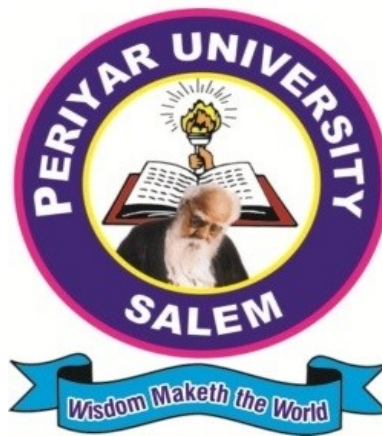


**PERIYAR UNIVERSITY**  
**Department of Geology**  
**Salem-636 011, Tamil Nadu, India**



**DEGREE OF MASTER OF SCIENCE**

**M.Sc.,- APPLIED GEOLOGY**

**CHOICE BASED CREDIT SYSTEM (CBCS)**

**(SEMESTER PATTERN)**

**REGULATION & SYLLABUS**

For University Department  
Effective from the academic year 2018-2019 onwards

**2018**

M.Sc., APPLIED GEOLOGY  
DEPARTMENT OF GEOLOGY  
CHOICE BASED CREDIT SYSTEM (CBCS)

REGULATIONS

M.Sc Applied Geology programme is being offered under Choice Based Credit System (CBCS). The CBCS enables the students to select varieties of subjects as per her /his interest and requirement. Acquiring knowledge in the related discipline is advantageous to the students. The CBCS programme is framed in such a way that to impart more Knowledge in the field of Earth Sciences.

Eligibility for Admission

A candidate who has passed B.Sc degree in Applied Geology/ Geology of this university or an examination of any other university accepted by the Syndicate as equivalent thereto shall be permitted to appear and qualify for the M.Sc Applied Geology Degree examinations of this university after a course of two academic years, in the Department of Geology, Periyar University.

Duration of the Course

The course for the degree of Master of Science in Applied Geology shall consist of two academic years divided into four semesters. Each Semester consists of 90 working days.

Semester

An academic year consists of two semesters. The Normal semester periods are

- ✓ Odd Semester : July to November
- ✓ Even Semester: December to April

Each semester has 18 teaching weeks with working hours spread over 5 days a week.

Teaching Methodologies

The classroom teaching would be through conventional lectures and use of Power Point presentations and field demonstration. The lecture would be such that the student should participate actively in the discussion. Student seminars would be conducted and scientific discussions would be arranged to improve their communicative skill. In the laboratory, instruction would be given for the experiments/exercise followed by demonstration and finally the students have to do the experiments individually. Periodic tests would be conducted and for the students of slow learners would be given special attention.

Course Components

Core courses

Core courses are compulsory basic subjects in the programme offered by the department. Each core course carries 4 credits. Core courses offered by one department will

not be treated as elective by other. Core courses include theory, practical, project work, geological mapping, internship, training, field training and industrial visits. Students can be permitted to carry out project works at reputed institutions and industries.

#### Elective courses

Elective courses (disciplinary) are offered by the parent department. Each elective course carries 4 credits.

#### Supportive courses

Supportive courses are aimed at bridging the gap in the curricula and to learn the advancements in other disciplines. The department, in consultation with other departments, will offer supportive courses during I, II & III semesters. Similarly, students from Geology Department will study the supportive course from other department.

#### Compulsory Course

A course on Human rights-Duties is compulsory in the II semester.

#### Massive Open Online Course (MOOC)

Massive Open Online Course (MOOC) introduced to the students to help them compare their course content with that of the eminent faculty across the country. MOOC online course is available in the SWAYAM and SWAYAM PRABHA MHRD web portal. All the master level students must enroll and complete two MOOC courses related to their discipline of study.

#### Field Work/Training

Geological mapping/Field work mine, industrial trainings and internship training are the integral part of the curriculum.

#### Credits

The quantum of syllabus for various programmes in terms of hours of study. It indicates differential weightage given according to the contents and duration of the courses in the curriculum design. The minimum credit requirement for a two-year Master's programme shall be 90.

#### Course weightage

A course carrying one credit for lectures will have instruction of one period per week during the semester. If four hours of lecture are necessary in each week for that course, then 4 credits will be the weighted. Thus, normally in each of the courses, credits will be assigned on the basis of the lectures/ tutorials/ laboratory work and other forms of learning in a 18-week schedule.

#### Evaluation

Evaluation will be done on a continuous basis during the course work through class test and midterm exams. Evaluation may be done by objective type questions, short answers,

essays or a combination of these, but the end semester examination is a written examination.

#### Examinations

There shall be four examinations in the 2 year programme, each at the end of the semester. Candidates failing in any subject/ subjects will be permitted to appear for subsequent semesters as per University norms.

The practical examinations will be conducted at the end of the first, second and third semester. Candidates failing in any of the practical examination / examinations will be permitted to appear for such failed practical examination/ examinations at corresponding subsequent practical examinations.

#### Passing Minimum

A candidate has to secure a minimum of 50% mark in each course and earn a minimum of 90 credits for the award of a Master's degree.

#### Distribution of Marks

##### Theory

University Examination (External)	:	75 marks
Internal Assessment	:	25 marks

#### Distribution of Internal Assessment mark

Test	:	10 marks
Attendance	:	5 marks
Assignment	:	5 marks
Seminar	:	5 marks

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Total : 25 marks  
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Passing Minimum : Internal Assessment : 50% - 12 marks

Passing Minimum : External Assessment : 50% - 38 marks

Total Passing Minimum - 50 marks

#### Practicals

University Examination (External)	:	60 marks
Internal Assessment	:	40 marks

#### Calculation of Internal Assessment mark

Attendance	:	05 marks
Number of Experiments/Exercise	:	10 marks
Practical Test	:	10 marks
Geological Field work, Sample Display and Report	:	15 marks

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Total : 40 marks

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Passing Minimum : Internal Assessment : 50% - 20 marks

Passing Minimum: External Assessment : 50% - 30 marks

Total Passing Minimum - 50 marks

Everything should be supported by proper record separate passing minimum is necessary for Internal and External

M.Sc., Applied Geology  
Curriculum and Scheme of Examinations

Sl.No	Paper Code	Title of the Paper	Hours	I	E	M	C
<b>I-Semester</b>							
1	18AGC01	Applied Geomorphology	4	25	75	100	4
2	18AGC02	Structural Geology and Geotectonic	4	25	75	100	4
3	18AGC03	Mineralogy	4	25	75	100	4
4	18AGC04	Palaeontology	4	25	75	100	4
5	18AGE...	Elective I/II	4	25	75	100	4

6	18AGP01	Practical –I Structural Geology, Mineralogy and Palaeontology*	4	40	60	100	4
7	18AGM01	MOOC Course – I	-				4
<b>II-Semester</b>							
1	18AGC05	Igneous and Metamorphic Petrology	4	25	75	100	4
2	18AGC06	Sedimentology	4	25	75	100	4
3	18AGC07	Stratigraphic Principles and Indian Stratigraphy	4	25	75	100	4
4	18AGC08	Exploration Geology	4	25	75	100	4
5	18AGP02	Practical – II Petrology and Sedimentology*	4	40	60	100	4
6	18AGE...	Elective – III / IV	4	25	75	100	4
7	---	Supportive Course	3	25	75	100	3
8		Human Rights -Duties	-				
9	18AGM02	MOOC Course – II	-				4
10	18AGFT	Geological Mapping/ Field Training	-				
<b>III-Semester</b>							
1	18AGC09	Economic Geology	4	25	75	100	4
2	18AGC010	Applied Micropalaeontology	4	25	75	100	4
3	18AGC011	Applied Hydrogeology	4	25	75	100	4
4	18AGC012	Advanced Remote Sensing and GIS	4	25	75	100	4
5	18AGP03	Practical – III Economic Geology and Micropaleontology*	4	40	60	100	4
6	18AGP04	Practical – IV Hydrogeology, Remote Sensing and GIS*	4	40	60	100	4
7	18AGIT	Internship Training	-				
<b>IV- Semester</b>							
1	18AGC013	Fuel Geology	4	25	75	100	4
2	18AGE...	Elective V/VI	4	25	75	100	4
3	18AGPJ	Project/Dissertation	7	50	150	200	7
<b>Elective Courses</b>							
1.	18AGE01	Mining and Engineering Geology	4	25	75	100	4
2.	18AGE02	Analytical and Instrumentation Techniques	4	25	75	100	4
3.	18AGE03	Applied Stratigraphy	4	25	75	100	4
4.	18AGE04	Meteorology and Climate Change	4	25	75	100	4
5.	18AGE05	Environmental Geology	4	25	75	100	4
6.	18AGE06	Marine Geology	4	25	75	100	4
<b>Supportive Courses</b>							
1.	18GS01	Earth System Science	3	25	75	100	3
2.	18GS02	Water Resources Management	3	25	75	100	3

3.	18GS03	Gemmology	3	25	75	100	3
4.	18GS04	Rainwater Harvesting and Artificial Groundwater Recharge	3	25	75	100	3
5.	18GS05	Geohazards	3	25	75	100	3
<b>Massive Open Online Course (MOOC)</b>							
1	18AGM01	Mineral Resources: Geology, Exploration, Economics and Environment		-			4
2	18AGM02	Introduction to Geographic Information System		-			4
3	18AGM03	Disaster Management		-			4
4	18AGM04	Introduction to Mineral Processing		-			4
5	18AGM05	Geology and Soil Mechanics		-			4

Note: \*Practical examination will be held at the Even Semesters

1. Human Rights -Duties – Compulsory course for All P.G. Students
2. C- Core Course, E – Elective Course & S-Supportive Courses, L – Lecture, T-Tutorial, P – Practical

Credits for Core Courses	75	Credits for MOOC Courses	08
Credits for Elective Courses	12	Credits for Human Rights-Duties	02
Credits for Supportive Courses	03		
Total Credits	90		

#### Question Paper Pattern

Time: 3 Hours

Max. Marks - 75

PART-A Objective Type: 20X1=20  
(Answer all questions)  
(Four questions from each unit)

PART-B Descriptive Type : 3 X 5=15  
(Answer any three questions)  
(One question from each unit)

PART- C Descriptive Type : 5X8=40  
(Answer all questions)  
(One question from each unit with either or type)

Syllabus for M.Sc., Applied Geology  
18AGC01 – APPLIED GEOMORPHOLOGY

Unit I

Definition of Geomorphology. Evolution of geomorphic concepts. Principles/laws of geomorphology. Endogenic and exogenic driving forces. Resisting forces. Dynamic equilibrium of driving and resisting forces and Threshold. Modern concepts, quantitative geomorphology, process geomorphology.

Unit II

Role of tectonics, climate, slope, lithology, vegetation, land cover/land use and human in landscape evolution. Spatio-temporal scale of geomorphic processes. Mineral stability series. Physical, chemical and biological weathering. Soil profiles, Types of soils. Erosional and Depositional landforms. Agents of geomorphic processes – Volcanism, Gravity, glaciers, wind, rivers, tides, waves, currents.

Unit III

Classification of mountains, Types of volcanoes. Volcanic landforms. Isostasy, Tectonic landforms, Gravity landforms. Climate zones of the World. Genesis, distribution and types of glaciers. Landforms in glaciated regions. Aeolian process as a geomorphic agent. Aeolian landforms. Characteristics of dry and wet deserts.

Unit IV

Overland and subsurface flow. Fluvial process. Types of drainage pattern. Fluvial landforms. Types of Deltas. Classification of coast lines, Depositional and erosional coast lines. Coastal and marine landforms.

Unit V

Geomorphic sub-divisions of Indian sub-continent – Himalayan landscape, Indo-Gangetic plains, Deccan Plateau, Coastal low lands. Application of Geomorphology in groundwater exploration, environmental and natural resource management. Geomorphic mapping methods and tools.

Text / Reference Books

1. Bloom.A.L. (1992), Surface of the Earth, Prentice Hall India, New Delhi
2. Gass, I.G., Smith, P.S & Wilson, R.C.L., 2ndEdt., (1972), Understanding the Earth, The English Language Books Society, London
3. Holmes.A, (1972), Principles of Physical Geology The English Language Book Society and Nelson
4. Jacob.J, Russel, R.D & Wilson, J.T, (1959), Physics and Geology, McGraw – Hill, New York.
5. Leopold,L.S, Wolman, K & Miller, J.P, (1970), Fluvial processes in Geomorphology, Eurasia Publishing House Pvt Ltd., New Delhi.
6. Richard Huggett (2007) Fundamentals of Geomorphology. II Edition.
7. Robert, S.A. and Suzanne, P.A.,(2010) Geomorphology – The mechanics and chemistry of landscapes. Cambridge University Press.
8. Routledge N. Y. Ritter,D.F., Kochel, R.C.,Miller, J.R.,(2002) Process Geomorphology, Waveland press,.
9. Sagan, C. (1973). , Planetary Engineering on Mars, Icarus, 20, 513.



10. Sharma.H.S. (1990) Indian Geomorphology. Concept Pub. Co., New Delhi.
11. Thornbury, W.D., (2004) Principles of Geomorphology. II edition. Wiley Eastern Ltd. New Delhi.
12. Wyllie., P.J, (1971), Dynamic Earth, John Wiley & sons, New York.

## 18AGC02 - STRUCTURAL GEOLOGY AND GEOTECTONIC

### Unit I

#### Deformation, Stress and Strain

Deformation: Definition - Components of deformation. Strain: Homogeneous and heterogeneous deformation - One-dimensional strain, Strain in two dimensions, Three-dimensional strain - The strain ellipsoid. Uniaxial strain (compaction) - Pure shear and coaxial deformations - Simple shear - Progressive deformation and flow parameters - Steady-state deformation - Incremental deformation - Strain compatibility and boundary conditions. Stress: Definitions, magnitudes and units - Stress on a surface - Stress at a point - Stress components - The stress tensor (matrix) Deviatoric stress and mean stress Mohr circle and diagram. Rheology: Rheology and continuum mechanics - Idealized conditions - Elastic materials - Plasticity and flow: permanent deformation - The role of temperature, water, etc. Definition of plastic, ductile and brittle deformation.

### Unit II

#### Brittle Deformation

Fracture : Brittle deformation mechanisms - Types of fractures - Failure and fracture criteria - Fracture termination and interaction - Fluid pressure, effective stress and poroelasticity. Joints: Definition and characteristics - Kinematics and stress -How, why and where joints form - Joint distributions - Growth and morphology of joints - Joints, permeability and fluid flow.

Faults: Fault anatomy – Types of Faults – Recognition of Faults – Fault Geometry – Characteristics of Normal Faults – Shape and Displacement of Normal Faults – Kinematic Models of Normal Fault, Thrust or reverse faults, and strike-slip faults - Contractual faults - Thrust faults - Ramps, thrusts and folds - Extensional regimes: Extensional faults Fault systems Low-angle faults and core complexes - Ramp-flat-ramp geometries - Rifting Half-grabens and accommodation Strike-slip, transpression and transtension: Strike-slip faults - Transfer faults -Transcurrent faults - Development and anatomy of strike-slip faults – Transpression and transtension.

### Unit III

#### Ductile Deformation

Folds and folding: Geometric parts of Folds – Kinematic of Flexural folding, Passive shear folding, Homogeneous flattening, Folding of multilayer - Formation of Kink and Chevron folds-Superposed folding. Folding: mechanisms and processes - Fold interference patterns and refolded folds - Fold in shear zones - Folding at shallow crustal depths.

Foliation and cleavage: Basic concepts - Types of foliation: Slaty cleavage or schistosity - Fracture cleavage- Crenulations cleavage – Shear cleavage – Bedding cleavage – Axial plane cleavage. Cleavage development- Cleavage, folds and strain.

Lineation: Types of Lineation: Intersection Lineation – Crenulation Lineation – Mineral Lineation – Stretched – pebble Lineation – Rodding Lineation – Mullion Lineation – Boudinage – Pencil Structures. Lineations related to plastic deformation Lineations in the brittle regime Lineations and kinematics.

#### Unit IV

Boudinage, Shear zones, and salt tectonics

Boudinage: Boudinage and pinch-and-swell structures - Geometry, viscosity and strain -Asymmetric boudinage and rotation - Foliation boudinage - Boudinage and the strain ellipse.

Shear zones and mylonites: Definition: shear zone - The ideal plastic shear zone Adding pure shear to a simple shear zone Non-plane strain shear zones Mylonites and kinematic indicators.

Salt tectonics Salt tectonics and halokinesis Salt properties and rheology Salt diapirism, salt geometry and the flow of salt Rising diapirs: processes Salt diapirism in the extensional regime Diapirism in the contractional regime Diapirism in strike-slip settings Salt collapse by karstification Salt décollements.

#### Unit V

Geotectonics

Plate tectonics: Concept of plate and plate movements, nature of convergent, divergent and conservative plate margins. Plate tectonics in relation to igneous, sedimentary and metamorphic processes and mineralization. Triple junctions, aulocogens, plume theory, island arcs. Nature and origin of earth's magnetic field. Evolution of Himalaya and Himalayan tectonics.

Text / Reference Books

1. Badgley.P.C. (1965), Structural and Tectonic Principles, Harper International, New York.
2. Belousov,V.V.(1968).Structural Geology, Mir Publishers.
3. Billing, M.P.(1972).Structural Geology, Prentice-Hall.
4. Chiplonkar C.W. & Power K.B., (1988), Geological Maps, DastaneRamchandra& Co., Pune.
5. Condie, K.C.,(1976).Plate tectonics and Crustal evolution.
6. Davis,G.H., 1984.Structural Geology of Rocks and Regions. John Wiley & Sons.
7. De Sitter. L.U. (1956), Structural Geology, McGraw Hill, New York.
8. Haakon Fossen, 2010. Structural Geology, Cambridge University Press.
9. Hill. E.S. (1972), Elements of Structural Geology, John Wiley, New York
10. Hobbs, B.E., Means, W.D. and Williams, P.F. John Wiley, (1976) An outline of structural geology,
11. Paor, D. (1996). Structural Geology and Personal Computer, Pergamon,
12. Park, R.G., (1983). Foundations of Structural Geology, Blackie and Sons Ltd.

13. Ragan, D M John Wiley, (1985) Structural geology - An Introduction to Geometrical Techniques,
14. Ramsay.J.G&Huber.M.I, (1983), The Techniques of Modern Structural Geology: Vol I – Strain Analysis.
15. Ramsay.J.G&Huber.M.I, (1987), The Techniques of Modern Structural Geology: Vol II – Folds & Fractures
16. Rowland, S.M. and Duebendorfer, E.M. (1994).Structural Analysis and Synthesis, Pergamon,
17. Twiss, Robert J. and Moores, Eldridge M., (2007). Structural geology, W.H.Freeman and Company, New York., p.742
18. Uemura, T., and Mizutani, S., (1979). Geological Structures, Ed.Volume.John Wiley & Sons.
19. Windley, B.F.,(1976).The Evolving Continents. Jhon Wiley and, New York.

## 18AGC03 – MINERALOGY

### Unit I

*Crystallography*: Atomic structure of crystal, space lattice and unit cell. Bonding in minerals. Nature of crystal. Symmetry elements. System of crystallization. Weiss and Millerian system of crystal notation. Interfacial angle. Twin crystals and Irregularities of crystals.

## Unit II

*X- rays study of crystal:* Application of X- rays in the study of crystal structures. Classification and structure of silicates. Classification and structure of clay minerals. Mineral identification by X- rays and Differential Thermal Analysis (DTA).

## Unit III

*Mineral optics:* Nature of light, polarized light. Double refraction. Snell's law. Parts and function of petrological microscope. Optical properties of minerals, uniaxial and biaxial minerals. Relative relief (RI) of minerals by Becke-line test. Extension angle and its types.

## Unit IV

*Crystal chemistry:* Crystalline and amorphous, Isomorphism, Polymorphism and Pseudomorphism. Physical properties of minerals. Chemical classification of minerals. Precious and semiprecious minerals. Chemical identification of industrial and ore minerals.

## Unit V

*Rock and ore forming minerals:* Physical, chemical, optical properties and mode of occurrence of olivine group, pyroxene group, amphibole group, feldspar group, mica group, quartz group and spinel group. *Paragenesis and mode of alteration:* Silicates, oxides, carbonates, sulphates and halides.

## Text / Reference Books

1. Andrew Puttins.,(1992),Introduction to mineral sciences, Cambridge University Press.,
2. Battey,M.H.,(1972),Mineralogy for students,
3. Berry Mason, (2004), Mineralogy, CBS Publishers, New Delhi.
4. Brian Mason, (1966), Principles of Geochemistry, Wiley & Sons, New York.
5. De Jong,W.F.,(1955), General crystallography,Freeman.
6. Deer, W., Howie, R.A. & Zussman, J., (1996), The Rock forming minerals. Longman.
7. Hans-Rudolt Wenk and Andrei Bulakh.,(2004), Minerals – Their constitution and origin.Cambridge University Press.
8. Hurlbut.C.C, (1961), Dana's Manual of Mineralogy, New York
9. Hutchison, C.S., (1974), laboratory handbook of Petrographic Techniques. John Wiley.
10. Joseph .V.Smith., (1982), Geometrical and structural crystallography. John Wiley& sons.
11. Keith Frye.,(1974), Modern Mineralogy.Prentice-Hall.Inc New Jersey. Klein, C and Hurlbut, Jr., C.S. (1993), Manual of Mineralogy. John Wiley.
12. Kerr.P.F. (1959), Optical Mineralogy, McGraw Hill, Tokyo.
13. Martin.J.Burger.,(1970), Contemporary Crystallography.McGraw-Hill book company.
14. Oliver and Boyd. Dana,E.S.(1962),Text book of Mineralogy Revised by Ford,W.E.Wiley.
15. Phillips, Wm, R. & Griffen, D.T., (1986), Optical Mineralogy, CBS edition.
16. Phillips,F.C.,(1963),Introduction to crystallography,Thomas Nelson.
17. Phillips,W.J.&N.,(1980), An introduction to mineralogy for geologist. John Wiley& sons.

18. Putnis Andrew., (1992), Introduction to Mineral Science, Cambridge University Press.

## 18AGC04 – PALAEOONTOLOGY

### Unit I Principles

Definition of palaeontology. Theories on the origin and evolutionary history of Life. Fossilization process and the nature of fossil record. Definitions for Species, index fossil, cosmopolitan species, fossil assemblage, fossil diversity, phylogeny. Types of biozones. Geological timescale. Morphological classification and Nomenclature. Cladistics. Species evolution, proliferation and extinction through time.

### Unit II

#### Invertebrate Paleontology I

Morphology, taxonomy, age, distribution and ecological niches of Anthozoa, Trilobita, Graptoloidea, Porifera, Bryozoa.

### Unit III

#### Invertebrate Paleontology II

Morphology, taxonomy, age, distribution and ecological niches of Brachiopoda, Bivalvia, Gastropoda, Cephalopoda, and Echinoidea.

### Unit IV

#### Vertebrate Paleontology

Evolutionary history of Reptilian, Avian, Piscean, and Amphibian fauna. Evolution of mammals. Evolution of horse, elephant and human. Functional morphology.

### Unit V

#### Paleontological applications

Introduction to palynology, micropaleontology, ichnology, Taphonomy and basin analysis. Applications of palaeontology in palaeoclimatic and palaeoenvironmental studies, age fixation and stratigraphic correlation, hydrocarbon exploration.

### Text / Reference Books

1. Arnold.R (1947), An Introduction to Palaeobotany, McGraw Hill, New York
2. Arumugam (1989), Organic evolution, Sara Publication, Kanyakumari
3. Benton, M.J. and Harper, D.A.T., (2009) Introduction to Paleobiology and the fossil record. Wiley-Blackwell. London.
4. Clarkson E.N.K. (1986). Invertebrate paleontology and evolution. George Allen & Unwin.
5. Colbert, E. (1955), The Evolution of Vertebrates, John Wiley, New York.
6. Jain, P.C & Anantharaman, M.S (1996), Palaeontology, Evolution and Animal Distribution, Vishal Publications
7. Moore R.C., Lalicker & Fisher (1952). Invertebrate fossil. McGraw Hill Book Co., San Francisco.
8. Murray, J.W., (1985) Atlas of invertebrate macrofossils. Longman. London.
9. Nield, E.W. and Tucker, V.C.T., (1985) Palaeontology: An introduction. Pergamon Press Ltd., Oxford.
10. Raup D.M. & Stanley (1985). Principles of paleontology. CBS Publ. & Distributors, New Delhi.

11. Romer, A.S (1959), The Vertebrate Story, University of Chicago Press 4thEdt. Chicago
12. Sherock, R.R & Twenohofel, W.H (1953), Principles of Invertebrate Palaeontology, New York
13. Swinnerton, H.H (1961), Outlines of Palaeontology, Edward Arnold Publ. Ltd., London.



## PRACTICAL - I

### 18AGP01 - STRUCTURAL GEOLOGY, MINERALOGY AND PALAEOONTOLOGY

#### Structural Geology

1. Preparation and interpretation of geological maps and sections.
2. Structural problems concerning economic mineral deposits.
3. Plotting and interpretation of petrofabric data and resultant diagrams.

#### Mineralogy

4. Study of symmetry and forms in the crystal models.
5. X-rays and X-ray refraction, Powder method, Determination of unit cell parameters.
6. Crystal projections –Stereographic projection, Spherical Projection and Gnomonic projection.
4. Study of common rock forming minerals under petrological microscope.
5. Colour enhancement and gem testing.
6. Determination of relative relief (RI) of minerals by Becke-line test.
7. Determination of sign of elongation of minerals.
8. Determination of pleochroic scheme of minerals.
9. Determination of optic sign of uniaxial and biaxial minerals.
10. Determination of extension angle and its types.
11. Identification of rock forming minerals in hand specimens.
12. Mineralogical calculations.
13. Chemical examination of Industrial and ore minerals.

#### Palaeontology

Morphological descriptions, systematics and illustrations of representative fossils belonging to Trilobita, Gastropoda, Bivalvia, Cephalopoda, Brachiopoda, and Echinodermata.

Interpretation of palaeoclimate and palaeoenvironment based on fossil data.

Biostratigraphic zonal assignment.

Identification of source, reservoir and seal facies with fossil data.

#### Text / Reference Books

1. Murray, J.W. (1985), Atlas of Invertebrate Macrofossils, Longman.
2. Woods, H. (1966), Invertebrate Palaeontology, International Book Bureau,

## 18AGC05 - IGNEOUS AND METAMORPHIC PETROLOGY

### Unit – I

Energy and the Mantle heat engine: Forms of energy - Flow and Transformation of Energy- Heat Flow in the Earth (Pressure and Temperature variations with depth) – Mantle melting and magma generation – Volatile fluids in melts – Nature of volatiles – solubility of volatiles in silicate melts – Exsolution of volatiles from a melt. Chemical dynamics of melts and crystals Textures: Primary textures ( Rates of Nucleation, growth, and diffusion – Nucleation at Preferred sites – compositional zoning – crystallization sequence – differential movement of crystals and melt- cumulative textures- volcanic textures crystal /melt interactions) – Secondary textures – exsolution – secondary reactions and replacements- deformation.

### Unit – II

Magma Diversity: Partial melting- Magmatic differentiation - Fractional crystallization, Volatile transport, Liquid immiscibility, Magma mixing and Assimilation. Basics of thermodynamics and Phase diagrams: Gibbs free energy – the Gibbs free energy for a phase – Gibbs free energy for reaction - Phase equilibrium and the Phase rule - One component system (SiO<sub>2</sub>)- Two (binary) component system – Binary systems with complete solid solution (Plagioclase system, Ab-An) – Binary Eutectic System (Diopside – Anorthite) – Binary Peritectic systems.

### Unit – III

Classification and Nomenclature of igneous rocks: The IUGS classification – calculations and plotting – Phaneritic rocks – Aphanitic rocks – Pyroclastic rocks. Magmatic Petrotectonic Associations: Oceanic spreading ridges and related basaltic rocks – Mantle plumes and oceanic island volcanic rocks – Plume heads and basalt flood plateau lavas – Arc magmatism – Oceanic island arcs – Continental margin magmatic arcs. Paragenesis: Ophiolite – Characteristics – origin and emplacement – Anorogenic A –type felsic rocks – characteristics – Petrogenesis – Granitoid rocks – Continental rift associations bimodal and alkaline rocks – Alkaline orphans (mostly in stable cratons) - Lamprophyres.

### Unit – IV

Concept of Metamorphism: The limits of metamorphism – Metamorphic agents and changes – Temperature, Pressure, Deviatoric stress, and Metamorphic fluids. Types of metamorphism: Contact Metamorphism: Pyrometamorphism – Regional metamorphism: Orogenic Metamorphism – Burial Metamorphism – Ocean Floor Metamorphism – Hydrothermal Metamorphism – Fault-zone Metamorphism - Metamorphic structures and textures – The processes of deformation, recovery, and recrystallisation- Textures of contact metamorphism – High-Strain metamorphic textures – Regional orogenic metamorphic textures –Gneissose structure and layers – Deformation versus metamorphic mineral growth – Analysis of polydeformed and polymetamorphosed rocks – Replacement textures and reaction rims. Classification of metamorphic rocks: Foliated and lineated rocks – Non-foliated and non-lineated rocks- Specific metamorphic types – High-strain rocks.

## Unit – V

Stable Mineral Assemblages in Metamorphic rocks: Equilibrium Mineral Assemblages – The Phase rule in Metamorphic systems – Chemographic diagrams: The ACF diagram –The AKF diagram – Projecting in chemographic diagrams. Metamorphic facies and facies series – Metamorphism of mafic rocks – Metamorphic fluids, Mass transport and Metasomatism - Anatexis and migmatites - Geothermobarometry.

### Text / Reference Books

1. Alexander R. McBirney, 2ndEdti., (1993), Igneous Petrology, CBS Publishers and Distributors, New Delhi.
2. Asworth,J.R.(Ed) (1985), Migmatites.Blackie.
3. Baskar Rao,B.(1986), Metamorphic Petrology. Oxford &IBH.
4. Best,M.G.(2002), Igneous and Metamorphic Petrology,2nd edition, Blackwell Publishers.
5. Bose, M.K, (1997), Igneous Petrology, The World Press Pvt Ltd., Calcutta.
6. Bowen N.L.(1995), The evolution of Igneous Rocks –Princeton University Press, Carmichel,I.S.E.
7. Carmichael.I.S.E,Turner.F.J and Verhoogen.J, (1974), Igneous Petrology McGraw – Hill, New York.
8. Chatterjee, S.C (1974), Petrography of the Igneous and Metamorphic rocks of India Macmillan.
9. Cox,K.G., Bell.J.D and Pankhrust.,R.J.(1979),Interpretation of igneous rocks.George Allen Unwin
10. Ernst.W.G, (1976), Petrologic Phase Equilibria, W.H. Freeman & Co, USA.
11. Freeman W.H.(1982), Petrography, An introduction to the study of rocks in thin sections - Howell, William and Turner.
12. Hall,A.(1987), Igneous Petrology. Longman Scientific &Technical.
13. Harker A. (1909), Natural Histroy of Igneous rocks –Mc.Millan.
14. Hyndman,D.W,(1985), Petrology of igneous and metamorphic rocks. McGraw Hill.
15. Loren A. Raymond, WCB Publ. (1995), Petrology, The Study of Igneous, Sedimentary and Metamorphic Rocks.
16. Mason R, (1984), Petrology of Metamorphic Rocks, CBS Publishers & Distributors, New Delhi
17. Mason,R.(1984),Petrology of metamorphic rocks.CBS Publishers and Distributors.
18. McBirney,A.R.(1993), Igneous Petrology.CBS Publishers and Distributors.pp.508.
19. Miyashiro,A (1973), Metamorpism and Metamorphic belts, John Wiley and Sons, New York
20. Nockolds,S.R., Knox O.B., Chinner,G.A (1979), Petrology for Students, Cambridge University Press.
21. Philpotts A. R.(1990), Principles of Igneous and Metamorphic Petrology,Prentice Hall.
22. Robin Gill. (2010), Igneous Rocks and Processes: A Practical Guide Wiley-Blackwell

Publ.,

23. Spray, A.H.(1969), Metamorphic textures. Pergamon Press.
24. Turner,F.J.&Verhoogen,J.(1974),Igneous Petrology. McGraw Hill.pp.694
25. Turner,F.J.(1980),Metamorphic Petrology. McGraw Hill.
26. William,H, Turner,F.J, &Gilbert,C.M, (1954), Petrography, San Fransisco
27. Winkler.H.G.E.(1979),Petrogenesis of metamorphic rocks. Springer Verlag.
28. Winter, John D., (2012) Principles of Igneous and Metamorphic Petrology, Pearson Education Inc., Publishing as Perason Pretice Hall, New Jersey, U.S.A.pp.702.

## 18AGC06 – SEDIMENTOLOGY

### Unit I Principles

Definition and principles of Sedimentology. Development of Sedimentology as an interdisciplinary subject of geoscience. Time and space in Sedimentology. Completeness of sedimentary record. Primary and indirect modes of data acquisition in Sedimentology.

### Unit II

Rock cycle. Processes of sediment genesis, transport and deposition. Physical, chemical and biological sedimentary structures. Sediment texture – classification of unconsolidated sediments, siliciclastics, carbonates, evaporates, volcanoclastics, and miscellaneous types.

### Unit III

Controlling factors of sedimentation – Tectonics, eustatic cycles, climate and sediment influx. Facies concepts. Facies association, facies succession, depositional models. Facies successions formed under gravity, glacial, lacustrine, aeolian, fluvial, coastal and deep sea environments.

### Unit IV

Classification of sedimentary basins. Diagenesis of sediments – Stages, zones and environments of diagenesis. Compaction, Porosity types and evolution, cementation, neomorphism, dissolution-recrystallization, dolomitization, and silicification. Palaeocurrent, heavy mineral and clay mineral analyses for provenance and basin analysis.

### Unit V

An overview on Sedimentary basins of India. Applications of Sedimentology for palaeoclimatic and palaeoenvironmental interpretation. Study of sedimentary geochemistry for understanding depositional and diagenetic processes.

### Text / Reference Books

1. Collins J.D. and D.B. Thompson (1982) Sedimentary Structures. George Allen & Unwin, London.
2. Flugel, E.V., (2002) Microfacies analysis of limestones. Elsevier.
3. Leeder, M., 1999. Sedimentology and Sedimentary Basins. From Turbulence to Tectonics. Blackwell, Oxford, 592 pp
4. Lindholm, R., (1988) A practical approach to Sedimentology. Blackwell publication.
5. Nicholls, G. (1999) Sedimentology and Stratigraphy. Wiley-Blackwell,.
6. Pettijohn F.J. (1975) Sedimentary rocks. Harper and Row Publ., New Delhi.
7. Selley, R.C., (2000) Applied sedimentology, 2nd Edn., Academic Press,.
8. Sengupta.S.M, (2007), Introduction to Sedimentology, CBS Publishers & Distributors, New Delhi.
9. Tucker M.E. and V.P.Wright (1990) Carbonate Sedimentology. Blackwell publication.

## 18AGC07 - STRATIGRAPHIC PRINCIPLES AND INDIAN STRATIGRAPHY

### Unit I

Principles of Stratigraphy: Stratigraphic Principles and approaches to measurement of geological time. Recent developments in stratigraphic classification and Geological Time Scale. International Stratigraphic Code- development of a standardized stratigraphic nomenclature. Concepts of Stratotypes, Global Stratotype Section and Point (GSSP). Principles of Stratigraphic Classification, Categories of Stratigraphic Classification and

concept of Litho, Bio and Chrono Stratigraphy. Brief idea about sequence, magneto- seismic- chemo- and event, cyclo- Stratigraphy. Stratigraphic correlations. Approaches to paleogeography.

#### Unit II

Precambrian stratigraphy: Precambrian stratigraphic succession of and economic importance of Dharwar Supergroup, Eastern Ghats and Southern Granulite belt, Singhbhum-Chhotanagpur-Orissa belt with special reference to Sausar, Sakoli and Iron Ore Groups, Dongargarh and Aravalli Supergroups. Proterozoic stratigraphy of Cuddapah, Vindhyan, Delhi Supergroups and their equivalents. Precambrian-Cambrian boundary.

#### Unit III

Paleozoic stratigraphy: History, tectonics, life and paleogeography during the Paleozoic Era. Stratigraphic frame work and fossil contents of the Paleozoic rocks of India with special reference to Kashmir and Spiti. Permian-Triassic boundary.

Gondwana stratigraphy: Concept, classification, sedimentation and paleoclimates, fauna, flora, age and economic potential of Gondwana Supergroup.

#### Unit IV

Mesozoic stratigraphy: Classification, geographic distribution, lithologic characteristics, fauna and flora economic potential of Triassic, Jurassic and Cretaceous systems in principal basins of India with special reference to Triassic of Spiti, Jurassic of Kutch and Cretaceous of Tiruchirappalli (formerly Trichinopoly). Deccan traps. Cretaceous-Tertiary boundary.

#### Unit V

Cenozoic stratigraphy: Classification, depositional characteristics, fauna and flora and economic potential of the Palaeogene, Neogene and Quaternary Systems with special reference to Siwalik Group, Assam-Arakan region, Andaman-Nicobar Islands and its equivalents. Himalayan orogeny. Quaternary deposits and their significance. Paleogene-Neogene and Neogene-Quaternary boundary.

#### Text / Reference Books

1. Danbar, C.O. and Rodgers, J. (1957) Principles of Stratigraphy. John Wiley & Sons.
2. Doyle, P. & Bennett. M.R. (1996) Unlocking the Stratigraphic Record (John Willey).
3. GSI Misc. Publn. No. 30. (2006) Geology and Mineral Resources of the States of India
4. Krishnan, M.S. (1982) Geology of India and Burma. CBS Publishers, Delhi Naqvi, S.M. and Rogers, J.J.W. (1987) Precambrian Geology of India. Oxford University Press.
5. Pascoe, E.H.(1968) A Manual of the Geology of India & Burma (Vols.I-IV) Govt. of India Press, Delhi
6. Ramkrishnan, M. and Vaidhyanadhan, R. (2008) Geology of India, Volume I and II, Geological Society of India, Bangalore
7. Ravindra kumar. (1985) Fundamentals of Historical Geology and Stratigraphy of India. Wiley Eastern Ltd., New Delhi.
8. Robert, M. S. (1989) Stratigraphy: Principles and Methods, Van Nostrand Reinhold, New York. ,

9. Wadia, D.N. (1998) Geology of India. Tata McGraw Hill, India.

## 18AGC08 - EXPLORATION GEOLOGY

### UNIT I

#### Geological Exploration

*Introduction:* Ore genesis in relation to minerals exploration. Regional local parameters for exploration. *Exploration:* Geological techniques and procedures of exploration. Regional (concept-based) exploration-different stages, planning and operations. Resources and reserves-Classification of resources and reserves. Documentation of exploration data.

### UNIT II

#### Geological Mapping & Exploration Techniques

*Geological mapping:* reconnaissance and detailed mapping-Selection of sites for geological prospecting. Different stages of exploration: objectives and tasks involved; preliminary studies and reconnaissance surveys. *Geologic aspects of drilling-*Types of drills- drill bits, core / sludge recovery, core logging; Drilling methods, planning, selection of sites, angle and direction of bore-holes. *Methods of sampling:* Weighting of samples and calculation of average grades-mathematical and statistical methods.

### UNIT III

#### Geophysical Exploration: I

*Gravity method:* Nature of gravity and its variation. Accuracy and precision of measurements. Gravimeters. Field procedures. Corrections. Free-air & Bouger anomalies. Interpretation of anomalies. Explorations for minerals. *Magnetic method:* Geomagnetic field and its variations. Magnetometers. Field procedures for land and airborne surveys. Exploration for minerals and oil and engineering sites.

### UNIT IV

#### Geophysical Exploration: II

*Seismic method:* Seismic waves and their speeds in rocks. Snell's law. Critical refraction. Instruments and field procedures for seismic refraction method. Corrections, Interpretation of data. Seismic reflection methods for oil exploration. Equipment for seismic reflection. Time and depth sections. *Electrical methods:* Introduction to S.P method and its use. Resistivity, true and apparent D.C. resistivity, true and apparent D.C. resistivity equipment, electrode arrangement, field procedure, and use for mineral exploration and at engineering sites.

### UNIT V

#### Geochemical Exploration

*Mobility:* Geochemical cycle. Mobility and association of elements. Geochemical tracers-elements and isotopes. *Dispersion:* Primary and secondary geochemical dispersion patterns. Geochemical and metallogenic provinces. *Methods of geochemical exploration:* Lithochemical methods-Pedochemical methods-Atmochemical geobotanical and biogeochemical methods. Geochemical sampling techniques-statistical analysis and interpretation of geochemical prospecting data.



1. F.J. Pettijohn (1975) Sedimentary rocks. Harper and Row Publ., New Delhi.
2. Flugel, E.V., (2002) Microfacies analysis of limestones. Elsevier.
3. J.D. Collins and D.B. Thompson (1982) Sedimentary Structures. George Allen & Unwin, London.
4. Lindholm, R., (1988) A practical approach to Sedimentology. Blackwell publication.
5. M.E. Tucker and V.P.Wright (1990) Carbonate Sedimentology. Blackwell publication. Nicholls, G. Sedimentology and Stratigraphy.
6. Wiley-Blackwell, (1999) Selley, R.C., Applied sedimentology, 2nd Edn., Academic Press, 2000. Leeder, M., (1999) Sedimentology and Sedimentary Basins. From Turbulence to Tectonics. Blackwell, Oxford, 592 pp.

## **PRACTICAL - II**

### **18AGP02 - PETROLOGY AND SEDIMENTOLOGY**

#### **Igneous Petrology**

1. Megascopy of ultramafic, basic, intermediate and acidic igneous rocks.

2. Microscopy of ultramafic, basic, intermediate and acidic igneous rocks.
3. Modal classification of ultramafic, and basic igneous rocks following the IUGS nomenclature.
4. Modal classification of intermediate and acidic igneous rocks following the IUGS nomenclature.
5. Chemical classification of igneous rocks in the (Na<sub>2</sub>O+K<sub>2</sub>O) vs SiO<sub>2</sub> diagram.
6. Calculation of the CIPW norm of gabbro
7. Calculation of the CIPW norm of diorite.
8. Calculation of the CIPW norm of granite
9. Calculation of the CIPW norm of syenite
10. Calculation of the CIPW norm nepheline syenite.

### Metamorphic Petrology

1. Megascopy of metamorphic rocks: slates, phyllites, schists and gneisses.
2. Megascopy of metamorphic rocks: amphibolites, charnockites, khondalites, eclogites.
3. Megascopy of metamorphic rocks: marbles and quartzites.
4. Microscopy of metamorphic rocks: slates, phyllites, schists and gneisses.
5. Microscopy of metamorphic rocks: amphibolites, charnockites, khondalites and eclogites.
6. Microscopy of metamorphic rocks: marbles and quartzites.
7. Construction and interpretation of ACF diagrams.
8. Construction and interpretation of AFM diagrams.

### Sedimentology

1. Megascopic study of sedimentary rocks and their identification through characteristic features.
2. Granulometric analysis of unconsolidated sediments and interpreting their modes of transport, and environments of deposition.
3. Petrographic study of clastic and non-clastic rocks and interpreting textural properties, depositional environments and diagenesis.
4. Separation and analysis of heavy minerals from unconsolidated sediments and understanding provenance.
5. Construction of facies succession and depositional models with facies characteristics

## 18AGC09 - ECONOMIC GEOLOGY

### Unit I

Scope of economic geology. Mode of occurrences and morphology of ore bodies and relationship with host rocks -Textures and Structures of ore and gangue minerals. Modern concepts of ore genesis. Fluid inclusions -Wall rock alteration. Geothermometry-geobarometry.

### Unit II

Paragenesis and zoning in mineral deposits-Metallogenetic Epochs and Provinces. Structural, physico-chemical and stratigraphic controls of ore localization. Study of ore forming processes- Orthomagmatic processes- Sedimentary processes- Metamorphic processes- Hydrothermal processes. Ore deposits in relation to plate tectonics.

### Unit III

Mineralogy, mode of occurrences, uses and distribution in India of the following metalliferous deposits – Iron, Manganese, Aluminium, Copper, Gold, lead, Zinc – Chromium, Molybdenum, Rare Earth Group of metals.

### Unit IV

The study of non- metallic mineral deposits with reference to geology, mode of occurrence, origin, uses and distribution in India of Mica, Asbestos, Barytes, Gypsum, Limestone, Garnet, Corundum, Calcite, Quartz, Feldspar, Clays, Kyanite, Sillimanite, Graphite, Talc, Fluorite, Beryl and Gem minerals.

### Unit V

Introduction to ore microscopy, techniques, methods, textures and microstructures of ores, interpretation of ore texture and optical properties of common sulphide, oxide ore minerals; Industrial application of ore microscopy.

### Text/Reference Books

1. Anthony Evans, (1993) Ore Geology and Industrial Mineral, Jhon Wiley & sons, USA,
2. Bateman Allan .M. (1962) Economic Mineral Deposits, Asian Publishing House, 2nd Edition.
3. Coggin, B. and Dey, A.K. (1955) India's Mineral Wealth, oup.
4. Craig, J.M. & Vaughan, D.J., (1981): ore Petrography and Mineralogy. John Wiley
5. Cuilbert, J.M. and Park,Jr. C.F.(1986): The Geology of Ore Deposits, Freidman.
6. Deb.S. (1980) Industrial Minerals and Rocis of India, Allied,.
7. Edwards, R. and Atkinson, K. (1986) Ore deposit geology, Ist Edition, Chapman and Hall. New Delhi,.
8. Evans, A.M. (1993): Ore Geology and Industrial Minerals, Blackwell.
9. Gokhale, K.V.G.K. and Rao , T.C (1978)- Ore deposits of India, their distribution and processing, Thosmson press,.
10. James R. Craig and David J.Vaughan (1994): Ore Microscopy and Petrography.
11. Jansen M.L. & Bateman A.M.: (1981), Economic Mineral Deposits, John Wiley & Sons, Singapore.

12. Klemm, D.D. and Schnieder, H.J. (1977): Time and Strata Bound Ore Deposits, Springer-Verlag.
13. Krishnaswamy, s. - India's Mineral Resources, oxford and IBH.
14. Lindgren W. (1933)Mineral Deposits, MCGraw Hill,.
15. Mookherjee, A. (2000): Ore Genesis-A Holistic Approach, Allied Publisher.
16. Park, C.F. and Macdiarmid, R.A (1970) Ore deposits, Freeman,
17. R.M. Umathay, (2006)Mineral Deposits of India, Dattsons, New Delhi, India,
18. Ramdhor, P. (1969): The Ore Minerals and their Intergowths, Pergamon Press.
19. Robb, L. (2005)Introduction to ore-forming processes, Blackwell publishing, U.K.,.
20. Stanton, R.L. (1972): Ore Petrology, McGraw Hill.
21. Wolf, K.H. (1976-1981): Hand Book of Stratabound and Stratiform Ore Deposits, Elsevier Publ
22. Meher,D.N. Wadia, (1994), Mineral of India, National Book Trust, New Delhi.
23. Sinha.R.K and Sharma.N.L.(1970), Mineral Economics, Oxford IBH Publishing Co., New Delhi.

## 18AGC010 - APPLIED MICROPALAEONTOLOGY

### Unit I

Principles of Micropaleontology: Microfossils - definition, types of microfossils, uses of

microfossils in various fields of Geological Sciences and Industry. Definition, scope and relationship of micropaleontology with ocean sciences. Historical developments and recent trends in micropaleontological studies including deep sea drilling (JOIDES, DSDP, ODP, IODP, JGOFS). Modern field and laboratory techniques in the study of microfossils: surface and sub-surface sampling methods, processing and separation of microfossils, preparation of faunal slides and thin sections. Field and Laboratory equipments used for micropaleontological studies.

#### Unit II

Calcareous Microfossils I: Dimorphism, test morphology, wall structure, chamber shape and arrangements, aperture openings and ornamentation of foraminifera. Classification and evolution of foraminifera. Ecology, paleoecology and geological distribution of foraminifera. Application of foraminifera in stratigraphy with special reference to Jurassic, Cretaceous and Tertiary periods in India.

#### Unit III

Calcareous Microfossils II: Morphology, hinge types, ornamentation, sculpture, orientation of carapace, classification and geological distribution of Ostracoda. Significance of ostracodes in ecology and paleo-ecological studies. Sample preparation techniques, morphology, ecology, application and geological distribution of calcareous nannofossils. Brief study of pteropods, calpionellids, calcareous algae and bryozoa.

#### Unit IV

Phosphatic, Siliceous and Organic-Walled Microfossils: Extraction methods, outline of morphology, composition and stratigraphic significance of conodonts. Preparation techniques, major morphological groups and application of radiolarians. Sample collection, preparation techniques, morphology and application of diatoms. Maceration techniques, outline of morphology and application of fossil spores and pollen.

#### Unit V

Application of Microfossils: Application of microfossils in biostratigraphy - First Appearance Datum (FAD) and Last Appearance Datum (LAD), units of biostratigraphy and biostratigraphic correlation. Application of Microfossils in understanding patterns causes and types of global events. Micropaleontology in hydrocarbon exploration – sequence stratigraphy, subsidence analysis, thermal history and biosteering. Application of microfossils in interpretation of paleoenvironment and paleoclimate – paleobathymetry, back-tracking technique, paleo-temperature estimation and sea-level change, ocean eutrophication, acidification, environmental monitoring, paleoclimate and paleomonsoon. Application micropaleontology in oceanography, paleogeography and engineering geology.

#### Text / Reference Books

1. Armstrong, H. and Brasier, M.D., (2005). Microfossils. Blackwell Publishing.
2. Bignot, G., (1985). Elements of Micropaleontology. Graham and Trotman.
3. Brasier, M.D., (1980). Principles of Microfossils. George Allen & Unwin.
4. Burger. H.R. (1992)- Exploration Geophysics of the Shallow Subsurface: Prentice Hall.,
5. D.S. (1975).Principles of Applied Geophysics, Chapman and Hall Ramachandran Rao, M
6. Dobrin M.B.(1981) Introduction to Geophysical prospecting. McGraw Hill

International Book Company.

7. Dobrin, M.B. (1976) :-Introduction to Geophysical Prospecting Brooks,
8. Glaessner, M.F., (1945). Principles of Micropaleontology.
9. Gunter Faure. (1998) – Principles and applications of Geochemistry–prentice Hall.,
10. Hafner Publishing Company. , Haq, B.U. and Boersma, A., (1998). Introduction to Marine Micropaleontology. Elsevier.
11. Jones, D.J.,(1969). Introduction to Microfossils. Hafner Publishing Company, New York.
12. Jones, R.W., (1996). Micropaleontology in Petroleum Exploration. Oxford.
13. Kathal, P.K., (1997). Microfossils and their applications. CBS Publishers and Distributors.,
14. Kearey.P and Brooks.M (1984) An Introduction to Geophysical Exploration-ELBS.,
15. Lowire. W. (1997) - Fundamentals of Geophysics. Cambridge Low price Editions.,
16. Martin, R.E. (2000). Environmental Micropaleontology. Springer.
17. Mason.B (1966); Principles of Geochemistry – Willey Toppan.
18. Mathur S.M. (2001) – Guide to Field Geology: Prentice Hall of India
19. McKinstry H.E. (1960) - Mining Geology: Asia Publishing House
20. Ramachandra Rao M.B.(1975) – Outlines of Geophysical Prospecting – A manual for Geologist: University of Mysore.
21. Robinson. E.S. and Coruh.C. (2002)- Basic Exploration Geophysics– John Wiley.,
22. Sharma,P.V. (1986), Geophysical methods in Geology, Elsevier
23. Stanislane, M. (1984), Introduction to Applied Geophysics, Reidel Publishers

## 18AGC011– APPLIED HYDROGEOLOGY

### Unit I

*Hydrogeology*: Hydrologic cycle and its components, Origin and age of groundwater, Occurrence of groundwater, Global distribution of fresh water. Vertical distribution of groundwater. *Aquifers*: Types of aquifers. *Springs*: Types of springs. *Hydrologic properties of rocks*: Porosity, Permeability, Specific yield, Specific retention, Hydraulic conductivity, Transmissivity and Storage coefficient.

### Unit II

*Groundwater movements*: Sub surface movement, Base flow, Effluent flow and influent flow. Darcy's law, Reynold's number, Laminar flow and turbulence flow. *Water level fluctuation*: Water table and Piezometric surface and its fluctuations. *Pumping test*: objectives, layout of the test and measurements.

### Unit III

*Water well technology*: Well types, drilling methods, construction of well, design of well, development and maintenance of wells. *Artificial recharge of groundwater*: Concept and methods. *Saline water intrusion in aquifers*: Saline water intrusion, Ghyben–Herzberg relation between fresh and saline water, Prevention and control of salt water intrusion in the coastal aquifers.

### Unit IV

*Groundwater quality*: Chemical composition of groundwater, major cations and anions, trace elements and their sources. *Water quality measurements*: physical, chemical and biological parameters. *Graphical representation of hydrochemical data*: Piper's facies analysis. *Groundwater Contaminations and Pollutions*: Problems related to arsenic and fluoride contamination, radio isotopes in hydrogeological studies. Trace element and health hazards, Impact of urbanization. Hydrogeochemical provinces of India.

### Unit V

*Groundwater exploration techniques*: Surface investigation of groundwater-Geologic method, electrical resistivity method, seismic method, gravity and magnetic method. *Subsurface investigation of groundwater*: test drilling, water level measurements. Application of Geophysical logging in Groundwater exploration. Groundwater provinces of India.

### Text / Reference Books

1. Alley, W.M., (1993), Regional Groundwater Quality-VNR, New York
2. Davies, S.N. and De Wiest, D.R., (1966), Hydrogeology-John Wiley & sons, Inc, New York, 463p.
3. Fetter, C.W., (1990), Applied Hydrogeology-Mc Graw Hill, Publisher, New Delhi.
4. Freeze, R.A. and John, A., (1979), Groundwater, Cherry, Prentice Hall, Inc, 604p.
5. Handa, O.P (1984), Groundwater Drilling, Oxford & I.B.H. Publishing Co.
6. Hem J.D., (1970), Study and interpretation of the chemical characteristics of
7. Hiscock, K., (2005), Hydrogeology, Principles and Practice, Blackwell Publishing, 389p.

8. Karanth, K.R., (1987), Groundwater Assessment, Development and Management-Tata McGraw Hill New Delhi 720p.
9. Kazmann, (1973), Modern Hydrology, Harper and sons Publishers, New Delhi.
10. Manning,J.C.,(2007),Applied Principles of Hydrology, CBS Publishers and Distributers ,New Delhi.
11. Raghunath, H.M., (2007), Groundwater 3<sup>rd</sup> edition,New Age International Publishers,520p.
12. Reddy and Rami,J.P.,(2008), A Textbook of Hydrology, University Science Press, Bangalore.
13. Schwartz,F.W and Zhang,H.,(2003), Fundamentals of groundwater, John Wiley& sons, Inc, New York,583p.
14. Shaw,E.M., (1994), Hydrology in Practice,3<sup>rd</sup> edition, Chapman and Hall,London,569p.
15. Subramaniam, V., (2000), Water-Kingston Publ. London.
16. Todd, D.K., (1980), Groundwater Hydrology-John Wiley & sons publishers, New York,535p.
17. Tolman.C. (1972), Groundwater, McGraw Hill Book Company.
18. Walton.W.C. (1970). Groundwater Resource Evaluation, McGraw Hill Book Company.



## 18AGC012 – ADVANCED REMOTE SENSING AND GIS

### Unit I

#### Remote sensing

Definition Types of aerial photographs. Scale of photographs. Panchromatic, colour and infra-red films. Colour and infra-red films. Elements of photo interpretation: tone, texture, pattern, drainage pattern and lineaments. Applications: Structural mapping and lithological mapping, groundwater exploration.

### Unit II

#### Satellite Remote sensing

Electromagnetic Radiation, EMR spectrum, EMR interaction with atmosphere, EMR interaction with earth features. Atmospheric windows, Resolutions (Spectral, spatial, Temporal and Radiometric) Platforms and Sensors, Multi-spectral remote sensing data. Remote sensing satellites: Landsat, SPOT and IRS series of satellite data. Introduction to Hyperspectral remote sensing. Remote sensing Application in mineral exploration.

### Unit III

Digital Image Processing- Digital Image- Digital Data Format- Image Processing Techniques-Radiometric Correction -Geometric Correction -Image Enhancement Techniques-Principal Component Analysis-Supervised Classification-Unsupervised Classification.

### Unit IV

#### GIS data model

Geographic Information System (GIS): Introduction, Definition, GIS Components. Data models: Vector Data model, Topology and Non-Topology models. Raster Data: Quad tree model, Run-length encoding. Raster and vector data conversion. Database management.

### Unit V

#### GIS data analysis

Spatial Data analysis: Data editing, Data query, Logical operation, arithmetic operations. Map overlaying, DEM and uses. GIS application in Natural resource mapping. GPS principles and applications

#### Text / Reference Books

1. Anji Reddy, M. (2001), Text Book of Remote Sensing and Geographical Information Systems, BS Publicaton, Hyderabad .
2. Chandra A.M & S.K. Ghosh (2006), Remote Sensing & Geographical Information System, Narosa Publishing House, Chennai.
3. Curran,B (1985): Principles of Remote Sensing,Longman,London.Inc.
4. Drury, S.A. (1987). Image interpretation in Geology. Chapman and Hall.
5. Gupta, R.P. (2000) Remote Sensing Geology. Springer-Verlag. 356pp.
6. Ian Heywood, Sarah Cornelius and Steve Carver Parson, (2003), An Introduction to Geographical Information Systems (Edn) Singapore.
7. J. B. (1996) Introduction to Remote Sensing.622pp.
8. Jensen.J.R. (2005)Introductory Digital Image Processing-A Remote Sensing Perspective 3<sup>rd</sup> edition, pension prentic Hall,NJ,USA.
9. John Wiley., Pandey, S.N. (1987). Principles and applications of photogeology. Wiley Eastern, New Delhi.,

10. Lillesand, Thomas Kiefes (1979), Remote Sensing and Image Interpretation, John Wiley and sons
11. Sabins,F.F.Jr (1978):Remote sensing Principles and Interpretation, Freeman,sanfrancisco sons, New York.
12. Shiv.N.Pandey (1987), Principles & Applications of Photo geology, Wiley Eastern Ltd.,

### **PRACTICAL-III**

18AGP03 - ECONOMIC GEOLOGY AND MICROPALAEONTOLOGY

Economic Geology

Study of, Industrial and ore minerals with special emphasis on physical, chemical

characteristic mode of occurrences and uses

### Micropalaeontology

Techniques of separation of microfossils from matrix. Types of microfossils: Calcareous, Siliceous, Phosphatic and organic walled microfossils. Study of morphological characters of important benthic, planktic and larger foraminifera, ostracoda useful in ecology, paleoecology and biostratigraphy. Preparation of oriented sections of larger benthic foraminifera, nannofossils, radiolaria and diatoms. Exercises on Biostratigraphy and interpretations. Study of microfossil assemblages from various geological formations and interpretation of environment, geological age. SEM applications in Micropaleontology.

## PRACTICAL – IV

### 18AGP04 - HYDROGEOLOGY, REMOTE SENSING AND GIS

#### Hydrogeology

Estimation of chemical dissolved constituents: major, minor and traces in groundwater using standard laboratory techniques. *Diagrammatic representation of hydrochemical data*: bar, circular radial, multivariate schoeller diagram, four coordinate diagram, stiffs diagram, horizontal and vertical scale diagram. Plotting on maps-Piper, U.S. Salinity Laboratory diagram, Wilcox, Doneen, Gibbs and Durov plots. *Groundwater exploration techniques*: geophysical and geological methods of ground water exploration; *Pumping test*: time draw down and time recovery tests and evaluation of aquifer parameters.

#### Remote sensing and GIS

Aerial Photography: Stereovision Test, Pocket & Mirror Steoscope-3D Observation, Demarcation of marginal informations, Identification photo Recognition elements. Interpretation of drainage pattern, landforms, rock types and structures.

Satellite Remote sensing: Decoding of Satellite data, Interpretation of satellite data for geomorphology, structure and lithology. Exposure to Digital Image Processing techniques, spectral plot for different features.

GIS: Scanning, Digitization, Preparation of Vector and Raster Image, Geo-Referencing. Overlay analysis.

## 18AGC013-FUEL GEOLOGY

### Unit I

#### Coal Geology

Coal Petrology: Origin of Coal; Classification and optical properties of macerals and microlithotypes. Techniques and methods of coal microscopy. Application of coal petrology. Classification of coal in terms of Rank, Grade and Type. Indian classification for coking and non-coking coals. International classifications (I.S.O. and Alpern's classification).

### Unit II

Coal as a source rock in petroleum generation. Coal exploration and estimation of coal reserves. Indian coal reserves and production of coal in India. Coalbed methane – a new energy resource. Elementary idea about generation of methane in coal beds, coal as a reservoir and coal bed methane exploration.

### Unit III

#### Petroleum Geology

Petroleum – its composition and Properties;. Origin (formation of Source rock Kerogen, organic maturation and thermal cracking of kerogen) and migration of petroleum. Reservoir rocks-porosity and permeability. Reservoir traps – structural, stratigraphic and combination traps. Oil field fluids – water, oil and gas.

### Unit IV

Methods of prospecting for oil and gas (geological modeling); Elementary knowledge of drilling and logging procedures - Oil shale - An outline of oil belts of the world. Onshore and offshore petroliferous basins of India. Oil policy of India. Gas Hydrates: Exposure to gas hydrates and future prospective.

### Unit V

#### Atomic Energy

Concept of atomic energy. Radioactive minerals. Mode of occurrence and association of atomic minerals in nature. Methods of exploration for atomic minerals. Productive geological horizons of atomic minerals in India, Geothermal energy: Principles of utilization of Earth's heat. Types of geothermal source-Applications, exploration, distribution of geothermal energy. Geothermal sources in India.-Future scenario.

### Text / Reference Books

1. Chandra, D., Singh, R.M. Singh, M.P., (2000): Textbook of Coal (Indian context). Tara Book Agency, Varanasi.
2. Singh, M.P. (Ed.) (1998): Coal and organic Petrology. Hindustan Publishing Corporation, New Delhi.
3. Scott, A.C., (1987): Coal and Coal-bearing strata: Recent Advances. The geological Society of London, Publication no. 32, Blackwell scientific Publications.

4. Stach, E., Mackowsky, M-Th., Taylor, G.H., Chandra, D., Teichmuller, M. and Teichmuller R., (1982): Stach Textbook of Coal petrology. GebruderBorntraeger, Stuttgart.
5. Holson, G.D. and Tiratso, E.N., (1985): Introduction to Petroleum Geology. Gulf Publishing, Houston, Texas.
6. Tissot, B.P. and Welte, D.H., (1984): Petroleum Formation and Occurrence, Springer – Verlag.
7. North, F.K., (1985): Petroleum Geology. Allen Unwin.
8. Selley, R.C., (1998): Elements of Petroleum Geology. Academic Press.
9. Durrance, E.M. (1986): Radioactivity in Geology-principles and application. Ellis Hoorwool.
10. Dahlkamp, F.J., (1993): Uranium Ore Deposits. Springer Verlag.
11. VBoyle, R.W., (1982): Geochemical prospecting for Thorium and Uranium deposits, Elsevier

**ELECTIVE COURSES**  
18AGE01 - MINING AND ENGINEERING GEOLOGY  
MINING GEOLOGY

### Unit I

Mining terminology, classification, 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. Explosive types, composition and its applications. Surface mining machineries.

### Unit II

Alluvial mining: Types of placer mining, Panning, hydraulicking, Mechanical methods. Opencast mining Methods – bench cut, glory hole, strip mining. Factors considered for mechanization and transportation. Underground mining methods - board and pillar, room and pillar, long wall mining. Mine supports, Mine ventilation and Drainage. Mining hazards. Mines and Minerals Act.

## ENGINEERING GEOLOGY

### Unit III

Scope of geology in civil engineering and mining industry. Various stages of engineering geological investigations for civil engineering projects. Engineering properties of rocks, rock discontinuities, physical characters of building stones, concrete and other aggregates. Use of remote sensing in engineering geology.

### Unit IV

Geological considerations for the construction of dams and reservoir sites. Types of dams, dam foundation, rock problems. Geotechnical evaluations of tunnel alignments and transportation routes. Methods of tunneling; Classification of ground for tunneling purposes; various types of support.

### Unit V

Geological considerations for the construction of roads/ highways and bridges. Mass Movements with special emphasis on landslide and causes of hill slope instability. Engineering consideration of seismicity, influence of geological condition on foundation and design of buildings, seismic resistant structure, earthquake problems in India.

### Text / Reference Books

1. Arogyaswamy, R.N.P. (1994). Course in mining Geology. Oxford IBH – New Delhi.,
2. Chandra, B. Krishna, J and Chandrasekaran, A. (1994). Elements of Earthquake Engineering. South Asian Publishers.
3. Deshmukh, R.T. (1993)High Technology in Drilling and Exploration, Oxford-IBH, New Delhi.,.
4. Gupta, H.K. and Rastogi, B.K. (1976).Elements of mining Technology Dhanbad publishers., Dhanbad.
5. Indian Bureau of Mines (1979) Dams and Earthquakes. Elsevier Scientific Publishing Company.,
6. Mineral exploration. IBM, Nagpur., Krynine, D.H. & Judd, W.R. (1998) Principles of Engineering Geology, CBS Edition.,

7. Mckinstry, H.E. (1980). Mining Geology, Prentice Hall, N.Y., Parbinsingh 1991.
8. Peters, W.C. (1987) A Text Book of Engineering & General Geology. Kataria & Sons.,.
9. R.W. (1997). Geological methods in Mineral Exploration and Mining, Chapman & Hall, London.,
10. Schultz, J.R. & Cleaves, A.B. (1951). Geology in Engineering, John Willey & Sons.,
11. Staheler A.N. and Strahler A.M. (1973). Environmental Geoscience-John Wiley & Sons., Venkatramiah, 1989 Engineering Geology.Wiley

## 18AGE02 - ANALYTICAL AND INSTRUMENTATION TECHNIQUES

### Unit I

*Introduction to analytical chemistry:* Qualitative and quantitative analysis. Classification of methods. Types of instrumental analysis. various instrumental techniques and laboratory safety.

### Unit II

*Laboratory techniques:* Laboratory operation and practices. Units of measurements. Laboratory notes. Errors and evaluation. Determination of accuracy. Statistical evaluation of data.



### Unit III

*Petrological microscopes:* Principles, Parts, Operation and application of Petrological microscope, Ore microscope and Scanning electron microscope. Preparation of thin section. Preparation of rock powder for chemical analysis. Rock digestion through acid treatment, Rock digestion through fusion with alkali salts.

### Unit IV

*Geochemical sampling techniques:* Sampling methods and principles, Types of sampling, Sampling interval. Heavy mineral separation methods. *Flame photometer and UV spectrometer:* Basic principles, Parts and operation and mechanism.

### Unit V

*Instruments used for geochemical analysis:* Basic concept and techniques of Atomic Absorption Spectrometer (AAS). Inductively Coupled Plasma - Atomic Emission Spectrometer (ICP-AES). X-Ray Diffraction (XRD). X-Ray Fluorescence (XRF) and Differential Thermal Analysis (DTA).

### Text / Reference Books

1. Dana, E.S., (1955), Text book of Mineralogy, John Wiley., Deer,
2. W.A., Howie, R.A. and Zussman, J., (1996), The Rock forming Minerals-Longman.,
3. Flint, Y., (1970), Basic crystallography, Mid Publishers.,
4. Francis Rouessac and Annick Rouessac., (2007), Chemical Analysis (Modern Instrumentation Methods and Techniques) John Wiley & sons, 574p.,
5. Hutchinson, C.S., (1974), Laboratory Handbook of Petrographic Techniques-John Wiley.,
6. Kerr, P.F., (1959), Optical Mineralogy, McGraw Hill.,
7. Klein, C. and Hurlbut, Jr. C.S., (1993), Manual of Mineralogy-John Wiley.,
8. Madhu Arora., (2008), Analytical chemistry-Himalaya Publishing House, Mumbai., Phillips,
9. Wm, R. and Griffen, D.T., (1996), Optical Mineralogy-CBS Edition.,
10. Putnis, Andrew, (1992), Introduction to Mineral Sciences-Cambridge University Press.,
11. Spear, F.S. (1993), Mineralogical Phase Equilibria and Pressure-Temperature-Time paths-Mineralogical Society of America Publ.

### 18AGE03 - APPLIED STRATIGRAPHY

#### Unit I

Concept of time in stratigraphy – measuring time, radiometric age dating techniques and problems. Spatial and temporal scales of cycles in sedimentary records. Controls on the development of stratigraphic records. Recent developments in stratigraphy on Stratotypes, Global Boundary Stratotype Sections and Points (GSSP). Lateral variation and facies. Graphic representation of stratigraphic data, methods of stratigraphic correlation.

#### Unit II

International Code of Stratigraphic Nomenclature. Lithostratigraphy, Codes units, correlation and contacts. Biostratigraphy- units, biogeographic zone, provinces, controlling factors, zonation and their time significance. Geochronology. Chronostratigraphy - the ICS International Chronostratigraphic Chart, code and units.

### Unit III

Sequence Stratigraphy - Definition, origin of sequence concepts. Facies, facies association, facies succession, Conformity, unconformity, offlap, parasequences, systems Tracts, Roles of tectonics, eustasy, sediment influx and climate in sequence development. Sequences in clastic and carbonate deposits.

### Unit IV

Chemostratigraphy-definition, evolution of chemostratigraphic concepts, secular and cyclic variation of geochemical composition over time. Mobile and immobile elements. Geochemical indices, geochemical proxy, geochemical signature, marker, fingerprint, geochemical signals, positive and negative excursions, anomalies, enrichment and depletion, chemozone. Absolute and relative dating of chemozones, scales of correlation. Statistical distinction of depositional units. Applications in hydrocarbon exploration, reservoir characterization and stratigraphic correlation.

### Unit V

Relative sea level fluctuations, recognition of sequence surfaces and sequence cycles through seismic and outcrop data. Dating sequences through fossils and Defining sequence surfaces through palaeontological, petrographic, mineralogical, geochemical and other methods. Seismic and outcrop based sequence modeling. Limitations of sequences. Global bio-events and boundary problems in stratigraphy.

### Text / Reference Books

1. Cotillon, P. (1992). Stratigraphy. Springer
2. Doyle, P. & Bennett. M.R. (1996). Unlocking the Stratigraphic Record. John Willey.
3. Krishnan, M.S (1968), The Geology of India and Burma, C.B.S Publication & Distribution
4. Lemon R.Y (1990), Principles of Stratigraphy, Merrill Publishing Co.
5. Ramkrishnan, M. and Vaidhyanadhan, R. (2008). Geology of India, Volume I and II, Geological Society of India, Bangalore
6. Ravindrakumar (1985), Fundamentals of Historical Geology and Stratigraphy of India. Wiley Eastern Ltd, New Delhi.
7. Robert, M. S. (1989). Stratigraphy: Principles and Methods, Van Nostrand Reinhold, New York.
8. Rocha, R., Pais, J., Kullberg, J.C., Finney, S. (Eds.). (2014). First International Congress on Stratigraphy At the Cutting Edge of Stratigraphy. Springer
9. Wadia, D.N (1966), Geology of India, ELBS Tata McGraw Hill.

## 18AGE04 - METEOROLOGY AND CLIMATE CHANGE

### Unit I

#### Meteorology and radiation

Meteorology: introduction, definition, scales in meteorology, branches and applications. Earth Radiation balance: Sun's Energy output, Incoming radiation, Energy spectra of sun and earth, Insulation, Insulation over the globe, insulation losses in atmosphere, long wave radiation, Global radiation balance, Solar energy.

### Unit II

#### Atmosphere, temperature and precipitation

Atmosphere: Composition and structure of atmosphere, Layered structure of atmosphere. Temperature: Introduction, factors influences air temperature, Surface temperature, air temperature, daily cycle of temperature, annual cycle of temperature, urban heat island. Precipitation: Precipitation processes, orographic precipitation, convection precipitation, frontal type of precipitation.

### Unit III

#### El Nino and weather forecasting

El Nino: Introduction, upwelling. El Nino La Nino events and consequences: unusual weather and rainfall, sea surface temperatures, atmospheric consequences, economic consequence. Detection and prediction of El Nino. Weather forecasting: Persistence, trends, climatology, analog and numerical weather prediction methods. Forecasting surface features: Anti cyclone, cyclone, cold front and warm fronts. Forecasting precipitation: effect of frontal lifting, effect of moisture, rain and snow.

### Unit IV

#### Climate change

Introduction, definition. Classification of climate; Koppen's, Bergeron, Thornthwaite's and Strahler classification. Climate change, Palaeoclimatology, Climatic changes through geological time, Geological records of climate, Assessing climate change, Human intervention on climate change. Green house effect, green house gases, Climatic change and global warming, Kyoto protocol.

### Unit V

#### Causes and impact of climate change

Causes of climate change: Astronomical theories, Plate Tectonism, Ocean circulation pattern, Changes in compositions of atmosphere, Changes in solar radiation. Impact of climate change: Rising of CO<sub>2</sub>, impact on atmospheric circulation & weather pattern, biosphere, hydrosphere, sea level changes, Adaptation provinces.

### Text / Reference Books

1. Alan .H. Strahler and Arthur N.Strahlur 1992.Modern Physical Geography Fourth Editions John Wiley & Sons.In.p638.,
2. Alan Strahler and Arthur Strahler (2002). Physical Geography, 2<sup>nd</sup> edition John Wiley & Sons Inc.P748.
3. Byers(2005), Meteorology, The Encyclopedia Britannica 15<sup>th</sup> Ed.
4. Dorothy J.Meeritts and Andrew De (1997)Wet & Kirsten Menking, Environmental Geology – W.H.Freeman and Company, New York ,,
5. Horace General, (1994)Meteorology New York Mc Graw Hill.

6. John.M. Das (1995)The Monsoons, National Book house Trust, New Delhi (Third Edition),
7. Rev.Fr.S.Ignacimuthu (2010) Environmental Studies, MJP Publishers,
8. Travis Hudson (2012) Living with Earth- An Introduction to Environmental Geology, PHI Learning Private Ltd,

## 18AGE05-ENVIRONMENTAL GEOLOGY

### Unit I

#### *Environmental Geology*

Earth's place in space. *Fundamentals concepts of Environmental Geology:*

Human Population Growth - Sustainability - Earth as a System - Hazardous Earth Processes - Scientific Knowledge and Values. Internal Structure of Earth and Plate Tectonics - Plate Tectonics & Environmental Geology. Minerals and Rocks. Ecology and Geology.

### Unit II

#### *Natural Hazards*

Hazards, Disasters, and Nature Processes - *Evaluating Hazards:* History, Linkages, Disaster Prediction, and Risk Assessment - Fundamentals principles concerning Nature Hazards - Human response to Hazards - Global Climate and Hazards - Population Increase, Land - use Change and Nature Hazards.

### Unit III

#### *Volcanoes and Earthquakes*

*Earthquakes:* Magnitude and intensity. Plate boundary related Earthquakes - Earthquake processes (Faulting, Tectonic group). Earthquake shaking (seismic waves, seismograph) - Earthquake cycle - Earthquake caused by Human Activity - Effects of Earthquakes – Tsunami - Earthquake risk and Earthquake prediction - Earthquake warning system. *Volcanic activity* - Volcanic Hazards, Forecasting volcanic activity. *Landslides:* Human use Landslide - Minimising the Landslide Hazards- Perception of Landslides,

### Unit IV

#### *River, Flooding, and Coastal Hazards*

*Rivers and Flooding:* Sediments in River - River velocity, Discharge, Erosion, and Sediments deposition- Effects of Land - use Change - Channel Pattern & Floodplain Formation - River Flooding - Urbanisation & Flooding- The Nature and Extent of Flood Hazards - Adjustments to Flood Hazards - Perception of Flooding. *Coastal processes:* Erosion - Coastal Hazards & Engineering structure - Human activity and Coastal erosion - Perception of and Adjustment to Coastal Hazards.

### Unit V

#### *Resources and Pollution*

*Water Resources:* A brief global prospective surface water – Groundwater - Interactions between surface water and Ground water - Desalination - Water Managements - Water and Ecosystem. *Water Pollution:* Selected Water Pollutions – Oxygen - Demanding Waste - Pathogenic Organisms - Nutrients - Toxic Substances - Synthetic Organic Chemicals – Heavy Metals - Surface Water Pollution and Treatment- Point Source and Non-point Source - Ground water Pollution and Treatment. *Mineral resources:* Mineral of Human use - Geology of Mineral Resources - Environmental Impact of Mineral Development - Recycling Mineral Resource Energy. Geothermal Energy.

## Text / Reference Books

1. Bennett, M. R. B., Doyle, P. (1997) Environmental Geology By. John Wiley & Sons, New York., Rekha Ghosh and D. S. Chatterjee. Environmental Geology – Geoecosystems Protection in Mining Areas. Capital Publ. Co., New Delhi.,
2. Carla W. Montgomery WCH Wm.C (1989). Environmental Geology, Brown Publishers Dubuque, Iowa
3. Chiras, D.D, (1989) Environmental Science – A framework for decision making, Addison – Wesley Publishing Company. New York.,
4. Davis, N. et.Al., (1976) Environmental Geosciences, John Wiley and sones, New York.,
5. Detwiler, T.R, (1971) Man's Impact on Environment, McGraw Hill
6. Keith, L. H. (1996) Principles of Environmental Sampling. ACS Professional Reference book, Amer. Chem. Soc., Washington DC.
7. Khoshoo, T. L. (1988) Environmental Concerns and Strategies By. Ashish Publ. New Delhi.,
8. Montgomery, C.W., (1989) Environmental Geology, Brown publications.,
9. Ray, P. K. and Prasad, A. K. (1995) Pollution and Health. Wiley Eastern Publ., New Delhi.,
10. Strahler, A.N., (1973) Environmental Geology, John Wiley and sons, New York.,
11. Subramanian, V. (2002), A Text book in Environmental Science, Narosa Publishing House, New Delhi
12. Valdiya, K. S. (1987) Environmental Geology - Indian Context . McGraw Hill Publ.,

## 18AGE06 - MARINE GEOLOGY

### Unit I Introduction

History of Marine Geology, Waves, tides, currents, turbidity currents, long shore currents, rip currents, circulation, Wave Action: wave reflection, refraction and diffraction – Seiche and tsunamis – Coastal Zone Morphology (Estuaries, deltas, bays, raised beaches, features of wave erosion and deposition, tombolos, mud banks) – Deep sea Morphology (Continental shelf, Continental slope, abyssal plains, sea mounts, guyots, fracture pattern).

### Unit II

#### Marine Processes and Geomorphic features

Littoral processes - Evolution of headlands and bays - Beaches - Raised and sunken features – Evolution and classification of sea coasts and shore lines. Terrestrial-lacustrine-shallow marine-deep sea - siliciclastic versus carbonate sedimentation - deep ocean silica burps - shelf-to-basin transport phenomena turbidites and gravity flows – Submarine groundwater discharge.

### Unit III Seafloor Tectonics

Causes of marine regression and transgression – Description of important regressions and transgressions in the geological past – Eustasy –Origin and distribution of ocean basins – Palaeoceanography- Ocean floor tectonics: Characteristics of Oceanic Plate – Geologic processes along Oceanic Plate boundaries – Seafloor Spreading – Evidence - lithospheric plates –divergent plate boundaries – Trenches as convergent plate boundaries – Subduction zones – Transform fault boundaries

### Unit IV Marine Sediments and Marine Geochemistry

Marine sedimentation – Sources, types and distribution of marine sediments – Transport of sea bottom sediment - Rate of deposition – Mineral resources. Marine phosphorite, glauconites, barium sulphate concretions, Polymetallic nodules – Gas hydrates - Beach placers. Terrigenous, Biogenic and Chemical Types – Placer Deposits. Distribution of temperature, salinity and density.

### Unit V Applied Marine Geology

Trenches and Submarine Canyons – Bengal Fan). Biogenic structures: Reefs of corals and algae Mid-ocean ridges, and the structure of the oceanic crust - Coastal processes and the structure of continental margins.Coastal zone regulation in India – India as Pioneer Investor in Seabed mining. Seafloor geologic process – Volcanism and seismicity.

### Text / Reference Books

1. King, C.A.M., (1975). Introduction to marine Geology and Geomorphology. Edward Arnold, London.
2. Radhakrishnan, V., (1996). General Geology V.V.P. Publishers, Tuticorin.
3. Seabold, E. and Berger, W.H. , (1982). The Sea Floor, Springer Verlag. Kuenen, Ph.H., 1950. Marine Geology. John Wiley and Sons.
4. Shepard, F.P., (1978). Geological Oceanography, Heinmann, London.

5. Shephard, F.P., (1973). Submarine Geology,
6. Harper and Row. Kurekian, K.K., 1990. Ocean, Prentice Hall.
7. Svedrup, J.F., (1969). The Ocean, A Scientific American book, W.H. Freeman and company, San Francisco.
8. Kennett, J.P. (1982). Marine Geology. Prentice Hall. New Jersey.
9. Weisberg, C.P. (1979). Oceanography. McGraw Hill. New York.



SUPPORTIVE COURSES  
18GS01 - EARTH SYSTEM SCIENCE

Unit I

Space Science

Introduction to various branches of Earth Sciences. Solar System, Age of the Earth, Origin of Solar system. Meteors and Meteorites. Earth Dynamics : Interior of the Earth, Composition of the Earth, Seismic waves, Seismograph, Plate Tectonics, Basics of Earthquake Engineering, Landslides, Volcanoes.

Unit II

Geological Oceanography:

Sea waves, Tides, Ocean currents, Geological work of seas and oceans, Tsunami and its causes, Warning system and mitigation.

Unit III Hydrogeology

Hydrogeology: Water table- Aquifer- Groundwater fluctuations and groundwater composition, Hydrological cycle. Glaciology: Glacier types, Different type of glaciers, Landforms formed by glacier. Petrology - Geological bodies and their structures: Rock, mineral, batholiths, dyke, sill, fold fault, joint, unconformity.

Unit IV

Earth's Atmosphere :

Structure and composition of atmosphere, Atmospheric circulation, Geological work of wind, Greenhouse effect and global warming, Carbon dioxide sequestration. Steps to maintain clean and pollution free atmosphere with governing laws, precautionary measures against disasters.

Unit V Biosphere:

Origin of life, Evolution of life through ages, Geological time scale, biodiversity and its conservation. Natural Resources: Renewable and non-renewable resources, Mineral and fossil fuel resources and their geological setting, mining of minerals and conservation, effect of mining on surface environment

Text / Reference Books

1. Holme's Principles of Physical Geology. (1992). Chapman & Hall.
2. Emiliani, C, (1992). Planet Earth, Cosmology, Geology and the Evolution of Life and Environment. Cambridge University Press

## 18GS02 – WATER RESOURCES MANAGEMENT

### Unit I

*Introduction:* Definition, concepts of watershed, major objectives of watershed management, effects of watershed on community, ecosystem, Monitoring and evaluation of watershed.

### Unit II

*Principles of watershed management:* Delineating the watershed. natural processes at work in watershed, common elements of watershed management, multidisciplinary approach in watershed management, participatory resources mapping and appraisal, benefits of watershed approach.

### Unit III

*Degradation agents in watershed:* Flood, drought, fire, wind storms, erosion and deposition. Climate change. Glacial movement, Tectonic activity. Volcanic eruption. Human-induced changes. Impact of the degradation of watersheds in hydrology.

### Unit IV

*Engineering measures for soil conservation:* Rainfall parameters. Types of soil erosion. contour bunding, Surplusing structures contour and straggled trenching, gully control structures, graded bunding, bench terracing, land leveling and grading.

### Unit V

*Water Conservation and Harvesting:* Water conservation methods for crop land, Treatment of catchments. *Rainwater harvesting structures:* Check dam, farm pond, percolation tank, basin, ditch and furrow, channel, flooding, irrigation, subsurface dyke, nalla bund and pit methods. Conjunctive use of surface and groundwater.

### Text / Reference Books

1. Rajora,R.,(1998), Integrated Watershed Management, Rewat Publications, New Delhi.
2. Tideman.E.M., (1996), Watershed Management: Guideline for Indian Conditions, Omega Scientific Publishers,372p.
3. Lal.S., (2004), Watershed, Development, Management and Technology, Mangal Deep Publications,358p.
4. Paranjape,S.et.al.,(1998), Watershed Based Development: A Source Book, Bharat Gyan Vigyan Samathi, New Delhi.
5. Suresh,R.,(2002), Soil and Water Conservation Engineering, Standard Publishers and Distributers, Delhi.
6. Kakade,B.K.,(2002), Soil and Water Conservation Structures in Watershed Development Progammes ,BAIF Development Research Foundation, Pune.

## 18GS03 - GEMMOLOY

### Unit I

Introduction to Gems - Basic properties of gems. Formation of gem stones. Nature of gem material: quality necessary in gems-beauty, rarity, durability. Distinction between crystalline, amorphous and metamict materials. Crystal form and habit. Classification of gem stones. Observations with hand lens (10x)-importance and uses. Units of measurement: metric scale, carat, pearl and grain.

### Unit II

Nature of crystals: distinction between crystalline and amorphous material, crystal symmetry, Twinning, parallel growth, crystal form, crystal habit, seven crystal system. Identification of rough stones.

### Unit III

Physical properties: hardness its applications in gemmology and limitations. Cleavage, Fracture, parting, and their importance in gemology and lapidary work. Specific gravity-utility and determination by hydrostatic weighing, heavy liquids, floatation and pycnometer. Inclusions and other features of gemstones.

### Unit IV

Optical properties: The electromagnetic spectrum, reflection and its importance in gemology-lustre, aventurescence, sheen, chatoyancy, asterism, luminescence, play of colours, labradorescence, inclusions etc.. Laws of refraction, refractive index (R.I), total reflection- in design of refractometer. Construction and use of refractometer. Polariscope-construction and use in gemmology. Dichroscope-construction, use of Chelsea colour filter, Infra-red ultraviolet and x-rays in gem identification.

### Unit V

Enhancement and treatments- enhancement methods - coloured and colourless impregnation, dyeing, bleaching and its identification. Methods of treatment – laser drilling, irradiation, heat treatment, surface modifications, diffusion treatment and its identification. Composites - types, classification and identification.

### Text / Reference Books

1. Karan R.V.(2000),Gem and gemindustry in India,Memoir 45,Geological Society of India,Bangalore.,
2. Anderson,B.W(1990).Gem testing (10th edition),Butterworth Scientific,London.,
3. Babu,T.M.(1998) Diamonds in India.Geological society of India, Bangalore.,
4. Hall,C.(1994).Gemstone,Dorling Kindersley,London.
5. Deer,W.A., Howie,R.A and Zussman.S.(1992). An introduction to rock forming minerals,ELBS,London.
6. Kerr, P.F.(1997).Optical mineralogy,4th Ed.McGraw Hill Book & Co New York.,

- Gemmology 2nd Ed.-Peter Read (1991) Butter worth-Heinemanu Ltd.Lundu., Gems 5th Ed. Peter Read. Buurerworth, London
7. Richard Laddicoat (1987), Hand book of gem idendification- G.I.A.
  8. Santa Monica., Edward Gubelin (1986) Photo Atlas of Including in Gem Stones- ABC Edition Zurich., Gem Testing 10th Ed.
  9. B.W. Anderson (1990) Butterworth Scientific London., Gemstone Enhancement 2nd Edition,
  10. Nassan K. (1994)Butterworths London., Gems 5th Ed. Webster Butter worths London., Hall, C. Gemstones. ISBN 1564584992.
  11. Dorling Kindersley, (1994)., Read, P. Gemmology. ISBN 0750644117.
  12. Butterworth Heinemann, (1999)., O' Donoghue, M. Identification of Gemstones. ISBN 0750655127.

18GS04 - RAINWATER HARVESTING AND ARTIFICIAL GROUNDWATER  
RECHARGE

Unit I

Hydrological cycle and its components. Surface water and groundwater. Vertical distribution of groundwater. Over-exploitation of groundwater - Need for artificial recharge and rainwater harvesting - types of wells - drilling technology - design, construction and development of water wells: dug, bore and tube wells.

#### Unit II

Types of pumps - various artificial recharge structures: recharge ponds - recharge pits - percolation ponds - basin spreading - surface and subsurface dykes - recharge wells - recharge bore wells. Rainwater harvesting in urban areas : RWH structures - design - construction.

#### Unit III

Estimation of probable runoff from an area including from rooftops - maintenance and monitoring of RWH structures. Study of benefits - effects on local groundwater environments - remedial measures. Recycling of domestic water - sources of water to recharge in urban areas. Aquifer and its types.

#### Unit IV

Water table and its fluctuations. Water quality parameters. BIS and WHO standards. Watershed management strategy. Salt water intrusion and remedial measures. Interlinking of rivers in India. Indian monsoon pattern. Role of meteorological department.

#### Unit V

Groundwater management strategy, recycling of effluent water, sources of water contamination and remedial measures. Impact of urbanization on water resources. Definition for river basin, sub basin, watershed and micro watershed. Role of public in watershed management practices at village level.

#### Text / Reference Books

1. Rajora, R., (1998), Integrated Watershed Management, Rewat Publications, New Delhi. Tideman, E.M.,
2. Lal, S., (2004), Watershed, Development, Management and Technology, Mangal Deep Publications, 358p.
3. Paranjape, S. et al., (1998), Watershed Based Development: A Source Book, Bharat Gyan Vigyan Samathi, New Delhi.
4. Suresh, R., (2002), Soil and Water Conservation Engineering, Standard Publishers and Distributors, Delhi.
5. Kakade, B.K., (2002), Soil and Water Conservation Structures in Watershed Development Programmes, BAIF Development Research Foundation, Pune.

### 18GS05-GEOHAZARDS

#### Unit I

Natural Hazard – definition -Earth's processes: catastrophic geological hazards: study of floods, tsunamis, Landslides, Earthquakes, Volcanism and avalanches – with a view to assess

the magnitude of the problem, prediction and perception of the hazards. Laws and regulations towards hazard management.

## Unit II

Earthquakes-Definition –focus -epicenter-seismic waves-intensity and magnitude- Richter scales – Tsunami -Seismograph- seismogram-seismicity in Indian region - Seismic gaps - mitigation measures and management. Preparation of seismic hazard map.-Seismic Gap.

## Unit III

Volcanoes-Definition-structure - types –Global distribution - mitigation measures and management.Avalanche – Definition – types – mitigation.Flood- Definition - causes - vulnerable zones in India-Mitigation measures and management.Coastal erosion – its causes-mitigation measures and management.

## Unit IV

Landslides- types -slow flowage, rapid flowage, sliding and subsidence – causes and mechanism - Vulnerable zones in India - mitigation measures and management. Deforestation and land degradation-Cyclone- Definition -causes - vulnerable zones in India-mitigation measures and management.

## Unit V

Mass movement – factor influencing slope stability – types of mass movement – hazards of mass movement – strategies for their reduction and the role of geology. Soil erosion – Soil formation – soil classification – factor influencing soil erosion – hazards of soil erosion – Drought – types, mitigation measures.

## Text / Reference Books

1. Geology, environment, Society K.S.Valdiya (2004) Universities Press (India) Private Limited, Hyderabad,India
2. Coping with natural hazards: Indian context K.S.Valdiya (2004) Orient Longman Private Limited, Hyderabad,India.
3. Engineering and general geology Parbin Singh (2003) S.K.Kataria and sons Delhi India
4. Genaral Geology V.Radhakrishnan (1996) V.V.P.Publishers, Tuticorin,India.
5. Lundgren (1986). Environment Geology, Rentice Hall Publishers, New Jersey.