hydrographs and flood

frequency analysis. Submarine relief. Geomorphology and topographic analysis including DEM, Environmental change- causes, effects on processes and landforms.

OCEANOGRAPHY AND METEOROLOGY

Morphologic and tectonic domains of the ocean floor. Structure, composition and mechanism of the formation of oceanic crust. Seawater-basalt interactions. Ocean margins and their significance.

Ocean Circulation, Coriolis effect and Ekman spiral, convergence, divergence and upwelling, El-Nino. Thermohaline circulation and oceanic conveyor belt. Formation of Bottom waters; major water masses of the world's oceans. Oceanic sediments: Factors controlling the deposition and distribution of oceanic sediments. diagenetic changes in oxic and anoxic environments. Tectonic evolution of the ocean basins. Mineral resources.

Paleoceanography – Approaches to paleoceanographic reconstructions; various proxy indicators for paleoceanographic Interpretation. Joint Global Ocean Flux Study (JGOFS) and its applications in Paleoceanography. Ocean Drilling Programme and its major accomplishments in paleoceanography. Opening and closing of ocean gateways and their effect on circulation and climate during the Cenozoic. Sea level processes and Sea level changes. Cenozoic. Sea level processes and Sea level changes.

GEOCHEMISTRY AND GEOPHYSICS

Structure and atomic properties of elements, the Periodic Table; ionic substitution in minerals; Phase rule and its applications in petrology, thermodynamics of reactions involving pure phases, ideal and non-ideal solutions, and fluids; equilibrium and distribution coefficients. Nucleation and diffusion processes in igneous, metamorphic and sedimentary environments, redox reactions and Eh~pH diagrams and their applications. Radioactive decay schemes and their application to geochronology and petrogenesis. Stable isotopes and their application to earth system processes. Geochemical cycles. Plate Tectonics and Geodynamics, Seismology & Tomography, Gravity and Magnetic Methods, Electrical and Electromagnetic Methods, Seismic Methods, Well logging and other methods.

ECONOMIC GEOLOGY:

Magmatic, hydrothermal and surface processes of ore formation. Active ore-forming systems, methods of mineral deposit studies including ore microscopy and fluid inclusion, ores and metamorphism- causes and effect relationships. Characteristics, and genesis of ferrous, base and noble metals. Origin, migration and entrapment of petroleum; properties of source and reservoir rocks; structural, stratigraphic and combination traps. Methods of petroleum exploration. Petroliferous basins of India. Origin of peat, lignite, bitumen and anthracite. Classification, rank and grading of coal. coal resources of India. Gas hydrates and methane. Nuclear and nonconventional energy resources.

PRE - AND POST- CAMBRIAN GEOLOGY

Recent developments in stratigraphic classification. Code of stratigraphic nomenclature - Stratotypes, Global Bound Stratotype Sections and Point (GSSP). Lithostratigraphic, Chronostratigraphic and Biostratigraphic subdivisions. Methods of stratigraphic correlation including Shaw's Graphic correlation. Concept of Sequence Stratigraphy. Unconformities. Facies concept in Stratigraphy . Walther's law. Methods for paleogeographic reconstruction. Phanerozoic stratigraphy of India with reference to the type areas. their correlation with equivalent formations in other regions. Boundary problems in Indian. Evolution of lithosphere, hydrosphere, atmosphere, biosphere, and cryosphere; lithological, geochemical and stratigraphic characteristics of granite - greenstone and granulite belts. Stratigraphy and geochronology of the cratonic nuclei, mobile belts and Proterozoic sedimentary basins of India. Life in Precambrian. Precambrian - Cambrian boundary. Palaeozoic, Mesozoic and Tertiary Geology with special reference to India. Definition of Quaternary. Quaternary Stratigraphy - Oxygen Isotope stratigraphy, biostratigraphy and magnetostratigraphy. Quaternary climates glacial-interglacial cycles, eustatic changes, proxy indicators of paleoenvironmental/ paleoclimatic changes, wetland, ocean and cryosphere (ice core studies). Quaternary dating methods, -radiocarbon, Uranium series, Luminescence, Amino-acid, relative dating methods. Quaternary stratigraphy of India- continental records (fluvial, glacial, aeolian, palaeosols and duricrust; marine records; continental-marine correlation of Quaternary record. Evolution of man and Stone Age cultures. Plant and animal life in relation to glacial and interglacial cycles during Quaternary. Tectonic geomorphology, neotectonic, active tectonic and their applications to natural hazard assessment.

APPLIED GEOLOGY

(i). Remote Sensing and GIS: Elements of photogrammetry, elements of photointerpretation, electromagnetic spectrum, emission range, film and imagery, sensors, geological interpretations of air photos and imageries. Global positioning systems. GIS- data structure, attribute data, thematic layers and query analysis.

(ii). Engineering Geology: Engineering properties of rocks and physical characteristics of building stones, concretes and other aggregate. Geological investigations for construction of dams, bridges, highways and tunnels. Remedial measures. Mass movements with special emphasis on landslide and causes of hillslope instability. Seismic design of buildings.

(iii) Mineral Exploration: Geological, geophysical, Geochemical and geobotanical method of surface and sub-surface exploration on different scales, sampling, assaying and evaluation of mineral deposits.

(iv) Hydrogeology; hydrogeology of Rajasthan, hydrogeology of arid zones and wetlands Hydrostratigraphic units. Ground water quality, various estimation and treatment methods for its use for different purposes (drinking, agricultural, industrial). Groundwater quality map of India, water contaminants and pollutants, Problems of Arsenic and fluoride; Calculation of groundwater velocity, amount of inflow and outflow, permeability (hydraulic conductivity), transmissivity and storage coefficient.