



Module 6.

- Elements of Image Interpretation, Digital Image Processing: Rectification, Geometric correction, Radiometric correction, Noise removal, Image enhancement and classification – Application – GPS.

Module 7.

- GIS; - Concepts and components of GIS, Analog and digital map, Sources of spatial data, Functions of GIS. Data model - Raster and vector – Spatial data structure – Database, DBMS and functions – Relational data base models – Concept of SQL and metadata - Linking of spatial and attribute data.

Module 8.

- Methods of data input- Data editing -Edge Matching and Rubber Sheeting. Data Analysis: Measurement of length, perimeter and area-Queries-Buffering-Neighbourhood functions – Overlay – Raster overlay and vector overlay-Surface and network analysis -Web GIS.

- Gravity of the earth - gravity measurements - gravity anomalies - concept of geoid and spheroid. Concept of Isostasy.
- Earthquakes - types, causes and effects. Prediction of earthquakes.

Module 2. Geomorphology

- Geomorphic principles and processes. Cascading process system - solar energy cascade. Theories of Uniformitarianism, Catastrophism and Gradualism. Denudation, sediment cascade, transported load in rivers, rate of erosion over space and time. Influence of climate and structure on geomorphic processes and landforms. Morphogenetic landforms.
- Evolution of landforms - Models of landscape evolution by Davis, Penck and King. Geographical cycle - Treppen concept - Pediplanation cycle.
- Landforms - relation of igneous activity, structure and lithology to landforms.
- Hill slopes - processes and evolution.
- Fluvial geomorphology: drainage basin - morphometric analysis of drainage basins - fluvial processes and landforms.
- Concept of rejuvenation and interruption in the evolution of landforms.
- Coastal geomorphology: Coastal processes and associated landforms.
- Desert geomorphology: Aeolian process and associated landforms.
- Glaciers and glacial processes - glacial landforms; Glaciation.
- Concepts of Monocyclic, Polycyclic and Polygenetic landforms.
- Coral reefs: types and significance.
- Soils: formation, classification, soil profile. Soils of India and Kerala.
- Brief idea of the geomorphic features of the Indian sub-continent and Kerala.

Module 3. Planetary Geoscience

- Milky Way and the solar system. Big bang theory and formation of the planetary systems. Members of the solar system. Orbital characteristics of planets. General

11. Geology

Unit I

Module 1. Physical Geology

- Earth and the Solar system - Origin of the Earth - Different popular hypotheses. Geochronology and Age of the earth - dimensions of the earth.
- Internal structure of the earth - Basic concepts of seismology - heterogeneity of the earth's crust - physico-chemical and seismic properties of the earth's interior - Density distribution within earth.
- Earth's magnetic field - changes in magnetic field - origin of geomagnetic field - Geomagnetism - Palaeomagnetism- Magnetic anomalies - Magnetic reversals.
- Thermal history of the earth-Heat within the earth - Geothermal gradient and heat flow.



characteristics of the terrestrial planets - crust, surface features, volcanism.

- Moon: Selenology - definition, the Earth-Moon System, General physiography, Lunar atmosphere. Lunar rocks, soil and internal structure, Lunar phases and cycles, Lunar influence on Earth.
- Mars: Physiography, Atmosphere, Craters, Volcanism, Martian rock and soils.
- Meteorites: Chondrites, SNC meteorites, Refractory inclusions, Iron meteorites.
- Asteroids: Classification and composition, Surface features, Asteroid sources, Asteroid impacts on the earth.

Module 4. Marine Geology

- The ocean floor, general topography - Turbidity currents, Eustatic movements.
- Physical properties of sea water: distribution of temperature, pressure and density. Chemical composition and properties of sea water.
- Coastal processes: waves, currents and tides. Classification of Sea coasts and shorelines; Classification of shorelines and coasts, beach classification.
- Marine Sediments, their sources and transportation. Classification of marine sediments.
- Methods of exploring the ocean floor.

Unit II

Module 1. Crystallography and Mineralogy

- Crystalline state - Lattices- Point, Line, Space; Repetition theory, Translational Periodicity and Rotational Symmetries.
- Symmetry elements and Crystal Systems; study of normal classes.
- Crystal projection - Stereographic and spherical projections.
- Optical Mineralogy: Relief, Pleochroism, Birefringence and Interference colours in minerals, Optical accessories, Indicatrices. Conoscopic study and interference figures. Optic orientation, extinction angle, optic axial angle, optic sign and optic anomalies. Dispersion - types and uses.

- Descriptive Mineralogy: Classification and structure of silicates.
- Distinctive physical and optical characters and chemical composition of the following groups: Olivine, epidote, garnet, aluminosilicates, pyroxene, amphibole, mica, feldspar and feldspathoid.
- Distinctive physical properties, chemical composition and mode of occurrence of the following groups of minerals: oxides, sulphides, carbonates, halides, phosphates, sulphates.
- Application of modern techniques in mineral studies - XRD, XRF, ICP, EPMA.

Module 2. Igneous Petrology

- Igneous process - Phase rule and its application in the study of silicate systems - phase diagrams, Eutectic crystallization - Solid solution series - Incongruent melting.
- Course of crystallization in typical binary systems. Reaction principle and reaction series. Mode and Norm. CIPW Norm. Textures and their genetic significance.
- Equilibrium crystallization and melting paths in ternary systems.
- Anorthite - Wollastonite - Silica
- Diopside - Anorthite - Albite
- Albite-Anorthite - Orthoclase
- $\text{MgO} - \text{Al}_2\text{O}_3 - \text{SiO}_2$.
- Basalt system - classification of basalts.
- Igneous process and diversity in igneous rocks. Compositional variation in magmas. Variation diagrams. Trace elements in igneous processes; application of trace elements to petrogenesis. Radiogenic tracers.
- Classification of igneous rocks. Granites and granitic rocks. Ultramafic rocks. Alkaline rocks. Kimberlites and ultra-potassic rocks. Anorthosite and carbonatite.

Module 3. Metamorphic Petrology

- Concepts of metamorphism: Limits, Types and Factors of metamorphism.
- Application of phase rule in metamorphic mineral paragenesis.
- Metamorphic structures and textures - their significance.



- Classification of metamorphic rocks: after Eskola, Barrow and Winkler.
- Graphical representation of metamorphic mineral assemblages - ACF, A'KF and AFM diagrams.
- Metamorphic differentiation; Metamorphism and plate tectonics; Ultra High Temperature (UHT) and Ultra High Pressure (UHP) metamorphism, Anatexis.
- Geothermobarometry.
- General characteristics of metamorphic domains - Contact metamorphism, Regional metamorphism, Paired metamorphic belts, Orogeny and Metamorphism, Retrograde and Prograde metamorphism.
- Metamorphism of carbonate rocks, pelites, mafic and ultramafic rocks.

Module 4. Sedimentary Petrology

- The Sedimentary Cycle, Grain shape, Sphericity, Roundness and surface textures.
- Sedimentary Structures: Physical, chemical, biogenic and deformation structures.
- Mineral Composition, texture and classification of sandstone, limestone, shale and argillite. The concept of Average shale.
- Depositional Systems and environments: Sedimentary environments, Marine-Transitional-Continental depositional systems, Sedimentary Facies. Allochthonous and Autochthonous sediments.
- Sedimentary Basins: Basin forming Mechanisms. Classification of sedimentary basins.

Unit III

Module 1. Stratigraphy

- Contributions of the pioneers of Stratigraphy, Geologic Time Scale.
- Correlation in Stratigraphy: Types and methods. Basic stratigraphic principles.
- Unconformities: Types of unconformities, Concepts of Hiatus, Diastems. Geological significances of unconformities. Codes and Procedures for the establishment and description of stratigraphic units.

- Lithostratigraphic, Chronostratigraphic and Biostratigraphic classifications and units; Hierarchy.
- Reworked and leaked fossils. Concepts of death assemblage and living community. Concept of litho-bio facies.
- Basics of Magnetostratigraphy, cyclostratigraphy, pedostratigraphy, chemostratigraphy and sequence stratigraphy.

Module 2. Quaternary Geology

- Quaternary Glaciations: Cryosphere and the Pleistocene glaciation. Ice core records, Holocene glacier records, Causes of ice-sheet growth and decay, Patterns of glacial-interglacial cycles.
- Quaternary sea level changes: Evidences and causes of sea level changes. Recent and historic sea level fluctuations, Holocene transgression, Land bridges.
- Tools and evidences for Quaternary studies: Ocean Records - Microfossils, Oxygen isotopes, Trace element analysis, Pollen analysis, Ice-rafted materials. Fluvial Records - River characters, palaeochannels, base level change. Dendrochronology -Tree rings.
- Man in Quaternary: Anthropocene. The Miocene hominoids of Africa and Eurasia, the Pliocene hominids of Africa, Homo habilis, Homo erectus and their migration. Pleistocene faunal extinctions, Isotopic evidences of palaeodiet.

Module 3. Palaeontology

- The origin of life: Scientific models, the biochemical model, evidences for the origin of life, the great oxygen event, life during Precambrian, diversification of life. Evolution of life in the Palaeozoic, Mesozoic and Cenozoic eras.
- Fossil record and modes of evolution: Microevolution, Macroevolution and Tree of life. Patterns of evolution. Theory of organic evolution and the factors in the Darwinian theory. Theory of Punctuated Equilibria.
- Mass extinctions and biodiversity loss: Pattern and timing of extinctions, selectivity,



Periodicity of mass extinctions, the big five mass extinction events.

- General classification of microfossils.
- Classification, general morphology, ecology, evolution and geological history of Foraminifera, Ostracodes, Radiolaria and Diatoms.
- Evolutionary trends, Stratigraphic importance and Classification of the following invertebrates: Brachiopoda, Arthropoda and Mollusca.
- General characteristics, classification and evolution of Pisces, Amphibians, Reptiles, Birds and Mammals (Horse and Man).
- Plant fossils of Gondwana Age.

Module 4. Indian Geology

- Brief study of the physiographic divisions of India. Major geological divisions of India.
- Pre-Cambrian stratigraphy: Classification of Indian Pre-Cambrian with particular reference to Karnataka and Kerala. Greenstone belts and granulites of South India. Classification, lithology and ages of Sargur Group, Aravalli and Delhi Super Groups. Dharwar Supergroup, Cuddapah Supergroup and Vindhyan Supergroup. Intrusive rocks in Kerala.
- Major Phanerozoic Basins in India: General description, age, development, evolution, stratigraphy and classification of the following basins in India - Gondwana Basin, Kaveri Basin, Kerala Basin, Cambay Basin.
- Deccan traps: extent, distribution, classification, lithology, inter-trappeans and infra-trappeans. Age of Deccan Traps.
- Mesozoic Stratigraphy: Major Triassic, Jurassic and Cretaceous stratigraphic units in India.
- Cenozoic successions in India: Cenozoic succession of Assam, Siwalik Supergroup, Cuddalore, Quilon and Warkalli Formations, Karewa Group, Indo-Gangetic Alluvium.

Unit IV

Module 1. Structural Geology

- Faults and fractures: Brittle and shear failure - Fault geometry and nomenclature - Features of fault planes - Criteria for faulting. Joints - Analysis of fractures. Stress and strain ellipsoids and their use in the study of faults and joints.
- Folds: cylindrical, non-cylindrical and conical folds - Geometry and classification of cylindrical folds - Canoe fold and inverted canoe fold - Minor folds and their use in determining the major fold structures - Mechanics of folding - Fold classifications of Donath and Parker and Ramsay - Superposed folding - Fold interference patterns.
- Tectonites: classification, tectonic fabric. Foliation: types, classification and origin - Use of axial plane foliation and fracture cleavage in the determination of major structures.
- Lineation: types, classification and origin. Lineaments.
- Geologic bodies and scale, structural coordinates. Fundamentals of geometric analysis. Stereographic projections in Structural Geology.

Module 2. Geotectonics

- Continental drift: geological and geophysical evidences, mechanism, objections, present status.
- Major tectonic features of the continental and oceanic crust - Shield, cratons, etc.; Concept of Rheology.
- Plate tectonics: types of plate margins; Island arcs, oceanic islands and volcanic arcs; Subduction zones and Deep sea trenches; Sea floor spreading - Mid-oceanic ridges; Polar wandering and polar reversals.
- Orogeny and Epeirogeny;
- Mountains - classification.
- Global seismic belts.
- Geodynamics of the Indian plate.



Module 3. Engineering Geology

- Role of Geology in Civil Engineering.
- Engineering properties of rocks and soils.
- Rock as a building material - dimension and decorative stones - aggregates.
- Geologic criteria for selection and investigation of sites for dams, reservoirs and tunnels.
- Landslides: types, causes and mitigation.
- Influence of geological conditions on building foundations and design.

Module 4. Hydrogeology

- Hydrology: Global distribution of fresh water, Hydrological cycle. Hydrometeorology, Soil moisture, Run off.
- Physical Hydrogeology: Vertical distribution of subsurface water, water table and potentiometric surfaces, Rock properties affecting groundwater, Darcy's law, Aquifer, Aquiclude, Aquitard, Aquifuge, Types of aquifers. Aquifer parameters. Flow nets; Baseflow, Effluent and Influent conditions.
- Groundwater Exploration: Electrical resistivity methods - Wenner and Schlumberger electrode arrangements. Well logging - Geological and Geophysical logging.
- Groundwater Quality: Chemical composition of groundwater, graphical representation of hydro-chemical data. Water quality criteria and standards for domestic and irrigation purposes, Saline water intrusion.
- Groundwater Management: Dynamic and Static resources, Concept of Rainwater Harvesting, Artificial recharge and recovery techniques. Use of isotopes in hydrological studies.
- National Groundwater Status: Groundwater provinces of India, Hydrogeochemical provinces of India, Groundwater conditions and quality problems in Kerala.

Unit V

Module 1. Geochemistry

- Goldschmidt's geochemical classification of elements. Crustal abundance and concept of major, minor and trace elements.
- Geochemistry of important elements: Alkalies, alkaline earths, hydrogen, aluminium, carbon, silicon, nitrogen, oxygen and sulphur.
- Basic principles in geochemistry: Geochemical environment, surficial and deep seated environment, geochemical cycle, geochemical dispersion - primary and secondary dispersion, dispersion halos, geochemical mobility.
- Mineral stability, law of mass action, Le Chatelier's rule, influence of temperature and pressure. Enthalpy and change in enthalpy, free energy and free energies of formation. Eh-pH limits of natural environments.
- Isomorphism, Polymorphism, Solid solution, Exsolution.
- Isotopes: Physical and chemical properties of isotopes; stable and unstable isotopes. Principles of isotope dating. Isotope dating methods: U-Th-Pb methods. K-Ar, Rb-Sr, Sm-Nd methods. Fission track dating; ^{14}C dating.
- Stable Isotopes: Geochemistry, Notation. Theoretical Considerations. The Mass Spectrometer- principles and components. Characteristics and geological applications of Carbon, Nitrogen, Oxygen, Hydrogen and Sulfur isotopes.

Module 2. Economic Geology

- Ore mineral - definition; tenor, grade and specifications.
- Theories of ore genesis. Ore forming solutions and their migration. Wall-rock alteration -Controls of ore localization - Paragenetic sequence and zoning - Metallogenic epochs and provinces.
- Classification of ore deposits: Lindgren and Bateman. Processes of formation and characteristic features of various types of mineral deposits. Greisen deposits, skarn



deposits, disseminated sulphide, oxide and sulphate deposits of sedimentary and volcanic environments.

- Salient features of hydrothermal, sedimentary, residual and supergene sulphide ore deposits with examples. Stratabound and stratiform ore deposits.
- Ore deposits related to plate boundaries; ore deposits of metamorphic affiliations.
- Genesis, geological settings, mode of occurrence and distribution of deposits of iron, copper, lead, zinc, aluminium, magnesium, manganese, chromium and titanium in India. Major Indian occurrences of mica, asbestos, barite, graphite, gypsum, precious and semi-precious minerals. Indian occurrence of refractory minerals, abrasive minerals and minerals used in ceramic, glass, fertilizer, cement, paint and pigment industries.
- Coal Geology: classification, coal petrography, macroscopic and microscopic components of coal. Mode of origin of coal; Periods of coal formation. Distribution and nature of occurrence of coal deposits of India - Gondwana coal fields; Coal deposits of Raniganj and Jharia, Lignite deposits of Neyveli and Palana, Tertiary coal fields of Assam.
- Petroleum Geology: Physical properties and chemical composition of petroleum; Occurrence and origin of petroleum -Source rocks -process of transformation of organic matter to petroleum; Migration and accumulation of petroleum - Reservoir rocks: types -general, structural, stratigraphic, salt domes. Important petroliferous basins of India: Distribution of oil fields in India - Assam shelf basin, Bombay offshore basin, Cambay basin, Krishna-Godavari basin.
- Brief idea of gas hydrates; Coal bed methane; Natural gas - distribution and nature of occurrence in India.
- Atomic minerals: distribution and mode of occurrence in India.
- Mineral resources of the sea: sources of sea minerals, sea water, extraction of elements,

continental shelves, Deposits under the surficial sediments of the continental shelves, deposits in the deep sea floor. Law of the sea - UNCLOS - Exclusive Economic Zone, International sea bed area and authority - Indian strategy for future exploitation of seabed deposits.

- National Mineral Policy - MM (R&D) act - Procedures for Grant of Mineral Concessions in India - UNFC classification - Global mineral reserves and resources - Minerals and sustainable development.
- Strategic, Critical and Essential minerals: definition; distribution in India.
- State-wise share of mineral production in India.

Module 3. Exploration Geology

- Methods of surface and subsurface exploration. Principles and methods of sampling and assaying.
- Methods of estimation of ore reserves. Field equipments and field tests used in exploration.
- Phases of geological exploration. Drilling: Methods and types of drilling. Logging of bore holes; preparation of sections and level plans, fence diagrams. Subsurface mapping.
- Sampling: sampling pattern of surface exposures, mine workings, trenches, pits, drill holes, channels, placers; Bulk sampling.
- Geochemical exploration: principles, methods of sampling. Geochemical anomalies, indicators and path finders; Materials for geochemical sampling - soil, stream sediment, water, vegetation and vapour.
- Geobotanical exploration: Biogeochemical exploration; methods of biogeochemical prospecting of ore deposits; Biogeochemical anomalies; Geobotanical indicators.
- Geophysical exploration: Principles, scope, chief methods and their applications. Electrical methods: principles and instruments; Self potential method. Gravity methods: Principles and applications; gravity anomalies - regional and local; Bouguer anomaly and corrections. Instrument used -



gravimeter - survey methods. Magnetic methods: Principles and applications; earth's magnetic field, survey methods; instrument used - magnetometer. Seismic methods: Principles and applications - seismic waves and their velocities in different geological materials; Field survey method -refraction and reflection survey; seismic instruments and records. Radiometric methods: Principles of radioactivity, methods; GM counters and scintilometers.

- Geophysical well logging: electrical, radiometric, sonic and thermal logging.

Module 4. Mining Geology

- Basic mining terminology - classification of mining methods: alluvial mining, open cast mining and underground mining.
- Coal mining - deep sea bed mining - petroleum mining.
- Methods of stoping- shaft sinking - mine supports - mine ventilation - mine hazards - principles of mine evaluation - role of geologists in operative mining.
- Mineral and ore beneficiation: Principles of ore dressing: crushing and grinding - comminution units - comminution practices - sizing - screening units.
- Classifying techniques - filtering and drying. Hydroclones: classifiers and gravity concentration units; Ore concentration methods: Froth floatation reagents and practices, magnetic and electrostatic separation methods.

Unit VI

Module 1. Remote Sensing

- History and the developments of Aerial photography - Geometry and type of aerial photographs - Scale of photographs - Type of aerial cameras, films and filters - Multiband photography - Tilt and height displacement - Vertical exaggeration - Stereoscopy - Mosaics - Elements of photo interpretation, Use of Aerial photographs in photogrammetry, geology, geomorphology, mineral and groundwater exploration, land

use, forestry, agriculture, environmental studies.

- Basic principles of Satellite Remote Sensing: definition and components - Electromagnetic spectrum - Black body radiations - spectral reflectance of land covers - Atmospheric window - Platforms and sensors - Active and passive sensors - Sun synchronous and geosynchronous satellites - Payloads - Land coverage capability. Resolution concepts; Multi Spectral Scanners (MSS); Spectral signatures - data acquisition and format.
- Microwave remote sensing: SLR system - terrain characteristics influencing the RADAR return - Thermal Remote Sensing: Thermal radiometers and scanners - collection and interpretation of thermographic data - Introduction to hyperspectral remote sensing.
- Interpretation and Geological application of satellite remote sensing data - visual and digital - Basic concepts of digital image processing - use of satellite data in geological studies.

Module 2. Geoinformatics

- Geoinformatics: definition - history and development - geoinformatics and geomatics - Geographical Information System (GIS) - definition, components of a GIS - GIS softwares - Raster and Vector data - Spatial data - Maps and GIS - Layer concept in GIS - thematic characters of spatial data - Different sources of spatial data.
- Spatial data models - spatial data structures, modeling surfaces and networks - modeling the third and fourth dimensions.
- GIS database. Data input and editing - Integrated database - Digital Elevation Modeling and Integration of Remote Sensing and GIS. Tools in spatial analysis. Applications of GIS in Geosciences.
- Global Navigation Satellite System (GNSS) - GPS: Satellite constellation - signals and data



- receivers - Differential GPS. Glonass and Galileo systems -IRNSS - Application of GPS.

Module 3. Environmental Geology

- Scope of environmental geosciences: Natural resources- Renewable resources, non-renewable resources - Sustainable management of resources - Alternative energy sources. Land, its uses and management - Resources of the ocean floor - Mineral Resources: Conservation, management and concept of sustainable development.
- Natural hazards: Effects, management and prediction of earthquakes, cyclones, tsunami, landslides, floods and droughts. Hazard Zonation maps. Concept and stages of disaster management.
- Waste Management: Changing concepts of wastes, types, management and their disposal. Waste disposal methods. Impacts of mining activities on land surface, air and water environment.
- Pollution: Air, water and soil pollution, causes, effects and managements. Greenhouse Effect and Ozone Layer Depletion. Global warming and climate change.
- Environmental problems associated with urbanization. Development of technology and human factors. Desertification - causes, symptoms and prevention. Accelerated soil erosion - causes, effects and control.
- EIA: Introduction, Definition, aim, principles and concept.

Module 4. Field Geology

- Scope and importance of Field Geology - geologic map and mapping - types of mapping - map symbols - reconnaissance - preparation. Basic equipments necessary for geological mapping and their uses.
- Basic procedure in the field: Taking compass bearing - taping and pacing - locating the position in the map - use of GPS. Observation

in the field, interpretation of the outcrop - filed notes - drawing and photographing the outcrops - measuring the attitudes of planar and linear features - collecting fossils, rock samples - their identification and naming.

- Geological mapping of sedimentary, igneous and metamorphic terrains and structures.
- Preparation of final geological map and reports: Field study to report writing, major illustrations, photographs, drawings, diagrams, designing the report, format and specific parts of the report.

12. German

Unit I

Linguistik / Deutsche Sprachgeschichte Basic Linguistics -

Module 1. Sprachliche Kommunikation

Module 2. Phonetik - Phonemik - Morphemik - Syntax

- Text Book: Basic Linguistics - Linguistik I hrsg. von Otmar Werner und Franz Hundsnurscher (Germanische Arbeitshefte)
- Jean Aitchison: Teach Yourself Linguistics
- History of German Language

Module 3. Vom Wesen der Sprache - Sprache und Rede - Sprache und Schrift

Module 4

- Sprachauffassung des Altertums - Einstellung des Mittelalters zur Sprache - Einstellung des Humanismus - Einstellung der Reformation - Einstellung des Barock - Einstellung der Aufklärung - Der sprachliche Wandel und seine Ursachen

Module 5

- Einteilung der Sprachen der Erde - Von der deutschen Sprache und ihrer Geschichte - Das Germanische - Germanische Neuerungen - Zweite Lautverschiebung - Zeitliche Gliederung des Deutschen - Die