

MAHATMA GANDHI UNIVERSITY  
NALGONDA-508 254



Revised and Modified  
M.Sc. GEOLOGY SYLLABUS (CBCS)  
(w.e.f. 2016-2017)

Department of Geology  
University College of Science & Informatics

DEPARTMENT OF GEOLOGY  
MAHATMA GANDHI UNIVERSITY, NALGONDA  
M Sc Geology under CBCS (academic year 2016 - 17)

Scheme of Instruction and Examination

*Duration of examination: 3 hrs for each paper*

**Semester - I**

S.No.	Code	Paper	Paper Title	Hours/ Week	Credits	Internal Assessment marks	End Semester Exam marks	Total marks
<b>Theory</b>								
1	G 101 T	I	Crystallography, Optical Mineralogy & Mineralogy	4	4	20	80	100
2	G 102 T	II	Structural Geology & Geotectonics	4	4	20	80	100
3	G 103 T	III	Palaeontology and Stratigraphy	4	4	20	80	100
4	G 104 T	IV	Geomorphology & Field Geology	4	4	20	80	100
<b>Practicals</b>								
5	G 105 P	I	Crystallography + Mineralogy & Optical Mineralogy	9	4	-	100	100
6	G 106 P	II	Geomorphology & Palaeontology Field Geology, Structural Geology	9	4	-	100	100
7	G 107 P		Communicative English & Soft Skills	2	2	10	40	50
8	G 1		Seminar	2	1		25	25
Total				<b>38</b>	<b>27</b>	<b>90</b>	<b>585</b>	<b>675</b>

**Field training:** Field training mandatory. It will be conducted immediately after the I-Semester and before the start of II-Semester. The duration of field training camp will be about 2 to 3 weeks. For conducting the field training program, the teacher-student ratio will be 1:10. The student has to submit a report and it will be evaluated. It is essential to obtain atleast *Satisfactory Grade* to get promoted to the next year. An amount of Rs. 1000/-, part from the regular fee, shall be collected from each student at the time of admission towards the field training. One Lab Assistant and one Attendant will accompany the faculty and students during the Field Training.

DEPARTMENT OF GEOLOGY  
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 Scheme of Instruction and Examination  
**Semester - II**

No.	Code	Paper	Paper Title	Hours/ Week	Credits	Internal Assessment marks	End Semester Exam marks	Total marks
<b>Theory</b>								
1	G 201 T	I	Igneous Petrology & Geochemistry	4	4	20	80	100
2	G 202 T	II	Metamorphic Petrology & Thermodynamics	4	4	20	80	100
3	G 203 T	III	Sedimentology & Petroleum Geology	4	4	20	80	100
4	G 204 T	IV	Ore Genesis and Mineral Deposits	4	4	20	80	100
<b>Practicals</b>								
5	G 205 P	I	Igneous Petrology & Metamorphic Petrology and Geochemistry	9	4	-	100	100
6	G 206 P	II	Sedimentology & Ore genesis Mineral Deposits	9	4	-	100	100
7	G 207 P		Human Values & Ethics	2	2	10	40	50
8	G 2		Seminar	2	1		25	25
<b>Total</b>				<b>38</b>	<b>27</b>	<b>90</b>	<b>585</b>	<b>675</b>

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**Semester – III**

S.No.	Code	Paper	Paper Title	Hours/Week	Credits	Internal Assessment Marks	Semester Exam marks	Total Marks marks
<b>Theory</b>								
1	G 301 T	I	Mineral Exploration	4	4	20	80	100
2	G 302 T	II	Precambrian Geology and Crustal Evolution	4	4	20	80	100
3	G 303 T	III	Mining Geology&Eng.Geology	4	4	20	80	100
4	G 304 T	IV	Mineral Economics and Fuels	4	4	20	80	100
<b>Practicals</b>								
5	G 305 P	I	Mineral Exploration & Mining Geology & Mineral Economics	9	4	-	100	100
6	G 306 P	II	Precambrian Geology and Engineering geology	9	4	-	100	100
7	ID/P 307 T		Inter Disciplinary paper (Students opted a paper offered by the other Department)	4	4	20	80	100
8	G 3		Seminar	2	1	-	25	25
<b>Total</b>				<b>40</b>	<b>29</b>	<b>100</b>	<b>625</b>	<b>725</b>

**Semester IV**

S.No.	Code	Paper	Paper Title	Hours/Week	Credits	Internal Assessment Marks	End Semester Exam marks	Total Marks Marks
<b>Theory</b>								
1	G 401 T	I	Medical and Environmental Geology	4	4	20	80	100
2	G 402 T	II	Hydrogeology	4	4	20	80	100
3	G 403 T	III	Remote Sensing & GIS	4	4	20	80	100
4	G 404 T	IV	Disaster Management	4	4	20	80	100
<b>Practical's</b>								
5	G 405 P	I	Hydrogeology , Remote Sensing ,GPS & GIS	9	4	-	100	100
6	G 406 P	II	Environmental Geology & <b>Project work</b>	9	2+2=4	-	100	100
7	ID/P 407 T		Inter Disciplinary paper (Students opted a paper offered by the other Department)	4	4	20	80	100
8	G 4		Seminar	2	1	-	25	25
<b>Total</b>				<b>40</b>	<b>29</b>	<b>100</b>	<b>625</b>	<b>725</b>

# I Semester

## Paper - I (G 101T): Crystallography, Optical Mineralogy & Mineralogy

### Unit – I

**External symmetry of crystals:** Symmetry Elements, methods of projection, derivation of 32 crystal classes, Hermaun Muguin notation. Internal symmetry of crystals: Derivation of 230 space groups, diffraction of crystals by X-rays, Braggs' law.

### Unit –II

**Principles of optical mineralogy:** Optical mineralogy, polarized light, behavior of isotropic and anisotropic minerals in polarized light, refractive index, double refraction, birefringence, sign of elongation, interference figures, 2V, dispersion in minerals. Optic sign, Pleochroic scheme and determination of fast and slow vibrations and accessory plates.

### Unit – III

**Introduction to mineralogy:** Definition and classification of minerals. Structural and chemical principles of crystals/minerals, chemical bonds, ionic radii coordination number (CN) and polyhedron. Structure, chemistry, physical and optical characters and paragenesis of the following mineral groups: Olivine, pyroxene, amphibole, mica and spinel groups.

### Unit – IV

**Structure, chemistry, physical and optical characters and paragenesis of the following mineral groups:** Feldspar, quartz, feldspathoid, aluminum silicate, epidote and garnet groups. Accessory minerals: Apatite, calcite, corundum, scapolite, sphene and zircon. Average mineralogical composition of crust and mantle and mineral transformations in the mantle with depth.

## PRACTICALS

PAPER: (G-105P)

### **Crystallography, Optical Mineralogy & Mineralogy:-**

1. Study of important crystal models corresponding to Normal Class of Cubic, Tetragonal, Trigonal, Hexagonal, Orthorhombic, Monoclinic, Triclinic systems.
2. Stereographic projections on the Wulf's Stereonet.
3. Megascopic and Microscopic studies of the rock forming minerals: Olivines, Pyroxenes, Amphiboles, Micas, Feldspars, Feldspathoids, Silica & Alumino Silicates, Miscellaneous minerals such as Apatite, Zircon, Magnetite, Ilmenite, Calcite, Epidote and Sphene etc.,
4. Centering, orthoscopic & conosopic arrangement of the petrological microscope.
5. Determination of relative refractive index (RI) OR relief of minerals by Becke test.
6. Determination of Sign of elongation & Pleochroic scheme of minerals.
7. Determination of optic sign of Uniaxial & Biaxial minerals.
8. Determination of Anorthite content of Plagioclase by Michel Levy Method.

### **Books Recommended**

1. Deer, W.A., Howie, R.A. & Zussman, J., 1996; An introduction to The Rock forming minerals. Longman.
2. Klein, C and Hurlbut, Jr., C.S. 1993; Manual of Mineralogy. John Wiley and sons.
3. Putnis Andrew, 1992; Introduction to Mineral Science, Cambridge University Press.
4. Spear, F.S. 1993; Mineralogical Phase Equilibria and Pressure – Temperature- Time paths. Mineralogical society of America Publisher.
5. Phillips, Wm, R. & Griften, D.T 1986. Optical Mineralogy, CBS edition.
6. Hutchison, C.S., 1974 laboratory handbook of Petrographic Techniques. John Wiley
7. Crystallography by Phillips.
8. Optical Mineralogy by Kerr.

## Paper – II (G 102T) Structural Geology & Geotectonics

### Unit – I

*Concept of stress and strain:* Stress-strain relationships of elastic, plastic and viscous materials, measurement of strain in deformed rocks, behaviour of minerals and rocks under deformation conditions. *Folds:* classification and causes of folding, diapirs and salt domes.

### Unit – II

*Shear zones:* Recognition of shear zones and faults in the field, mechanics of shearing and faulting. Geometry of thrust sheets: Block faulted and rifted regions. Wrench faults and associated structures. Tectonic mélanges, Dome and basin structures, Structural behaviour of igneous rocks. *Foliations and Lineations:* classification, origin and significance. *Petrofabric analysis* (microfabrics): Data collection, plotting, symmetry and interpretation, concept of symmetry of fabric of tectonites.

### Unit – III

*Geotectonics:* Introduction, tectonic framework of earth's crust, interior of earth. isostasy, convection currents, Wilson Cycle. *Continental Drift:* Computer fitting, geological and palaeontological evidences in support of continental drift and insitu theories. *Sea-floor spreading:* Hess's concept and evidences of sea-floor spreading. Vine-matthew's magnetic tape recorder.

### Unit – IV

*Plate tectonics:* Concept of plate and plate movements, plate model of Morgan, nature of convergent, divergent and conservative plate margins, transpression and transtension. Plate tectonics in relation to igneous, sedimentary and metamorphic processes and mineralization. Triple junctions, aulocogens, plume theory, island arcs. *Earth's magnetism.*

### **PRACTICALS** PAPER: (G -106P)

#### **Structural Geology:-**

1. Reconstruction of folds, determination of the depth & height at the end of the section.
2. Vertical & Inclined fault problems; standard geological maps.
3. Maps with uniformly dipping beds / unconformable beds, beds dipping with different dip amounts and directions, folded & faulted formations, intrusives / unconformities.
4. Maps of geotechnical importance.

#### **Books Recommended**

1. An outline of Structural Geology By Hobbs, Means and Williams, John Wiley:
2. Outline of Structural Geology By Mathuen, E S Hills, London:
3. Structural Geology of rocks and regions By H. davis, John Wiley.
4. Foundations of structural geology By R.G.Park, Blakie.
5. Structural Geology By L.U.De Sitter, McGraw Hill.
6. Structural Geology By M.P.Billings, P.H.I.
7. Fundamentals of modern structural geology By S.K. Ghosh., Elsevier Publication,
8. T.M.H.: Aspects of tectonics of SE Asia: K.S.valdiya Understanding the earth By Artemis Press: P.H.I.: Gass, Smith and Wilson,
10. Plate tectonics and crustal evolution By K.C.Condie Pergomon press,
11. Holmes principles of Physical Geology. By D.Duff Chapman & Hall,
12. The evolving continents: By B. F. Windley John .Wiley and Sons.,
13. Crustal evolution and orogeny By S.P.h.Sychanthavong. Oxford & IBH.,
14. The evolving earth By Sawkins and others. Mac Millan,
15. The evolving Earth By L A M Cocks. Cambridge University Press,
16. Plate tectonics and magnetic reversals. Allan Cox . Freeman,
17. Basic problems in Geotectonics. V V Belousov. Mc Graw Hill,
18. Development in Geotectonics. Series from Vol.1 to 6. Elsevier,
19. Continental deformation By Paul Hancock. Oxford Publication House.

## Paper – III (G 103T) Palaeontology & Stratigraphy

### Unit – I

*Micro-palaeontology*: Origin and evolution of life. Classification and uses of microfossils. Detailed study of microfossils such as Foraminifera, Radiolaria, Conodonta, Ostracoda, Bacteria, Diatoms, Dinoflagellata and Charophyta.

*Plant fossils*: Gondwana flora and their significance.

### Unit – II

*Vertebrate palaeontology*: General characters, classification, evolution of *Fishes* including Agnaths, Placoderms, Chondrichythis and Osteichthytes. General characters, age of *Amphibians*, *Reptiles* and *Mammals*. General characters, classification, evolution, age and extinction of *Dinosaurs*. General characters, classification and evolution of *Horse*, *Elephant* and *Man*.

### Unit - III

*Principles of stratigraphy*: Nomenclature and the modern stratigraphic code. Litho-, bio-and chrono-stratigraphic units and their inter-relationships. Geological time scale. Magneto-stratigraphy. Dating of rocks. Modern methods of stratigraphic correlation. *Precambrian stratigraphy*: Archaean stratigraphy -tectonic frame-work, geological history and evolution of Dharwar, and their equivalents; Easternghats mobile belt; Proterozoic Stratigraphy: Tectonic framework, geological history and evolution of Cuddapahs and their equivalents.

### Unit -IV

*Palaeozoic stratigraphy*: Palaeozoic formations of India with special reference to type localities, history of sedimentation, fossil content. *Mesozoic stratigraphy*: Mesozoic formations of India with special reference to type localities, history of sedimentation, fossil content. Palaeogeography and Gondwana system. *Cenozoic stratigraphy*: Cenozoic formations of India, Rise of the Himalayas and evolution of Siwalik basin. Deccan volcanics. Stratigraphic boundary problems in Indian geology.

**PRACTICALS PAPER: (G -106P)**

#### Palaeontology:-

1. Morphology, Classification, Geological Age and Stratigraphic position of important fossils of Protozoa, Corals, Gastropoda, Cephalopoda, Lamellaebanchia, Brachiopoda, Echinodermata & Arthropoda, Plant, Microfossils and Vertebrate fossils

#### Books Recommended:-

1. Outline of palaeontology - H.H.Swinnerton
  2. Principles of invertebrate palaeontology-Shrock and Twenhofell.
  3. Introduction to evolution-Paul Ames Moody
  4. microfossils by Howard Armstrong and Martain Brasier
  5. palaeontology by Henry Woods
  6. Evolution of the invertebrate-Jean chaline
  7. Palaeobotany - Arnold
  8. Elements of Micropalaeontology by G. Bignot
  9. Palaeontology–Evolution and Animal distribution by P.C. Jain & M.S. Anantharaman
  10. A text book of Stratigraphy and Micropalaeontology and Palaeobotany by S.K. Tiwari
  11. Sedimentation and stratigraphy - Krumbein and Sloss L.L.
  12. Principles of stratigraphy - Dunbars & Rodgers
  13. Principles and practices in Stratigraphy - Marvin Weller
  14. Geology of India & Burma- M.S.Krishnan,
  15. Geology of India- D.N. Wadia,
  16. Fundamentals of Historical geology & stratigraphy of India- Ravindra Kumar.
  17. Geology of India : Geological Society of India, Bangalore Vol. 1 by Ramakrishna M. and Vaidyanadhan . R. (2008)
- Geology of India : Geological Society of India, Bangalore Vol. 2 by Vaidyanadhan . R. Ramakrishna M (2010).

## Paper – IV (G 104T) Geomorphology & Field Geology

### Unit – I

**Geomorphology:** Definition and fundamental concepts of geomorphology, **Geomorphic processes:** Exogenetic processes -gradation, degradation and aggradation; Endogenetic process -diastrophism, and volcanism. Extraterrestrial process -fall of meteorites. **Weathering:** physical weathering, chemical weathering and differential weathering, formation of soil, soil profile and mass wasting and its types. **Fluvial cycle:** Streams and valleys, drainage patterns and their significance, stream deposition, Peneplain concept, topography on domal, folded and faulted structures. **Groundwater cycle:** Origin of limestone caverns. Landforms of karst regions and karst topography.

### Unit – II

**Glacial cycle:** Features resulting from Glaciers, development of landforms, effects of Glaciation beyond ice caps and interglacial deposits. **Arid cycle:** Origin of deserts and its landforms, topographic effects of wind erosion. **Volcanism:** Landforms resulting from eruption and deposition of volcanism. **Geomorphology of coasts:** Topographic features resulting from marine deposition. **Topography of ocean floors:** Landforms related to shelves, slopes and deep sea. **Applied geomorphology:** Application of geomorphology to various fields of earth sciences.

### Unit – III

**Field Geology:** Introduction, **Toposheets:** Definition, Scale –definition, reading various components of a toposheet. **Geological map** -definition, various components of a geological map including scale, legend, structures etc. **Field work and sampling:** Field work, geological items to be carried to the field, Use of clinometer compass, Brunton compass, strike and dip measurements; Sampling and oriented sample and its significance, and sampling for isotopic and geochronological studies and its significance; **Geological mapping procedures:** Geological mapping of igneous, sedimentary and metamorphic terrains.

### Unit – IV

**Geographic positioning system (GPS):** Introduction, definition and scope of GPS, advantages and uses of GPS in different fields. **Surveying:** Principles and methods surveying, chain survey, prismatic survey, plane table survey and theodolite survey. Dumpy's level and Abney's level. Methods of representation of survey-data.

### PRACTICALS PAPER: (G -106P)

#### **Geomorphology:-**

1. Intra-conversion of scales of toposheets.
2. Study of contour-variations and elevations on toposheets.
3. Identification and classification of various types of fluvial, aeolin, Glacial and volcanic landforms on toposheets, geological maps, aerial photos and Landsat imageries.
4. Identification, demarcation and classification of folds & faults, lineaments, drainage basin, Morphometry analysis, gully patterns, from the toposheet.
5. Preparation of landuse- and landcover-maps from toposheet.
6. Identification and classification of geomorphological units on toposheet, aerial photos, Landsat imageries.



## **PRACTICALS**

### **Field Geology:-**

1. Reading of toposheets, geological maps and mine plans.
2. Representation factor of scale, representation of scale on the maps
3. Chain survey of an object taking offsets
4. Prismatic compass survey of an object by taking forward and backward bearing
5. Plane-table survey -radiation , traversing and intersection methods
6. Profiling using Abny's level and Levelling using Dumpy's level
7. Theodolite survey - countouring and height measurements
8. Operation of GPS.

### **Books Recommended**

1. Principles of Geomorphology by Thornbury, W.D..
2. Photogeology by Miller and Miller
3. Geomorphology by Arthur Bloome
4. Principles of Physical geology by Arthur Holmes
5. Analysis of landforms by Twidale, C.R
6. Geomorphology by Lobeck by Lobeck, A.K.
7. Field Geology by F.H. Lahee
8. Field Geology by Compton

## II Semester

### Paper – I (G 201T) Igneous Petrology & Geochemistry

#### Unit – I

- **Origin of magmas:** Normal state of mantle, onset of partial melting of mantle, process of partial melting in mantle, mantle-magmas in relation to degree and depth-level of partial melting.
- **Phase equilibrium in igneous systems:** Binary systems including Fo-Fa and An-Ab, ternary systems including Di-Ab-An and Fo-Di-An.
- **Bowen's reaction principle:** Reaction series and its application to petrogenesis.
- **Magmatic evolution and differentiation:** Fractional crystallization, gravitational differentiation, gas-streaming, liquid immiscibility and assimilation.
- **Structures and textures:** Definition, description, rock examples and genetic implications of common structures and textures of igneous rocks.
- **Classification of igneous rocks:** Mode, CIPW norm, IUGS and Irvine-Baragar classifications; **Magmatism and tectonics:** Inter-relationship between tectonic settings and igneous rock suites.

#### Unit – II

- **Igneous rock suites:** Form, structure, texture, modal mineralogy, petrogenesis and distribution of the following igneous rocks:
- **Ultramafic igneous rocks:** Dunite-peridotite-pyroxenite suite; kimberlites, lamprophyres, lamproites, komatiites;
- **Basic igneous rocks:** Gabbro-norite-anorthosite-troctolite suite, Dolerites; Basalts and related rocks;
- **Intermediate igneous rocks:** Diorite-monzonite-syenite suite; Andesites and related rocks;
- **Felsic igneous rocks:** Granite-syenite-granodiorite-tonalite suite; Rhyolites and related rocks;
- **Alkaline rocks:** Shonkinite, ijolite, urtite, melteigite, malignite, alkali gabbros, alkali basalt, alkali granite, alkali syenite, nepheline syenite and phonolite;
- **Carbonatites;**
- **Ophiolite suite.**

#### Unit – III

- **Geochemistry: Introduction:** Definition, scope and objectives.
- **Elements:** origin, abundance of elements in the solar system and earth, and its constituents; average mineralogical, petrological and, major and trace elemental composition of crust.
- **Meteorites:** Classification, mineralogy, chemical composition, origin and age of meteorites.
- **Primary geochemical differentiation of earth:** Original molten system, phases involved, chemical reactions and chemical affinity of elements.
- **Goldschmidt's geochemical classification of elements:** Definition, theoretical basis and significance of the classification, siderophiles, chalcophiles, lithophiles and atmophiles with examples.
- **Periodic table:** Definition and examples of transition elements, platinum group of elements, rare-earth elements, compatible elements, incompatible elements, high-field strength elements (HFSE), large ion lithophile elements (LILE).
- **Magmatism as geochemical process: Major elemental distribution in igneous rocks:** Geochemical trends of Mg, Fe, Mn, Ca, Al, Na, K and Si, Ti and P and, variation of Si/Al, (Na+K)/Al and Ca/Na ratios during differentiation by fractional crystallization of a basaltic magma. Goldschmidt's rules governing distribution of major elements.
- **Trace element distribution in igneous rocks:** trace elements during magmatic crystallization including camouflage, capture and admittance with examples of these substitutions.

#### Unit – IV

- **Sedimentation as a geochemical process:** Chemical breakdown and products of sedimentation, soil geochemistry, major and trace element composition of sandstone, shale and limestone, positive and negative colloids, Eh-pH relations during sedimentation;
- **Metamorphism as a geochemical process:** Chemical composition of metamorphic rocks;
- **Isotope geochemistry:** Definition, stable isotopes and radiogenic isotopes.
- **Stable isotopes:** Variations in abundance of O, S, C and H in minerals, rocks and water with respect to international standards, significance of stable isotope study.
- **Radiogenic isotopes:** Geochronology, radioactivity decay schemes and growth of daughter isotopes. **Radiometric dating:** Brief outline of U-Th-Pb, K-Ar, Sm-Nd and Rb-Sr methods of dating.
- **Atmospheric geochemistry:** Zonal structure of atmosphere, variable and non-variable chemical constituents of atmosphere.

## **PRACTICALS PAPER: (G-205 P)**

### **Igneous Petrology:-**

1. Megascopic and Microscopic studies of ultramafic, mafic (basic), intermediate and felsic (acidic) igneous rocks.
2. Modal classification of ultramafic, mafic intermediate and acidic igneous rocks following the IUGS nomenclature.
3. Chemical classification of igneous rocks on the  $(\text{Na}_2\text{O}+\text{K}_2\text{O})$  vs  $\text{SiO}_2$  diagram of Le Bas et al.(1986) Le Maitre et al (2002)
4. Calculation of the CIPW norm of Gabbro, Diorite, Granite, Syenite and Nepheline Syenite.

### **Geochemistry:-**

1. Mineral formula recalculation of Olivine, Pyroxene, Amphibole, Mica, Feldspars, Feldspathoid
2. Preparation and interpretation of Binary variation diagrams for whole rock major and trace element compositions of igneous rock suites using Harker's diagram and Ternary variation diagrams of AFM and Ca-Na-K diagrams,
3. Preparation and interpretation of REE patterns for common igneous rocks.

### **Books Recommended**

1. Igneous petrology – Middlemost,
2. Igneous Petrology – Antony Hall,
3. Igneous and Metamorphic Petrology-M.G. Best,
4. Principles of igneous and metamorphic petrology by A.R.Philpotts
5. Principles of igneous and metamorphic petrology by J.D. Winter
6. Introduction to Petrology- P.J.Wyllie, Prentice Hall,
7. Petrology – V. Hyndman Ed II,
8. The evolution of Igneous Rocks – N.L.Bowen, Princeton University Press,
9. Natural History of Igneous rocks – Harker A.Mc.Millan,
10. Basalts Vol I and II Poldervaart and Hess, H.H.,
11. Ultramafic rocks – Wyllie, P.J.Heffer,
12. Petrography, An introduction to the study of rocks in thin sections - William Turner, and Gilbert - W.H.Freeman,
13. Petrology by Walter T. Huang, McGraw-Hill Publ., 1962,
14. Igneous rocks by Alok K. Gupta, Allied Publ., 1998,
15. Igneous petrogenesis -a Global tectonic approach ( 1989) M. Wilson Unwin Hyman Ltd.,
16. Principles of Geochemistry by B. Mason and C. B. Moore,
17. Principles of isotope geology –Gunter Faure, John Wiley,

## Paper – II (G 202T) Metamorphic Petrology & Thermodynamics

### Unit – I

- **Metamorphic Petrology:** Definition, scope, historical background, factors and kinds of metamorphism and metamorphic processes;
- **Classification:** Classification of metamorphic rocks and nomenclature;
- **Structures and textures:** Definition, description and physical conditions of formation of various structures of metamorphic rocks;
- **Concepts of metamorphism:** Zones, grades, and facies of metamorphism.
- **Phase relations:** ACF, AFM and AKF phase diagrams for metamorphic mineral assemblages.

### Unit – II

- **Contact metamorphism:** Definition, physical conditions, distribution, sub-facies and characteristic mineral assemblages of sandinite facies and hornfels facies;
- **Regional metamorphism:** Definition, physical conditions, distribution, sub-facies and characteristic mineral assemblages of zeolite facies, greenschist facies, blueschist facies, amphibolite facies, granulite facies, and eclogite facies. Inter-relationship between metamorphism and tectonism.

### Unit – III

- **Phase rule:** Gibb's phase rule and study of phase relations in  $\text{Al}_2\text{SiO}_5$  system; Goldschmidt's mineralogical phase rule. 'pressure-temperature-depth relations' among various metamorphic facies and ultrametamorphism. ;
- **P-T diagrams:** Petrogenetic grids, univariant reaction curves for important metamorphic reactions, geothermobarometry, Pressure (P)-Temperature (T)-Time (T) paths.
- **Paired metamorphic belts:** Definition, characteristics and distribution, case study of Sanbagawa-Ryoke paired metamorphic belt, Japan;
- **Pressure vs metamorphic minerals:** Metapelitic and metabasic minerals and mineral assemblages characteristic of various basic types of metamorphism

### Unit – IV

- **Thermodynamics: Introduction:** Definition, scope, and objectives of thermodynamics, inter-relationship between petrogenetic processes and
- **thermodynamics;** Role of thermodynamics in geochemistry;
- **Chemical potential:** Fugacity and activity of a solute, activity coefficient,
- **Chemical processes:** Reversible and irreversible processes;
- **Internal energy:** Definition and expression of internal energy of a system, First law of thermodynamics;
- **Entropy:** Definition and expression of entropy of a system, Second law of thermodynamics,
- **Enthalpy:** Definition and expression of enthalpy of a system;
- **Free energy:** Gibb's free energy and Helmotz free energy of a system;
- Clausius- Clapeyron Equation and Calculation of Reaction Boundries

### PRACTICALS PAPER: (G-205 P)

#### (G-205P) Metamorphic Petrology:-

1. Megascopic and Microscopic identification of metamorphic rocks: Slates, Phyllites, Gneisses. Schists, Amphibolites, Charnockites, Khondalites, Eclogites, Marbles and Quartzites.
2. Construction and interpretation of ACF, AFM & AKF diagrams.

### **Books Recommended**

1. Elementary Thermodynamics for Geologists by B. J .Wood and D .G. Fraser.
2. Principles of Igneous and Metamorphic Petrology by A. R. Philpotts.
3. Igneous and Metamorphic Petrology by G. M. Best.
4. An Introduction to Metamorphic Petrology by B. W.D. Yardley
5. Petrogenesis of Metamorphic Rocks by Helmut G. F. **Winkler**

## Paper – III (G 203 T) Sedimentology & Petroleum Geology

### Unit – I

*Sedimentology: Sedimentary environments:* Definition and classification, non-marine environments including fluvial, Glacial, eolian and lacustrine environments, transitional environments including deltaic, beach and tidal flats, marine environments including shelf (clastic and non-clastic) and deep sea sedimentary environment.

### Unit – II

*Evolution of sedimentary basins:* Sedimentary basins, geosynclinal concept, plate tectonics, pre-flysch, flysch, molasse and turbidites; *Tectonic setting of sedimentary basins:* Sedimentary basins in various tectonic environments including divergent-, convergent-, transform fault-, hybrid- and intraplate-tectonic settings.

### Unit – III

*Petroleum Geology:* Definition, nature and origin of petroleum hydrocarbons; *Constitution:* Composition of petroleum and natural gas; *Origin:* Genesis of hydrocarbons, conversion of organic matter to petroleum, variety of petroleum hydrocarbons and gas hydrates; *Reservoir rocks:* Migration and accumulation of oil; *Oil traps:* Different types of traps including structural traps, stratigraphic traps and combination traps, salt domes.

### Unit – IV

*Exploration and exploitation of petroleum:* Surface indications, direct detection of hydrocarbons including geological, geophysical (electrical and seismic), geochemical and remote sensing methods. *Distribution:* Geographic and stratigraphic distribution of oil and gas, Global distribution, petroliferous basins in India.

## **PRACTICALS PAPER: (G-206P)**

### **Sedimentology:-**

1. Megascopic and Microscopic of Clastic and Non-Clastic of sedimentary rocks.
2. Grain size analysis by sieving method.
3. Heavy mineral (zircon, rutile and tourmaline, ZRT) analysis using Bromoform.
4. Estimation of sphericity and roundness of grains.
6. Identification of sedimentary structures and interpretation of depositional environments.
7. Construction and interpretation of rose diagrams using palaeocurrent data.
8. Classification of sedimentary rocks by plotting the modal and whole rock chemical compositions in relevant triangular diagrams.
9. Study and interpretation of lithofacies maps.
10. Classification of stromatolites (algal bioherms) using Logan et al (1964) scheme.

### **Books Recommended**

1. Sedimentary Rocks By Pettijohn, F. J., Harper & Row, N. Y.
2. Origin of Sedimentary Rocks By Blott, H., Middleton and Murray R.
3. Procedures in Sedimentary Petrology By Carver R.C.
4. principles of sedimentology and Stratigraphy by sam jr boggs.
5. Sedimentology Process and Product By Leader, M. R.
6. Sand and Sandstones By Pettijohn, F.J., & Potter, P.E.
7. Palaeocurrents and Basin analysis By Potter, P.E., & Pettijohn, F.J.
8. Depositional Sedimentary Environments By Rieneck, H.E., Singh, I.B.
9. An Introduction to Sedimentology By Shelly, R.C.
10. Practical Manual of Sedimentary Petrology By Babu, S.K., & Sinha, D.K.
11. Petrology of Sedimentary Rocks By Folk, R.L.
12. Practical Manual of Sedimentology By Lindholm, R.
13. Sedimentary Structures: CBS Publications

14. Petroleum Geology (Paperback - 2003) by Jon Guyas and Richard Swarbrick. Publisher: Blackwell Publishers. flipcart.com
15. Elements of Petroleum Geology. (Paperback - 1998) by Richard C. Selley. Publisher: Academic Press. flipcart.com
16. Geostatistics And Petroleum Geology. (Hardcover - 1998) by Michael Edward Hohn and M. E. Hohn. Publisher: Kluwer Academic Publishers.
17. Elements of Petroleum Geology By Shelley, R.C. 100/998 Academic Press.
18. Petroleum Geology By North, F.K.
19. Petroleum Geology By Chapman, R.C, 20. Petroleum Geology By Levenson, A.I.,
21. Sedimentation and stratigraphy By Krumbein and Sloss, 22. Petroleum Formation and Occurrence By Tissot, B.A & Welte, D.A 1984. Springer Verlag.

## Paper – IV (G 204 T ) Ore Genesis and Mineral Deposits

### Unit – I

**Ore genesis: Introduction:** Modern concept of ore genesis, **Ore mineral groups:** Detailed study of all principal ore mineral groups, plate tectonics and ore deposits; **Metallogeny:** Metallogeny through geological time. **Ore textures:** Advanced study of ore textures, scientific application of ore textures and ore genesis; **Paragenesis:** Paragenetic sequences and zoning in metallic ore deposits. **Ore microscopy:** Application of ore microscopy in mineral technology, **P-T estimation:** Application of geothermobarometry, **Fluid inclusion study:** Principles, assumptions, limitations and applications of fluid inclusions in ores: **Isotopic ore genesis:** Role and application of stable isotopes in ore genesis.

### Unit – II

**Ore associations:** Petrological ore associations with Indian examples, orthomagmatic ores of mafic-ultramafic association, diamonds in kimberlites, REE in carbonatites, chromite in chromitites and basic rocks, PGE in ultramafic and basic rocks; Cyprus type Cu-Zn, ore of silicic igneous rocks -Kiruna type Fe-P and Kuroko type Zn-Pb-Cu.

### Unit – III

**Ores of sedimentary affiliation:** Chemical and clastic sedimentation, stratiform and stratabound ore deposits (Mn, Fe, non-ferrous ores), placer concentrations; **Ores of metamorphic affiliation:** Greisen deposits and skarn deposits.

### Unit – IV

**Ore deposits:** Study of geology, nature of occurrence and the genesis of the following ore deposits with special reference to India: 1. Iron ore formations and deposits, 2. Chromite deposits. 3. Manganese deposits. 4. Copper deposits. 5. Lead and Zinc deposits. 6. Bauxite deposits. 7. Magnesite deposits. 8. Barite deposits. 9. Mica deposits. 10. Asbestos deposits. 11. Dimension and decorative stones; **Mineral based Industries:** Iron and steel; **Refractories:** Ceramic, electrical and insulators, Gass.

### PRACTICALS (G-206 P)

#### **Ore Genesis:-**

1. Demonstration and study of ore microscope with respect to the nature of reflected light and magnifications by objectives.
2. Ore sample preparation for ore petrography: polishing, mounding and cleaning with xylene.
3. Identification, classification of textures and paragenesis of pyrite, Pb, Sphalerite, Bornite, Arsenopyrite, Chalcocite, Pyrrhotite, Fe, Mn and Cr ores under ore microscope.

#### **Mineral Deposits:-**

1. Megascopic description with diagnostic physical properties, identification, classification of the Fe, Mn, Cr, Al, Cu, Pb, Zn ore minerals and Micas, Asbestos, Cassiterite, Pitchblende, Molybdenite, Orpiment, Realgar and Cinnabar, Gemstones, Apatite, Gypsum, Fluorite, Graphite, Limestone, Dolomite and Aluminosilicates.

#### **Books Recommended**

1. An introduction to the ore geology. By Anthony M Evans 1987 ELBS Books, Willey Scientific Publication, New York,
2. Economic Mineral Deposits. By Bateman Alan M. and Jenson 1981, John Willey & sons,
3. Ore Deposits. By Park C.G. McDiarmid 1972,
4. The geology of ore deposits. By John M. Golbert & Charles Park: W.H. Freeman & Co New York,
5. Geology of Mineral Deposits. By Smirnov, V.I 1972 ,
6. Ore Petrology. By L. Stanton. 1972,
7. Atlas of ore minerals. By Picot:
8. Ore minerals and their intergrowths. By Ramdhor, P. Permagaon Press,



9. Plate tectonics and crustal evolution. By R.C. Kondie 1983,
10. Ore Petrography and Mineralogy. By Craig.J.M. & Vaughjan, D.J. 1981 John Wiley,
11. Metal deposits in relation to plate tectonics By Sawkins, F.J. 1984 Springer Verlag,
12. Economic Geology and Geotectonics. By Toriling, D.H. 1981. Blackwell Sci. Publ.,
13. Geochemistry of Hydrothermal ore deposits By Barnes, H.L. 1979, John Wiley,
14. Time and strata Bound Ore Deposits. By Klemm, D.D. and Schneider, H.J. 1977 , Springer Verlag,
15. Ore genesis – a Holistic approach. By Mookherjee, A. 2000 Allied publisher,
16. Ore deposits and related to structural features. By W.H. New House.

## III Semester

### Paper – I (G 301 T) Mineral Exploration

#### Unit – I

- **Geological exploration: Introduction:** Definition, scope and objective of geological exploration, controls of mineralization;
- **Guides to ore deposits:** Physiographic guides, lithologic guides, stratigraphic guides, structural guides and mineralogical guides.

#### Unit – II

- **Geologic techniques and procedures of exploration:** Evaluation of outcrop, trenching, pitting, channeling; *Methods of sampling*;
- **Drilling and its application:** Types of drills and drill bits, core / sludge recovery, core logging;
- **Resources and reserves:** Calculation of average grade classification of ore reserves,
- UNFC classification.

#### Unit – III

- **Geophysical exploration:** Concepts, objectives and significance of geophysical exploration;
- **Geophysical instruments:** Simple types of measuring instruments; *Methods of Geophysical prospecting:* Field procedures and interpretation of data from various methods of geophysical prospecting including gravimetric, magnetic, electrical and radiometric methods;
- **Logging:** Well logging techniques and interpretation of data.

#### Unit – IV

- **Geochemical exploration: Introduction:** Definition, scope and objectives of geochemical exploration, geochemical environments, dispersion, mobility, geochemical associations, and, pathfinders and their application.
- **Primary environment:** Primary dispersions and halos.
- **Secondary environment:** Chemical weathering, significance of Eh and pH, absorption, mobility of elements in secondary environment, geochemical anomalies including significant, non-significant and displaced anomalies.

### **PRACTICALS (G-305 P)**

#### **Mineral Exploration:**

##### **Geological Exploration:-**

1. Calculation of assay values of the ore deposit, Tonnage by grid pattern, Vein-type ore deposit with Regular and Irregular intervals,
2. Study of area of influence of ore samples,
3. Estimation of Restricted and Non- Restricted lease holds by Triangular and Polygonal methods.
4. Ore reserve estimation by Geometrical, Cross-Sectional and by Graphical methods.

##### **Geophysical Exploration:-**

1. Study of the Geophysical interpretation of Gravity, Magnetic survey data and Seismic profiles of across southern India and Bombay-high of seismic map of India
2. Electrical resistivity survey: Wenner and Schlumberger methods

3. Plotting and interpretation of electrical resistivity survey data.

**Geochemical exploration:-**

1. Calculation of threshold value of Cu, Pb, Zn, from stream sediments,
2. Preparation and interpretation of geochemical map of Au, Ag, Pt, from the data,
3. Preparation of cross sections and determination of local threshold, regional threshold and geochemical anomaly from the geochemical map of Cu, Mn, Pb, Ag.

**Books Recommended**

1. Ore deposits and related to structural features By W.H. New House,
2. Courses in Mining Geology By Arogyaswamy,
3. Introduction to exploration geochemistry By Levinson, A.S.,
4. Mining geology By Mckenistry,
5. Exploration geology By Peters,
6. Geochemistry in mineral exploration By Rose, A. W., Hawkes H. E and Webb, J. S,
7. Geochemistry in mineral exploration By Govett. G. J Rock,
8. Introduction to geophysical prospecting By Dobrin, M.B.,
9. Ore deposits and related to structural features By W.H. New House,
10. Geochemistry in mineral exploration By Rose, AW. Hawkes H. E and Webb, J. S .

## Paper – II (G 302 T) Precambrian Geology and Crustal Evolution

### Unit I

Tectonic divisions of India. **Cratons**: Stratigraphy, geochronology and evolution of cratonic nuclei including Dharwar, Bastar, Sighbhum, Bundelkhand and Aravalli cratons. **Granite-greenstone belts**: Lithological, geochemical and stratigraphic characteristics of granite-greenstone belts of southern India.

### Unit II

**Mobile belts**: Structure, metamorphism, zonation and evolution of the Eastern Ghats, Pandyan, and Satpura mobile belts. Precambrians of the Himalayas.

### Unit III

**Proterozoic sedimentary basins**: *Palaeoproterozoic basins*: Structure, lithology and evolution of Papaghani, Bijawar, Sonrai, Gwalior, Abujmar basins. *Meso-Neoproterozoic basins*: Structure, lithology and evolution of Cuddapah, Vindhyan, Pranhita-Godavari, Pakhal, Kaldgi, Bhima, Chhattisgarh, Khariar, Indravati and Sabari basins. Boundary problem: Precambrian-cambrian boundary problems with special reference to India.

### Unit IV

**Precambrian igneous intrusions**: Locations, associated rock types and ages of the Precambrian anorthosites, alkaline rocks and carbonatites in coastal- and southern granulite terrains. **Precambrian igneous intrusions in Purana basins**: Locations, associated rock types and ages of igneous rocks in Vindhyan, Khariar, Indravathi and Cuddapah basins. Evolution: Evolution of lithosphere, hydrosphere, atmosphere, biosphere and cryosphere. Life in Precambrian.

### PRACTICALS (G-306 P)

#### Precambrian Geology:

- Megascopic and microscopic description of Precambrian rocks
- Demarkate the different Cratons in the Peninsular India
- Plotting of Kimberlites, Anorthosites and Alkaline rocks in the Precambrian shield of India.
- Demarcate Purana Basins in the Precambrian shield of India.

#### Books Recommended

1. Ramakrishnan, M and Vaidyanathan, R. (2010) Geology of India (Vol.1) Geological Society of India, Bangalore, 552pp
2. Vaidyanathan, R. and Ramakrishnan, M. (2010) Geology of India (Vol.2) Geological Society of India, Bangalore, 438pp.
3. Naqvi, S. M. and Roggers, J. J. W. (1990) Precambrians of South India. Geological Society of India, Bangalore, Mem.4.
4. Radhakrishna, B.P. and Ramakrishnan, M. (1983) Archaean Greenstone belts of South India, Mem.19, (Eds.) Geological Society of India, Bangalore.
5. Pitchamuthu, C.S. (1985) Archaean Geology. Oxford and IBH Publ.

## Paper – III (G 303 T) Mining Geology & Engineering Geology

### Unit - I

- **Mining Geology:** Introduction: Definition, basic concepts, terminology, broad classification of mining methods, planning, exploration and exploratory mining of surface and underground mineral deposits;
- **Geological factors considered for the selection of mining method viz.-** Alluvial/Surface mining, Quarrying, Open-cast mining, and Underground mining methods;
- **Geological conditions for-** Types of openings, their position, shape and size - adits, inclines, shafts, levels, cross-cuts, winzes and raises.
- **Types of drilling methods.**

### Unit – II

- **Alluvial mining/placer mining methods** – panning, batea, sluicing, longtom, hydraulicking, dredging and fore poling; Quarrying – controls of topography, structural features and methods of working;
- **Opencast/open pit/pit mining – Methods** – bench cut, Glory hole, strip mining. Factors considered for mechanization and transportation. Advantages and disadvantages; **Underground mining methods for epigenetic and bedded deposits:** advance and retreat mining, shaft sinking, drifting, crosscutting, winzing, stoping, top-slicing, sub-level caving and block caving. production and retreat stages, bord and pillar, room and pillar, long wall mining. Mine supports-factors considered for types of supports used. Mine ventilation- planning, its significance and effects;
- **Drainage- planning:** significance and its effect.
- **Mining hazards:** mine inundation, fire and rock burst; Procedure for grant of mining leases, mining plan preparation, mine closure plans.

**Unit – III : Engineering Geology:** Physico-mechanical properties of rocks-porosity, water absorption, specific gravity, abrasive hardness, compressive strength, tensile strength, shear strength, Modulus of elasticity; Physical characters of building and decorative stones, concrete aggregates; Road aggregates. Engineering properties of soils. Groundwater implications on civil engineering constructions.

**Unit – IV :** Geological considerations for the selection of dam sites and types of dams, Case histories of some major dams. Geological considerations and investigations in reservoir site selection, leakage problems and silting of reservoirs. Geological considerations in the selection of tunnels and their alignment. *Soil and rock slope failures* –causes, effects, and stabilization techniques.

### PRACTICALS

#### PAPER: (G-305 P)

#### Mining Geology:-

1. Determination of direction and dip of sub-surface mineral deposit, persistence of coal seam at depths, true dip based on apparent dips, true dip and direction of the mineral in a quarry face, vertical thickness of dipping mineralization in different directions.
2. Determination of true dip, dip direction, thickness and distance of outcrop from the nearest borehole.
3. Estimation of reserves in underground mine using borehole data.
4. Alignment of Adit, Shaft and incline in a moderately dipping ore body and in a steeply dipping ore body
5. Mine Planning – Open-cast & Underground mining exercise on geological section

## **PRACTICALS PAPER : (G-306)**

### **Engineering Geology**

1. Preparation of rock specimen for laboratory testing as per the method of IS: 9179 (1979),
2. Determination of unconfined compressive strength of some important rocks as per the method of IS: 1121, Part I (1974) and IS: 13030 (1991),
3. Determination of water absorption, apparent specific gravity and porosity of some important rocks as per the method of IS: 1974,
4. Determination of tensile strength of rocks by indirect test – Brazilian Test as per IS: 10082 (1981),
5. Determination of aggregate abrasion value as per the method of IS: 2386, Part IV (1963),
6. Petrographic examination of aggregates for concrete as per the method of IS: 2386, Part VIII (1963),
7. Calculation of shear strength of rocks,
8. Study and interpretation of geological maps pertaining to the major dam sites of India,
9. Study of Geotechnical Map of India published by GSI,  
Study of geological maps pertaining to some important Indian tunnels.
10. Interpretation of structural models of tunnels, faults and folds

### **Books Recommended**

1. Mining geology. Mckcnistry.
2. Mineral deposit Modelling By R.V. Kirkham and W.D. Sinclair, R.I. Thorpe and J.M. Duke. Geological association of Canada special paper 40 1997.
3. Principles of Mine Planning By Jayanth Bhattacharya. Allied Publ.
4. Mining Geology By R. N. P. Arogya Swamy.
5. Techniques in Underground Mining By Richard E. Gertsch and Richard L. Bullock. Society for Mining, Metallurgy and Exploration Inc. Littleton Co., USA.
6. Geology for Engineers By F.G.H. Blyth Defritas.
7. Geology for Engineers By Trefthen.
8. Engineering Geology and Geotechnics By F. G. Bell. Butterworth Publ. 1980.
9. Engineering Geology By Krynine and Judd.
10. Geology for Engineers By D.S. Arora.

## **Paper – IV (G 304 T) Mineral Economics and Fuels**

### **Unit – I**

*Mineral Economics: Introduction:* Definition-mining lease and regulations in brief; National mineral policy, conservation of minerals. \_Renewable and non-renewable resources. Recoverable reserves. Mines and Minerals Regulation & Development Act, Mineral Concession Rules Status of India in Mineral Resources.

### **Unit – II**

*Coal:* Origin of Coal-drift and insitu theories. Brief sedimentology of coal bearing strata. Rank, grade and type of coal. Indian and international classifications. Chemical characterization: proximate and ultimate analyses. Concept of ‘maceral’ and ‘microlithotypes’. Coal forming epochs in the geological past. Geological and geographical distribution of coal deposits in India. Detailed geology of Sone-Damuda-Mahanadi-Godavari coalfields.

### **Unit – III**

Methods of coal prospecting and estimation of coal reserves; Coal production and problems of coal industry in India; Coal bed methane: a new energy resource. Maturation of coal and generation of methane in coal beds. Coal as reservoir. Fundamentals of coal bed methane exploration and production. Principles of Coal petrology. Preparation of coal for industrial purposes, coal carbonization (coke manufacture), coal gasification and coal hydrogenation.

### **Unit – IV**

*Atomic Fuel:* Mode of occurrence and association of atomic minerals in nature. Atomic minerals as source of energy, Methods of prospecting and productive geological horizons in India. Beach sand deposits of India; Nuclear power plants of the country and future prospects. Atomic fuels and environment.

### **Books Recommended**

1. Text Book of Coal (Indian Context) By Chandra, D., Singh, R.M. and Singh, M.P., 2000 Tara Book agency, Varanasi
2. Coal and Organic Petrology. By Singh M.P. 1998, Hindustan Publication Corporation New Delhi.
3. Text Book of Coal Petrology By Stach,E. Mackowsky, M.T.H. Taylor G.H., Chadra, D., Teichmuller, M., and Teichmuller, R., 1982 By Bebruder Borntraeger, Stuttgart.
4. Geochemical Prospecting for Thorium and Uranium Deposits By Boyle, R.W. 1982 Elsevier.

## IV Semester

### Paper – I (G 401 T) Medical and Environmental Geology

#### Unit – I

*Introduction:* Definition and Scope, Historical background; Essential elements and toxic elements; Deficiencies, excesses and imbalances of trace elements; Elements in Atmosphere, Hydrosphere, Biosphere and Lithosphere in the Earth. Rock – Soil – Water-Plant – Human relations (RSWPH relations); *Geochemistry of Iodine* :iodine in drinking water and food ;Iodine deficiency disorders – goitrogens .

#### Unit – II

*Geochemistry of fluoride* : fluoride of soils, sediments and plants. Fluoride and health – Dental Fluorosis and Skeletal Fluorosis. Defluoridation of high fluoride groundwater; *Geochemistry of nitrates*: nitrogen cycle, nitrates, fertilizers and environment; human and animal wastes; methno Gobinaemia and cancer. *Geochemistry of arsenic*: arsenic in rocks and minerals and soils natural water; micro organism and arsenic; health effect water hardness.

#### Unit – III

Fundamental concepts of Environmental Geology-*Environmental geoscience*–it’s scope, objectives, and aims. *Earth’s thermal environment and Climates*. Gobar warming. Green house effect. Ozone depletion–Ice sheets and fluctuation in sea levels. *Concepts of ecosystem*. Earth’s major ecosystems terrestrial and aquatic. Meteorology as environmental science. *Earth resources* – Air, Pollution, sources, Ambient, Workplace, and Pollution due to dust, waste disposal. National and International standards. Environmental health hazards.

#### Unit – IV

*Elements of Environmental Impact Assessment* – impacts, primary, secondary, prediction, assessment, base-line data generation, physical, biological, cultural, socio-economic aspects. Carrying capacity based developmental planning – Assimilative capacity – supportive capacity – Resource based planning – Institutional strategies. *Concept of EHIA*, Concept of Regional Environmental Assessment (REA) – Strategic Environmental Assessments (SEA) – Its relevance to Indian Mining Industry. *Environmental Legislation* – Air Act, Water Act, Environmental Protection Act,

#### Books Recommended

1. Earth Materials and health-Research Priorities for Earth Science and Public Health. National Academic Press
2. Medical Geology by Dr. MIomir M. Komatina
3. Workshop on Medical Geology IGCP-454: Proceedings. Publisher – Geological Survey of India
4. Introduction of Medical Geology Series: Erlangen Earth Conference Series Dissanayake, C.B. Chandrajith, Rohana. Spriger
5. Environmental Geology - Indian Context By Valdiya, K. S. 1987. McGraw Hill Publ.
6. Environmental Geology By Keller, E. C. Bell and Howell, Columbus.
7. Environmental Concerns and Strategies By Khoshoo, T. L. 1988. Ashish Publ., New Delhi.
8. Environmental Geology By Bennett, M. R. B., Doyle, P. 1997. John Wiley & Sons, New York.
9. Pollution and Health By Ray, P. K. and Prasad, A. K. 1995. Wiley Eastern Publ., New Delhi.
10. Principles of Environmental Sampling By Keith, L. H. 1996. ACS Professional Reference book, Amer. Chem. Soc., Washington DC.



## **PRACTICALS (G-406 P)**

### **Environmental Geology and Project work**

1. Drainage basin analysis and terrain features evaluation based on toposheet and satellite imageries.
2. Preparation of rose diagram and ergograph (humidity, temperature, rainfall) data interpretation.
3. Field survey techniques in environmental sampling, base-line data generation.
4. Water quality monitoring, collection of water samples and analysis.
5. Electrochemical methods and volumetric analysis for few parameters.
6. Air quality monitoring, demonstration of instruments, collection of air samples and analysis.
7. Noise level monitoring, dispersion models.
8. Environmental Impact Assessment (EIA).
9. Environmental Management Plan (EMP).
10. Project work

### **Books Recommended**

1. Environmental Geology - Indian Context By Valdiya, K. S. 1987. McGraw Hill Publ.
2. Environmental Geology By Keller, E. C. Bell and Howell, Columbus.
3. Environmental Concerns and Strategies By Khoshoo, T. L. 1988. Ashish Publ., New Delhi.
4. Environmental Geology By Bennett, M. R. B., Doyle, P. 1997. John Wiley & Sons, New York.
5. Environmental Geology –Geoecosystems Protection in Mining Areas. Rekha Ghosh and D. S. Chatterjee. Capital Publ. Co., New Delhi.
6. Environmental Assessment Source Book 1991 Vol. I, II & III. Environment Department, The World Bank, Washington DC.
7. Pollution and Health By Ray, P. K. and Prasad, A. K. 1995. Wiley Eastern Publ., New Delhi.
8. Principles of Environmental Sampling By Keith, L. H. 1996. ACS Professional Reference book, Amer. Chem. Soc., Washington DC.

## Paper – II (G 402 T) Hydrogeology

### Unit – I

*Hydrology: Introduction:* Origin, type, age and Vertical distribution groundwater, hydrological cycle. hydrographs, water table contour maps; *Rock properties affecting groundwater:* Porosity, permeability, specific yield, specific retention, hydraulic conductivity, transmissivity, storage coefficient, Darcy Law

### Unit – II

*Well hydraulics:* General flow equations, steady unidirectional flow, steady radial flow to a well, unsteady radial flow in a confined and unconfined aquifer.

*Water level fluctuation:* Causative factors; *Pumping tests:* Methods of pumping tests and analysis of test data, evaluation of aquifer parameters. *Recharge:* Artificial recharge of groundwater, groundwater legislation.

### Unit – III

*Water well technology:* Well types, drilling methods, construction, design, development and maintenance of wells; *Exploration:* Surface and subsurface geophysical and geological methods of groundwater exploration, groundwater modeling.

### Unit – IV

*Ground water quality:* Sources of salinity, estimation of major elements, reporting of chemical analysis; quality criteria for groundwater use, salt water intrusion in coastal aquifers and remedial measures, *Groundwater pollution:*

## **PRACTICALS PAPER: (G-405)**

### **Hydrogeology:-**

1. Determination of flow direction of water, porosity & permeability of rocks
2. Analysis and interpretation of hydrographs.
3. Estimation of infiltration capacity.
4. Chemical analysis of water.
5. Pumping test – time drawdown and time recovery tests and evaluation of aquifer parameters and Step drawdown tests.
6. Resistivity survey for groundwater exploration.
7. Study of well logs.

### **Books Recommended**

1. Groundwater Hydrology By Todd, D. K., 1980. John Wiley.
2. Hydrogeology. Davies, S. N & De Wiest, R.J.M., 1966. John Wiley.
3. Groundwater. Freez, R. A & Cherry, J.A., 1979. Prentice Hall
4. Applied Hydrogeology. Fetter, C.W., 1990. Merrill Publishing.
5. Groundwater. Raghunath, N. M., 1982. Wiley Eastern
6. Groundwater Assessment-Development and Management. Karanth, K.R.,1987. Tata McGraw Hill
7. Regional Groundwater Quality. Alley. W. M., 1993:. VNR, New York.
8. Water. Subramaniam, V., 2000. Kingston Publ. London.
9. Geophysical Prospecting for Groundwater. Shankar Kumar Nath, Hari Pada Patra and Shamsuddin Shahid., 2000. Oxford IBH Publishing Co.Pvt.Ltd., New Delhi.

## **Paper – III (G 303 T) Remote Sensing, GPS & GIS**

### **Unit-I**

#### Aerial photography

- Introduction: Definition, scope and objectives, cameras, lenses, flight planning, scale of photographs, overlap and sidelaps.
- Types of aerial photographs, geometry, stereopairs and mosaics.
- Study and interpretation of aerial photographs.
- Identification of different landforms. terrain evaluation for strategic purpose, recent advancements and application.

### **Unit-II**

#### Remote Sensing:

- Definition, methods, scope and limitations, energy source and its
- interaction with atmosphere and earth features; Electro magnetic spectrum
- Laws of radiation, black body radiation.
- Remote sensing platforms: Active and passive systems;
- Satellites: High level and low level satellites, geosynchronous and sunsynchronous satellites;
- Types of sensors and scanners; IFOV, swath, satellite orbits,
- Resolutions: Spectral, spatial, radiometric and temporal resolutions Imageries:
- Types of imageries, visual interpretation;
- Space missions: Global and Indian space missions. different satellite exploration programmes and their characteristics, LANDSAT, METEOSAT, SEASAT, SPOT, IRS.
- Concepts of Global Positioning System (GPS)

### **Unit-III**

#### Geographic Information System (GIS)

- Maps: Maps and their different features/themes/layers, map projections-different types and their properties,
- Database: Definition and types of database,
- Data management: Data quality, data manipulation and analysis,
- advantages and vector and raster data models and their relative merits;
- Geographic Information System (GIS): Principles and application of geographic information system, introduction, definition and scope, components of GIS (hardware and software requirement for GIS application);
- GIS software in use, both proprietary and Open source software;
- GIS processes: Digitization, topology, attribution, attribute based query, spatial query, overlay analysis; Map generation and composition.
- Application of GIS and GPS, advantages, uses in different fields.

### **Unit-IV**

- Extraction of features from Satellite imagery and integrating with other themes in GIS
- GIS Project: Planning and implementation.

### **PRACTICALS (G-405 P)**

#### **Remote Sensing**

1. Study of Satellite data; Digital image techniques; Software etc
2. Interpretation of satellite images – False Color Composite.
3. Visual image interpretation and extraction of thematic layers.
4. Identification of structures and lineaments.
5. Delineation of land forms, study of geomorphology and hydro geomorphology.

6. Study of land use and land cover and demarcation of drainage basin.
7. Identification of rock types and minerals.
8. Integration of various thematic layers, ground truthing.
9. Aerial photo interpretation: scale, height, and slope from aerial photos; study of inclined and vertical photographs.
10. Report writing for reconnaissance survey; detailed survey and targeting.

### **Geographic Information System (GIS)**

1. Auto-CAD, digitization techniques, Auto-CAD software, import of images, creation of layers, digitization etc.
2. GIS, Softwares, ARC INFO, ARC-GIS, QGIS, ILWIS.
3. Georeferencing the Map and create Point feature, Line feature and Polygon features.
4. Exploring and planning data sets for GIS.
5. Preparing data sets for input in GIS environment.
6. Integration of spatial and temporal data
7. Analysis and manipulation of data in GIS.
8. Graphical representation of data.
9. Modelling and extrapolation of data.
10. Report writing.

### **Books Recommended**

1. Analysis of landforms By Twidale, C.R.,
2. Photogrammetry By Moffitt, F.H and Mikhail, E.M.,
3. Photogeology by Miller and Miller,
4. Elements of Photogrammetry By Wolfe, P.R.,
5. Aerial photography and image interpretation for resource management by Pandey, S.N.,
6. Remote sensing and GIS By Anji Reddy,
7. Remote sensing and image interpretation By Lillesand and Kiefer,
8. Image interpretation in Geology. By Drury, S.A.,
9. Image interpretation By Lender,
10. Remote sensing in geology By Gupta, R.P.,
11. Remote sensing – Principles and applications By Sabins, F.F.,
12. Geographic Information Systems By Stan Arnoff., 13. Principle of Geographical Information Systems for Earth Resources Assessment. By Burrough, P.A.

## **Paper – IV (G 404 T) Disaster Management**

### **Unit – I**

Definition, Nature, Types and Classification of Natural Disasters, Impact of disasters on environment, Infrastructure, Livestock, Human, Housing, Communication, Food, Shelter, Medicine. Rehabilitation hazards, Vulnerability, Risk analysis (assessment of hazard, nature of vulnerability), Basic Principles and elements of disaster mitigation, Disaster management, organization and methodology, cost benefit considerations, Progress in International disaster, reduction and mitigation.

### **Unit – II**

Earthquakes: Introduction to earthquakes, Earthquake prediction, Intensity scales, Seismic activity in India, Earthquakes in A. P., Action plan for Earthquakes, visibility of earthquake situation, Actions to be taken before earthquake, Dos & Don'ts during and after impact of Earthquakes. Action during Earthquakes, Recovery and rehabilitation after earthquake.

### **Unit – III**

Floods: Flood mitigation practice, flood management and community perspectives, (Flood control – disaster management, A study in cost benefit analysis), Vulnerability analysis, Risk assessment, Action to be taken before, after and during floods, Recovery and rehabilitation after floods, Visibility of flood situation, Psychological factors, Cyclone management in coastal area.

### **Unit – IV**

Drought, Characteristics of drought, Impact on environment, economy, contingency action plans, cost benefit analysis, vulnerability studies. Cost studies in disaster management of floods, Earthquakes, Wind and drought disasters, Relief operations to mitigation approach of natural disaster, i.e. floods, earthquakes, drought and cyclones.

### **Books Recommended**

1. Vinod K. Sharma (1999) Disaster Management. National Centre for Disaster management, IPE, New Delhi,
2. Alexander David (1993) Natural Disaster, UCC Press, London.
3. Kathkali S Bagchi (1991) Problems and Perspectives –Drought Prone India. New Delhi,

**ELECTIVES (ID PAPERS)**  
**MINERALS, GEMS AND ROCKS**

**Paper – I**

**UNIT I:**

**Minerals:** Definition genesis and formation of minerals, Chemical and structural principles of minerals.

**Rock forming minerals:** Quartz, Feldspars, Feldspathoids, Olivines, Pyroxenes, Amphiboles, Biotite and Muscovite.

**UNITE II:**

**Ore forming minerals:** Iron ores, manganese Ores, Copper ores, lead ores, zinc ores and aluminum ores.

**UNIT III :**

**Gemstones:** Definition, genesis and formation of gems. Ruby, Sapphire, aquamarine, Emerald, Topaz, Diamond, Garnet, Jade, Opal and Catseye.

Uses of gemstones.

**UNIT IV:**

**Rocks:** Definition, genesis and formation of rocks. Igneous rocks, Sedimentary rocks and metamorphic rocks. Building and decorative stones

**Books Recommended**

1. Rutley's elements of mineralogy 26<sup>th</sup> Edition By H.H. Read.
2. The Principles of Petrology by G.W. Tyrrell
3. Rutley's Elements of Mineralogy 27<sup>th</sup> Edition by Gribble
4. Gems and Gem Industry in India by R. V. Karanth
5. Economic Geology: Economic Mineral Deposits 2nd Edition by Umeshwar Prasad

# WATERSHED MANAGEMENT

## Paper – II

### Unit - I

*Introduction:* Definition, concepts of watershed; *Effects of watershed on community:* a) topography b) channel networks c) geology and soils d) vegetation and landuse; *Soils:* Types of rocks, weathering of rocks, factors of soil formation, soil forming processes, soil profile, physical properties, types of the soils in India; *Soil erosion:* Basic processes, factors affecting soil erosion, types of soil erosion; *Watershed development:* Land capability classification, concept, objectives and need for watershed development.

### Unit - II

*Hydrologic processes:* Hydrologic cycle, precipitation (liquid/solid), interception, evaporation and transpiration, infiltration and run-off; *Participatory rural appraisal (PRA) in watershed programme:* Basic principles, assumptions, basis, important types, benefits, tools, maps and models of PRA programmes; *Erosion control measures on agricultural land:* Contour cultivation, contour bunding, graded bunds, bench terracing, grassed water ways; *Mechanical erosion control measures for non agricultural land:* Contour trenching, gully control measures, vegetative control measures, checkdams, brush dams, semi permanent gully, control structures, permanent control structures.

### Unit - III.

*Water conservation and Harvesting:* Rainwater harvesting, catchment harvesting, harvesting structures, soil moisture conservation, check dams, artificial recharge, farm ponds, percolation tanks; *Groundwater management in watershed:* Types of aquifers, vertical distribution of groundwater, conjunctive use of surface and use of groundwater; *Remote sensing,* thematic maps, geological and hydrogeological maps.

### Unit - IV

*Ecosystem Management:* Role of ecosystem, crop husbandry, soil enrichment, inter-, mixed- and strip-cropping, cropping pattern, sustainable agriculture, bio-mass management, dryland agriculture, Silvi pasture, horticulture, social forestry and afforestation; *Grassland management,* /Joint forestry management Monitoring and evolution of watershed; *Planning of watershed management activities:* Preparation of action plan, administrative requirements.

### Books Recommended

#### Watershed Management

1. Watershed Management by JVS Murthy, - New age International Publishers.
2. Water Resource Engineering by R.Awurbs and WP James, - Prentice Hall Publishers.
3. Integrated watershed management – Rawat publications by – Rajesh Rajora.
4. Land and Water Management by VVN Murthy, - Kalyani Publications.
5. Irrigation and Water Management by D.K.Majumdar, Printice Hall of India.

# MODEL QUESTION PAPER (THEORY)

M. Sc. Geology

(I, II, III & IV Semester Examinations)

Papers – I, II, III, and IV

**Time: 3 Hours**

**Marks: 80**

**Max.**

Note: Answer all questions from Part A and Part-B.

Each question carries 4 marks in Part-A and 15 marks in Part-B.

Part-A (4 x 5 = 20 Marks)

(Short Answer Type)

1. Unit I
2. Unit I
3. Unit II
4. Unit II

Part-B (4 x 15 = 60 Marks)

(Essay Answer Type)

- 5 (a) Unit I  
Or  
(b) Unit I
- 6 (a) Unit II  
Or  
(b) Unit II
- 7 (a) Unit III  
Or  
(b) Unit III
- 8 (a) Unit IV  
Or  
(b) Unit IV