THIRUVALLUVAR UNIVERSITY MASTER OF SCIENCE M.Sc. GEOLOGY

DEGREE COURSE

UNDER CBCS

(With effect from 2020-2021)

The Course of Study and the Scheme of Examination

SI.	Study Components		ins.	Cre	Title of the Demon	Maximum Marks					
No.	Course Title		week	dit	The of the Paper	CIA	Uni.	Tatal			
SEMESTER I						CIA	Exam	Ιοται			
1	Core-Theory	Paper-1	5	4	Applied Geomorphology	25	75	100			
2	Core-Theory	Paper-2	5	4	Structural Geology and Geo tectonic	25	75	100			
3	Core-Theory	Paper-3	5	4	Mineralogy	25	75	100			
4	Core-Theory	Paper-4	5	4	Palaeontology	25	75	100			
5	Core-Practical	Paper1-	4	-	Practical –I Structural Geology, Mineralogy and Palaeontology*	-	-	-			
Internal Elective for same major students (Choose any one)											
6	Core Elective	Paper-1	3	3	A. Ore Geology B. Fuel Geology C. Marine Geology	25	75	100			
External Elective for other major students (Inter/multi disciplinary papers)											
7	Open Elective	Paper-1	3	3	A. Meteorology and Climate Change B. Geohazards	25	75	100			
			20	22	C. Water Resources Management	450	450	600			
			30	22		150	450	600			
SEMESTER II						CIA	Exam	Total			
8	Core-Theory	Paper-5	4	4	Igneous and Metamorphic Petrology	25	75	100			
9	Core-Theory	Paper-6	4	4	Sedimentology	25	75	100			
10	Core-Theory	Paper-7	4	4	Stratigraphic Principles and Indian Stratigraphy	25	75	100			
11	Core-Theory	Paper-8	4	4	Exploration Geology	25	75	100			
	Core-Practical	Paper1-	-	3	Practical –I Structural Geology, Mineralogy and Palaeontology*	25	75	100			
12	Core-Practical	Paper-2	4	3	Petrology and Sedimentology*	25	75	100			
Internal Elective for same major students (Choose any one)											
13	Core		4	3	A. Palaeo botany	25	75	100			

	Elective	Paper-2			B. Sequence Stratigraphy C. Petroleum Exploration							
External Elective for other major students (Inter/multi disciplinary papers)												
14	Open Elective	Paper-2	4	3	A. Earth System Science B. Gemmology C. Soil Geology	25	75	100				
15	*Field Study		-	2	Geological Mapping/ Field Training	100	-	100				
16	Compulsory Paper		2	2	Human Rights	25	75	100				
			30	32		300	600	1000				

* Field Study

There will be field study which is compulsory in the first semester of all PG courses with 2 credits. This field study should be related to the subject concerned with social impact. Field and Topic should be registered by the students in the first semester of their study along with the name of a mentor before the end of the month of August. The report with problem identification and proposed solution should be written in not less than 25 pages in a standard format and it should be submitted at the end of second semester. The period for undergoing the field study is 30 hours beyond the instructional hours of the respective programme. Students shall consult their mentors within campus and experts outside the campus for selecting the field and topic of the field study. The following members may be nominated for confirming the topic and evaluating the field study report.

(i). Head of the respective department

(ii). Mentor

(iii). One faculty from other department

THIRUVALLUVAR UNIVERSITY

MASTER OF SCIENCE

M.Sc. GEOLOGY

SYLLABUS UNDER CBCS (With effect from 2020-2021)

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.

- 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.

PAPER 2

STRUCTURAL GEOLOGY AND GEOTECTONIC

Unit I

Deformation, Stress and Strain

Deformaton: Definition - Components of deformation. Strain: Homogeneous and heterogeneous deformation - One-dimensional strain, Strain in two dimensions, Threedimensional 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 - Contractional 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 schisosity - 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 – Boundinage – Pencil Structures. Lineations related to plastic deformation Lineations in the brittle regime Lineations and kinematics.

Unit IV

Boudinage, Shear zones, and salt tectonites

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.

- 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.

PAPER -3

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.

- 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 Hurbut, 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 Cyrstallography.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. & Griften, 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.

PAPER - 4

PALAEONTOLOGY

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 times cale. 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.

- 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.

Core Practical - paper 1 STRUCTURAL GEOLOGY, MINERALOGY AND PALAEONTOLOGY

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.

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

CORE ELECTIVE PAPER-1 (to choose 1 out of 3)

A. ORE GEOLOGY

Unit I

Concept of ore bearing fluids, their origin and migration; Wall rock alteration; Structural, physicochemical and stratigraphic controls of ore localization; Ore deposits in relation to plate tectonics; Organic matters in ores and their significance; Fluid inclusions in ore - principles, assumptions, limitations and applications.

Unit II

Mineralogy, classification and genesis of ore deposits associated with orthomagmatic res of ultramafic-mafic rocks; Ores of felsic-silicic igneous rocks; Ores of sedimentary affiliation - biochemical, chemical and clastic sedimentation, placers and residual concentration deposits; Ores of metamorphic affiliations.

Unit III

Study of ore minerals related to the following metals with special reference to their ineralogy, genesis, specification (if any), uses and distribution in India: Fe, Mn, Cr, Cu, Pb, Zn. Al, Mg, Sn, and W.

Unit IV

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

Unit V

Megascopic study of Indian metallic ores and industrial minerals in hand specimens; Study of ore structures in hand specimens; Study of optical properties and identification of important ore minerals under ore-microscope; Preparation of maps showing distribution of metallic and industrial minerals in India and also classical world mineral deposits.

- 1. Branes, H.L. (1979): Geochemistry of Hydrothermal Ore Deposits, John Willey.
- 2. Cuilbert, J.M. and Park, Jr. C.F. (1986): The Geology of Ore Deposits, Freidman.
- 3. Evans, A.M. (1993): Ore Geology and Industrial Minerals, Blackwell.
- 4. James R. Craig and David J.Vaughan (1994): Ore Microscopy and Petrography.
- 5. Klemm, D.D. and Schnieder, H.J. (1977): Time and Strata Bound Ore Deposits, Springer-Verlag.
- 6. Mookherjee, A. (2000): Ore Genesis-A Holistic Approach, Allied Publisher.
- 7. Ramdhor, P. (1969): The Ore Minerals and their Intergowths, Pergamon Press.
- 8. Stanton, R.L. (1972): Ore Petrology, McGraw Hill.
- 9. Wolf, K.H. (1976-1981): Hand Book of Stratabound and Stratiform Ore Deposits, Elsevier Publ.

B. 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 propective.

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.

- 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.
- Stach, E., Mackowsky, M-Th., Taylor, G.H., Chandra, D., Teichumullelr, 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 Veralg.
- 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

C. 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. Terrestriallacustrine-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.

OPEN ELECTIVE PAPER-1 (to choose 1 out of 3)

A. 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 CO2, 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.,

- Alan Strahler and Arthur Strahler (2002). Physical Geography, 2nd edition John Wiley & Sons Inc.P748.
- 3. Byers(2005), Meteorology, The Encyclopedia Britannia 15th 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,

B. 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.

- 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.
- 6.

C. 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.
- Tideman.E.M., (1996), Watershed Management: Guideline for Indian Conditions, Omega
 Scientifica Publishers 272n

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 Progarmmes ,BAIF Development Research Foundation, Pune.

SEMESTER II PAPER-5

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 (SiO2)- 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 precesses 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 polymetamorphised 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.

- 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.
- 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.

PAPER-6

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.

- 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.
- 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.

PAPER-7

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-Quternary boundary.

Text / Reference Books

1. Danbar, C.O. and Rodgers, J. (1957) Principles of Stratigraphy. John Wiley & Sons.

- Doyle, P. & Bennett. M.R. (1996) Unlocking the Stratigraphic Record (John Willey).
- GSI Misc. Publn. No. 30. (2006) Geology and Mineral Resources of the States of India
- 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.

PAPER - 8

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, true and apparent D.C. resistivity 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.
- 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.

Core- Practical - Paper-2

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 (Na2O+K2O) vs SiO2 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

Core Elective Papers-2 (to choose 1 out of 3)

A. PALAEOBOTANY

Unit-I

Introduction and approach to palaeobotany, occurrence of plant fossils, their collection and preparation techniques.

Unit-II

principles of nomenclature (concept of genera and form genera), Classification of fossil plants andbroad characters of major plant groups.Nature of palaeobotanical record.

Unit-III

Application of palaeobotany in assessing palaeoclimate and palaeoenvironment. Dendrochronology and its application.

Unit-IV

Palynology and its applications, Distribution of pre-Gondwana, Gondwana.

Unit-V

Inter-trappean and Tertiary Floras of India and its relationship withother contemporaneous fossil floras of the world.

- 1. Arnold, C.A. (1947) An introduction to Palaeobotary, McGraw Hill
- 2. Andrews Jr., H.N. Studies in Palaeo; botony. Viley, New Yorks.
- 3. Chester, R.A. (1987). An introduction to Palaeobotony, Tata McGraw Hill.
- 4. Alfred Traverse (1988): Paleopalynology, Unwin Hyman, USA.
- 5. Bergland, B.E. (1986): Handbook of Holocene paleoecology and paleohydrology, John Wiley, NewYork.
- 6. Jones, T.P. and Rowe, T.P. (1999): Fossil Plants and Spores Modern Techniques, Geological Soc.ofLondon.
- 7. Pipero, Dologes, R. (1988): Phytolith analysis: an Archaeobiological and Geological perspective, Academic Press.
- 8. Prothero, D.R. (2004): Bringing Fossil to Life An Introduction to Paleontology (2nd Ed.), McGraw Hill.
- 9. Seaward, A.C. (1991): Plant fossils, Today's and Tomorrow, New Delhi.
- 10. Shipad N. Agashe (1995): Paleobotany, Oxford and IBH Publ., New Delhi.
- 11. Stewart, Wilson N. and Rothwell Gar W. (1993): Paleobotany and the Evolution of Plants, CambridgeUniv. Press

B. SEQUENCE STRATIGRAPHY

Unit-I

Approaches to measurement of geological time; Concept of sequence stratigraphy; brief ideas of magnetoseismic-chemo- and event stratigraphy and stratigraphic correlation

Unit-II

Precambrian geochronology; Precambrian chronostratigraphy of Rajasthan, Dharwar craton, Eastern Ghat belt,Southern Granulite belt and Singhbhum-Chotanagpur-Orissa belt; Proterozoic stratigraphy of Son valley,Cuddapah and Kurnool basins; Precambrian/Cambrian boundary.

Unit-III

Stratigraphy of the marine Palaeozoic rock formations of India, Permian/Triassic boundary, Classification, depositional characteristics, fauna and flora of Triassic, Jurassic and Cretaceous systems in principal basins of India.

Unit-IV

Cretaceous/Tertiary boundary, Classification, depositional characteristics, fauna and flora of the Palaeogene and Neogene systems in their type localities and their equivalents in India; Epoch boundaries of the Cenozoic in India.

Unit-V

Study of rocks in hand specimens from known Indian stratigraphic horizons and type localities; Exercises on stratigraphic classification and correlation, sequence, and magneto stratigraphic interpretations.

- 1. Boggs, S. (2001): Principles of Sedimentology and Stratigraphy, Prentice Hall.
- 2. Danbar, C.O. and Rodgers, J. (1957): Principles of Stratigraphy, John Viley and Sons.
- 3. Doyle, P. and Bennett. M.R. (1996): Unlocking the Stratigraphic Record, John Viley and Sons.
- 4. Krishnan, M.S. (1982): Geology of India and Burma, C.B.S. Publ. and Distributors, Delhi.
- 5. Naqvi, S.M. and Rogers, J.J.W. (1987): Precambrian Geology of India, Oxford University Press.
- 6. Pascoe, E.H. (1968): A Manual of the Geology of India and Burma (Vols.I-IV), Govt. of India Press, Delhi.
- 7. Pomerol, C. (1982): The Cenozoic Era? Tertiary and Quaternary, Ellis Harwood Ltd., Halsted Press.
- 8. Schoch, Robert, M. (1989): Stratigraphy: Principles and Methods, Van Nostrand Reinhold, New York.

C. PETROLEUM EXPLORATION

Unit-I

Identification and characterization (Petrographic and geochemical) of petroleum source rocks. Amount, type and maturation of organic matter. Oil and source rock correlation. Locating petroleum prospects based on principles of petroleum generation and migration (geological modeling).

Unit-II

Quantitative evaluation of oil and gas prospects through geochemical modeling. econstruction of paleogeothermal gradient. Migration modeling. Inputs for the assessment of accumulation of petroleum.

Unit-III

Elementary knowledge of geophysical methods of exploration: Magnetic, Gravity and Seismic methods.Elementary knowledge of well drilling: cable-tool drilling, rotary drilling and various types of drilling units.

Unit-IV

Borehole model, Elementary knowledge of Wireline logs: Resistivity, SP, Gamma, Density, Sonic and Neutronlogs. Application of logs in petrophysical analysis and facies analysis.

Unit-V

Megascopic and microscopic study of cores. Preparation of geological maps and sections, and derivation of geological history in relation to petroleum prospects. Calculation of oil reserves. Exercise on maturationstudies. Petrographic characterization of petroleum source rocks. Interpretation of electric and porosity logs.

- 1. Holson, G.D. and Tiratso, E.N. (1985) Introduction of Petroleum Geology. Gulf Publishing, Houston, Texas
- 2. Tissot, B.P. and Welte, D.H. (1984) Petroleum Formation and Occurrence. Springer – Verlag
- 3. North, F.K. (1985) Petroleum Geology. Allen Unwin.
- 4. Selley, R.C. (1998) Elements of Petroleum Geology. Academic Press.
- 5. Hunt, J.M. (1996) Petroleum Geochemistry and Geology, 2nd Edition Freeman, San Francisco.
- 6. Jahn, F., Cook, M. and Graham, M.(1998) Hydrocarbon exploration and production. Elsevier
- 7. Barker, C. (1996) Thermal Modeling of Petroleum Generation, Elsevier.
- 8. Darling, Toby (2005)Well Logging and Formation Evaluation (Gulf Drilling Guides) 2005, Second ed.edition Gulf Professional Publishing.
- 9. Schlumberger Log Interpretation Principles/Application, Schlumberger Wireline & testing 225
- 10. Schlumberger Drive sugar land, Texas 774778.

OPEN ELCETIVE PAPERS-2 (to choose 1 out of 3)

A. 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

- 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

B. 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, floation 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.

- 1. Karanh 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 Scoentitic,London.,
- 3. Babu, T.M. (1998) Dimands in India. Geological society of India, Bangalore.,
- 4. Hall,C.(1994).Gemstone,Dorling Kindesley,London.

- 5. Deer, W.A., Houre, R.A abd zussman.S. (1992). An introduction to rock forming minerals, ELBS, London.
- Kerr, P.F.(1997).Optical mineralogy,4th Ed.McGrow 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.
- 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,
- 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.

C. SOIL GEOLOGY

Unit-I

Concept of soil, components of soil, soil profile; Process of soil formation, pedogenic processes; Classification soil, mineral and chemical composition of soils, mineral stability during weathering; Soil organic matter formand function; A brief introduction to methods of soil conservation.

Unit-II

Fabric analysis - size and shape, concepts of size and shape, grade scale, methods of analysis, presentation ofdata, analysis and field grading; Concepts of structure fabric: Soil fabric, soil structure, soil texture and fieldgrading units; Unit-III

Peds and pedalilty, size and shape of peds, pedality, primary, secondary and tertiary structures and their interpretation; Voids - concepts, size, shape, arrangement and morphological classification.

Unit-IV

Paleosols - Field recognition, description, origin and causes; Paleosol in stratigraphic records; Significance of paleosol study; Paleosols and human evolution.

Unit-V

Calcrete - definition, classification, calcrete formation, pedogenic calcrete soil profile, macro features incalcretes, micromorphology (petrography), calcretes from Quaternary and ancient sedimentary sequences; significance of calcretes; Laterite - characteristics, genesis, Indian occurrences.

Text / Reference Books

- 1. Braddy, N.C./: Nature and properties of soils.
- 2. Gerrard, A.J.J. : Soil and Land forms
- 3. Govinda Rajan, S.V. & Gopala Rao, kH.G.: Studies of Soils of India.
- 4. Gurrison, S. (1989): The Chemistry of Soils, Oxford University Press.
- 5. Hunt,C.B.: Geology of Soils
- 6. Jeffe, J.S.: The A.B.C. of soils
- 7. Terzaghi, K. & Pock, R.G.: Soil Mechanics in Engineering
- 8. Tayler, D.W.: Fundamentals of Soil Mechanics
- 9. Wright;, V. Paul(Ejditer)j: Paleosols: their recognition and interpretation, Blackwell ScientificPublication.
- 10. Wright;, V. Paul and Tucker, M.E. (1991) Calcretes. Blackwell Scientific Publicaton.
