

EARTH SCIENCES

UNIT-1 : MINERALOGY

Descriptive Mineralogy: Study of the physical properties of the following groups in detail. Native elements, sulphides, tellurides, arsenides, antimonides, sulphosalts, haloids, oxides, Oxygen salts, carbonates, silicates, metasilicates, disilicates, chlorite, serpentine, kaolin, talc and titanosilicates, niobates phosphates, arsenates, vanadates, antimonates, borates, uraninites, sulphates, chromite, tellurates, tungstates, molybdenite mineral fuels. (Unit cell formulae calculations of minerals: garnets, amphiboles, and pyroxene) and its application (Plotting on various diagrams, type structure building models). Measures and identification of X-ray powder patterns of typical minerals. Unit cell calculation from X-ray powder patterns.

Optical Mineralogy: Identification of minerals under polarizing microscope. Optical Indicatrix. Pleochroic scheme of minerals, birefringence by Michael; Levy chart, Berek compensator: interference figures Uniaxial and biaxial: R.I determinations-Seck's method in thin sections: 4 axes Universal stage (description and application, measurement of 2ψ)

UNIT-2 : PETROLOGY

Definition and relationship of petrology with other branches, Branches of petrology - Petrography and Petrogenesis. Classification of Rocks based on Origin. Igneous, Sedimentary and Metamorphic rocks.

2. Igneous Petrology: a) Forms of Igneous rocks - Extrusive and Intrusive forms. Concordant types - sill, loccolith, phaccolith and Lopolith: Discordant types - Dykes, Stock, Boss and Batholith. b) Structures of lava flows - Vesicular, Amygdaloidal, Blocky, Ropy, pillow and Columnar. c) Textures, Definition, Factors controlling textures - types - Equigranular and Unequigranular - Porphyritic, poikilitic, Ophitic and Basaltic. 3. Sedimentary Petrology: a) Sedimentation - Weathering, Transportation, Deposition - Lithification and diagenesis. Depositional Environments - Terrestrial, Lacustrine, Fluvial and Marine. b) Structures of Sedimentary Rocks - Rippled Marks, Rainprints, Sun cracks, Current bedding, Graded Bedding, Stratification. c) Classification of Sedimentary Rocks: i) Clastic: Rudaceous - Conglomerate and Breccia. Arenaceous - Sandstone, Grit, Arkoses. Argillaceous - Shale, Siltstone. ii) Chemical and Biogenic: Carbonates & Carbonaceous deposits iii) Residual Sediments - Laterites. 4. Metamorphic Petrology: a) Definition and Agents of Metamorphism - Temperature, Pressure and fluids. b) Kinds of Metamorphism - Cataclastic, Contact (thermal), Regional Dynamothermal - Low P, Med. P. High P. c) Fabric (Structures/textures) of Metamorphic Rocks - Schistose, Granulose, Gneissose, Cataclastic and Porphyroblastic Granulitic.

UNIT-3 : PHYSICAL GEOLOGY & STRUCTURAL GEOLOGY

Relief orders. Geomorphic processes and land forms - fluvial, glacial, Aeolian, coastal and karst, Principles of terrain evaluation - terrain units - physiography, Land facets, Geomorphology in irrigation projects - Confined alluvial valleys - Riverine plans - Design of Channel network. Endogenic Processes acting on earth and their impacts.

STRUCTURAL GEOLOGY - Definition and importance of structural Geology. 2. Structures: Primary and Secondary. a) Primary: Ripple marks, Sun cracks, Rain prints, Stratification, Current bedding and Graded bedding. b) Secondary Structures: I) Folds: Definition, parts of a fold, types - Symmetrical and Asymmetrical - Anticline and syncline, Overtaken fold. Recumbent fold, Isoclinal, chevron, Fan and Drag folds. Erosional features - Inlier and Outlier. II) Faults: Definition, elements of fault - Fault plane, dip, strike, hade, heave, throw, hanging wall and foot wall. Step fault, ridge and trough faults, criteria for recognition of faults in the field. Joints: Definition and Terminology of joints - Dip, strike, Joint Plane, Joint block, Joint Set and Joint system. Classification of joints - Geometrical - dip, strike, oblique bedding. Genetic: Columnar, sheet joints, rift and grain. Significance of joints. II) Unconformities: Definition, Origin and Types - Disconformity, Non-conformity, Angular unconformity and blended unconformity, Recognition and significance of unconformities.

UNIT-4 : PALEONTOLOGY & STRATIGRAPHY

STRATIGRAPHY-a) Introduction - Definition of Stratigraphy, Relationship with other branches of Geology. b) Principles - Law of uniformitarianism, Law of Order of Superposition: Nature of Geological Record. c) Stratigraphic classification and Nomenclature Unit - Litho, Bio and Chronostratigraphic., d) Correlation of Strata - Criteria - Lithological, Structural, Metamorphic, Palaeontological, Geochronological and Stratigraphical. e) Standard Stratigraphic scale.

PALAEONTOLOGY- Definition of Palaeontology - Classification of life plant kingdom and animal kingdom - vertebrate and invertebrate - phylum, class, order, genera and species. 2. Fossils: Definition - types of fossils - modes of fossil preservation Mummification, Carbonisation, Petrification, Casts and Molds. Tracks and Trails. Uses of fossils. 3. Morphology and Geological distribution of Foraminifera, Brachiopods, Lamellibranchs, Gastropods, Cephalopods, Echinoids & Trilobites. 4. Plant fossils - Morphology and distribution of Lepidodendron, Siggillaria, Calamites, Glossopteris, Ptillophyllum.

UNIT-5 : GEOEXPLORATION

Geological Exploration: Mode of occurrence of commercial-grade deposits of Fe, Mn, Au-Ag-(W), Cu, Pb-Zn, Ti, Ni, Mo, Sn, Al, Pt - group. U-Th. Geological criteria for mineral prospecting. Indications of ore. Geological prospecting methods. Small and large scale geological mapping. Methods of geological exploration - exploratory grids, location and documentation of exploratory workings (pits, trenches underground workings), drilling, core logging. Sampling techniques and evaluation of grade. Delineation of ore deposit based on exploration data. Classification of ore reserves. Ore reserve estimation. Economic evaluation of ore deposit. Preparation of technical report

Geochemical Exploration: Geochemical cycle- mobility of elements, Pathfinder elements and geochemical anomaly. Mode of occurrence of trace elements. Primary dispersion patterns of deep seated origin, syngenetic and epigenetic. Geochemical rock surveys. Weathering and its products. Factors controlling mobility of elements in the surficial environment, Eh-PH, formation of complexes, absorption and ion exchange on colloidal practicals, formation of organic compounds, electro chemical dispersion.

Movement of surficial material - role of mechanical and biological factor (gravity movement, dispersion in surface and ground water dispersion by glaciers and wind action, effects of vegetation). Surficial dispersion patterns - syngenetic and epigenetic patterns. Forms of surficial patterns. Anomalies in residual over burden - clastic, hydromorphic and biogenic anomalies. Anomalies in ground land stream water. Anomalies in drainage sediments. Geochemical drainage surveys. Uptake of mineral matter by plants. Biogeochemical anomalies. Biogeochemical survey techniques. Vapour geochemistry. Selection of geochemical methods in mineral exploration.

UNIT-6 : MINING METHODS & MINERAL PROCESSING

Mining Methods: Terms used in open pit and underground mining. Classification of mining methods: Alluvial mining: Pan and batea, rocker, longtom, sluicing, hydraulicking, drift mining and dredging. Open-pit (cast) mining: loading by hand (manual), loading by machine-drag line, power shovels, scrapers, land dredges, over burden bridges, bucket wheel excavators. Underground mining: Metalliferous deposits-open stopes without support. Overhand stoping with support -Timbered stopes, filled stopes and caving methods. Mining of coal deposits. Explosives and blasting.

MINERAL DRESSING - Definition and Scope of Mineral dressing (ore dressing) Physical and Chemical Properties of minerals made use of in Mineral dressing. Comminution : Principles, theories of Comminution, ore grindability. Crushers : Primary and Secondary Crushers. Grinding Mills (Tumbling Mills):- types of Mills : Rod, Ball and Autogenous mills. Industrial Screening : Screens and their types.

UNIT-7 : ORE GEOLOGY & INDIA'S MINERAL DEPOSITS

ORE GENESIS: - Ore / bearing fluids. Migration of ore bearing fluids. Physical and chemical controls of ore deposit. Morphology of ore bodies. Texture of ores. Zoning of mineral deposits. Genetic classification of

ore deposits. Mafic igneous rock hosted ore deposits in layered mafic intrusions. anorthosites, kimberlites, carbonatites, Komatiites and ophiolite complexes, with typical examples. Ore deposits related to intermediate and felsic igneous rocks - Pegmatites, Porphyry, base-metals deposits, skarn deposits and hydrothermal cavity-filling and replacement type deposits with example.

Ore deposits related to subaerial volcanism. Ore mineralisation associated with submarine Volcanism and sedimentation-deposits of Fe (Algoma and superior types), Mn, U-Ag-W, dCu, Cu-Zn, Cu-pb-Zn-Ag. Sedimentary ore deposits of base metals, iron, manganese, phosphates and evaporites. Palaeoplacer and placer deposits of diamond, gold and other gem stones. Ore deposits related to weathering-Nickeli-ferous laterite and bauxite. Supergene alteration and enrichment of iron, manganese and base metal deposits. Ore mineralisation related to regional metamorphism and remobilisation. Ore deposits related to plate-tectonic regimes. With world occurrences of above ore-forming processes.

INDIAN INDUSTRIAL MINERAL DEPOSITS- Mode of occurrence, mineralogy, genesis and Indian distribution of the following metallic and non-metallic mineral deposits. Metallic minerals - iron, manganese, copper, chromium, tin, bauxites. Non-metallic minerals- fertilizers, refractive and abrasive minerals, ceramic and glass making minerals, mineral pigments, ornamental stones and gemstones. Radioactive minerals- Instrumental techniques of detection and measurement of radioactivity. Distribution of radioactive minerals in India. Strategic, critical and essential minerals, India's mineral wealth status and National Mineral Policy.

UNIT-8 : HYDROGEOLOGY

PHYSICAL HYDROGEOLOGY- Definition and scope, Distribution of Groundwater in the earth's crust, Groundwater in hydrological cycle, the global water budget, India's water budget, origin of groundwater, Classification of rocks with respect to water bearing characteristics, Geological structures favoring groundwater occurrence, Groundwater movement, Aquifer and its Classification, Hydrological properties of rock, Porosity, Permeability, transibility, specific yield, specific retention, transmissibility. Darcy's law, water table, flow nets, springs.

GROUNDWATER EXPLORATION- Aquifer test, Draw down, Groundwater resources of India, Groundwater recharge-Natural, artificial recharge methods, Rainwater harvesting, Groundwater runoff, Groundwater management, Methods of groundwater exploration-Geological, Geomorphological, geophysical and Remotesensing methods

UNIT-9 : GEOCHEMISTRY

GEOCHEMISTRY- Introduction to geochemistry - its scope. Geochemical classification of elements, Age, origin and composition of the universe with special reference to the solar system. Meteorites - Classification composition and their origin. Differentiation of the Earth. Biochemical classification of element and geochemical cycles. Geochemical fractionation of trace elements in magmatic processes, REE in igneous petrogenesis, Isotopes- Stable Radiogenic Fractionation and importance.

GEOCHRONOLOGY- Geochronology -Radio activity decay schemes, growth of daughter isotopes and radiometric dating. Isotope geochemistry: Kinds of isotopes, radiogenic isotopes: strontium isotopes, lead isotopes, neodymium. isotopes, Application of isotope geochemistry:, U-Pb , Rb-Sr and Sm-Nd isotope systematics.(mineral and whole rock).

UNIT-10 : REMOTE SENSING & GIS

AERIAL REMOTE SENSING AND PHOTOGRAMMETRY-Aerial Photography- Multispectral Photography - Types of aerial photos -Scale - Photogrammetry:-Basic principles - Electromagnetic spectrum - platforms- Sensors - Energy interaction with atmosphere and earth's surface - Reflectance of minerals, rock and water- Imaging and non-imaging sensors – Elements of image and Photographic -interpretation, Image processing and Indian imaging system.

REMOTE SENSING APPLICATIONS - Lithological mapping; - Structural mapping and tectonic study, suture zones and shear zones, mineral exploration, ground water exploration, mapping of native vegetation,

croplands and soils. Geomorphological mapping and land form studies. Buried and palaeo channels, Flood plains, Tsunamis, forest classification, Sea level changes - Fluvio-marine, air and water pollution, Wetland and Waste land, Land use - land cover studies and Urban planning .

GPS- Global positioning System and its functions. Components of GPS, segments of GPS, GPS satellites, Types of GPS, types of antennas, Data input from Automated Surveying and Global Positioning System. Types of projections of the global co-ordinates, development of Degree sheets, and UTM . Georeferencing using Toposheets, mapping with GPS, tracking with the GPS, Uses and advantages of GPS.

GIS- Introduction to Geographic Information Systems and spatial distribution of geological data. Components of GIS- Software modules of GIS- GIS as a set of Interrelated Subsystems-Data Processing Sub system, Data Analysis Subsystem, Information Use Subsystem, Management Subsystem. Data Input:- Modes of data input- Digitizer hardware, the digitizing operation, Problems with digitizing maps, Editing errors from digitizing, Digitizing costs, Scanners; Requirements for scanning, Conversion from other digital sources. Data verification.

MAP DATA SOURCES AND MAP PROJECTIONS-Compared to Maps-Data stores, Data indexes, Data analysis tools, Data display tools. Raster GIS: The Data Model, Creating a Raster, Cell by cell entry, Digital data, Cell Values-Types of values, one value per cell, Map Layers-Resolution, Orientation, Zones, Value, Location. Raster GIS Capabilities- displaying layers, basic display, Other types of display. Local operations- Recoding, overlaying layers. Advanced GIS: Artificial intelligence- expert systems- Object oriented GIS, On-line GIS packages of Internet.

APPLICATIONS OF GPS AND GIS-Applications of GIS in mapping geological bodies, geomorphic units, landuse / landcover categories, hydrogeology, geophysical prospecting, mineral exploration, planning of urban structures, potential zones for groundwater targeting, artificial recharge and mining. GIS case studies. GPS applications on mapping and Surveying , Crustal deformation and tectonic movements, Natural hazards.