



# Syllabus for III<sup>rd</sup> Semester Courses in M.Sc. Geology (June 2019 onwards)

## Courses:

SGEO0901 – General and Invertebrate Palaeontology

SGEO0902 – Hydrogeology

SGEO0903 – Geophysical Prospecting

SGEO0904 – Coal and Petroleum Geology

## Practical Course:

SGEO0901PR, SGEO0902PR, SGEO0903PR and SGEO0904PR.

(Pertinent to the above-mentioned theory courses)

**M.Sc-II Geology Course: SGEO0901**

**Title: General and Invertebrate palaeontology**

**Learning Objectives:** To understand scope and applications of palaeontology and to learn morphology and classification of invertebrate fossil fauna. To understand trace fossils and taphonomic record with Indian examples

**Unit -1: (15 lectures)**

**Introduction**

Palaeontology, definition, subdivisions and scope, its relationship with other sub-disciplines of geology; Fossils, definition, characters, kinds (body and trace fossils); Conditions of fossilization; Incompleteness of fossils record; Bathymetric distribution of organisms. Modern systematics; Concept and kind of type specimens; Micro and macroevolution. Trans-specific evolution, speciation and radiation.

**Unit -2: (15 lectures)**

**Invertebrate paleontology-1**

Chief characteristics, Evolutionary trends and geological history of following groups:  
Brachiopoda and Echinoidea  
Chief characteristics of  
Mollusca (Bivalvia, Gastropoda, Cephalopoda)

**Unit -3: (15 lectures)**

**Invertebrate paleontology-2**

Chief characteristics, Evolutionary trends and geological history of following groups:  
Trilobita, Graptoloidea.  
Chief characteristics and geological history Cnidaria (Corals),  
Ichnofossils, their modes of preservation, behavioral classification and ichnofacies.

**Unit -4: (15 lectures)**

**Paleoecology paleoenvironment**

Approaches to palaeo-ecological and paleoenvironmental studies based on benthic communities, trace fossils and taphonomic record with Indian examples. Distribution, migration and dispersal of organisms applied to palaeobiogeography and plate tectonics with Indian examples.

**Practical Course:**

**General and Invertebrate palaeontology**

Study of the morphological characters of some important invertebrate fossils belonging to Brachiopoda, Bivalvia, Gastropoda, Ammonoidea, Trilobita, Echinoidea and corals; Study of ammonoid suture pattern. Study of some important ichnofossils.

### **List of Recommended Reference Books**

- 1) Clarkson, E.N.K. (1998): Invertebrate Paleontology and Evolution, Allen and Unwin, London.
- 2) Prothero, D.R. (2004): Bringing Fossil to Life – An Introduction to Paleontology (2<sup>nd</sup> Ed.), McGraw Hill.
- 3) Raup, D.M. and Stanley, S.M. (1985): Principles of Paleontology ,CBS Publ..
- 4) Smith, A.B.(1994): Systematics and Fossil Record – Documenting Evolutionary Patterns, Blackwell.
- 5) Streat, C.W. and Carroll, R.L. (1989): Paleontology – the record of life, John Wiley.
- 6) Shrock, Robert R. and Twenhofel, William H. (2002): Principles of Invertebrate Paleontology, (McGraw Hill) Dist. CBS Publishers.
- 7) Benton, Michael J. and Harper, David A.T. (2009): Introduction to Paleobiology and fossil record, John-Wiley & Sons.

**M.Sc-II Geology Course: SGEO0902**

**Title: Hydrogeology**

**Learning Objectives:** To understand the functioning of groundwater systems and its interaction with surface water, climate change and landuse. To evaluate the quality parameters and its geological significance. To learn the techniques of groundwater exploration and management.

**Unit -1: Origin, occurrence and distribution of water. (15 lectures)**

Water on earth; Types of water — meteoric, juvenile, magmatic and sea water;  
Hydrological Cycle and its components; Water balance;  
Water-bearing properties of rocks — porosity, permeability, specific yield and specific retention;  
Vertical distribution of water; Zone of aeration and zone of saturation; Classification of rocks according to their water-bearing properties; Aquifers; Classification of aquifers; Concepts of drainage basins and groundwater basins;  
Aquifer parameters- transmissivity and storage coefficient; Water table and piezometric surface; Fluctuations of water table and piezometric surface; Barometric and tidal efficiencies; Water table contour maps; Hydrographs; Springs; Geologic and geomorphic controls on groundwater; Groundwater provinces of India.

**Unit -2: (15 lectures)**

**Groundwater Hydraulics**

Theory of groundwater flow; Darcy's law and its applications; Determination of Permeability in laboratory and in field;  
Flow through aquifers; steady, unsteady and radial flow conditions;  
Evaluation of aquifer parameters of confined, semi-confined and unconfined aquifers -Thiem, Thies, Jacob and Walton's methods; Groundwater modelling

**Groundwater management**

Groundwater problems related to foundation work, mining, canals and tunnels; Over-exploitation of groundwater and groundwater mining; Groundwater problems in urban areas; Ground water management in arid and semi-arid areas; Concept of sustainable development of groundwater resources; Groundwater management —supply side and demand side management; Rainwater harvesting and managed aquifer recharge; Conjunctive use of surface and groundwater; Groundwater legislation. Artificial Recharge of Groundwater

**Unit -3: Groundwater management and Quality (15 lectures)**

**Groundwater management**

Over-exploitation of groundwater and groundwater mining; Groundwater problems in urban areas; Ground water management in arid and semi-arid areas; Concept of sustainable development of groundwater resources; Groundwater management —supply side and demand side management; Rainwater harvesting and managed aquifer recharge; Conjunctive use of surface and groundwater; Groundwater legislation. Artificial Recharge of Groundwater

### **Groundwater quality**

Physical and chemical properties of water; Quality criteria for different uses; Graphical presentation of groundwater quality data; Water-Quality Standards and collection of Water Samples. Groundwater contamination; natural (geogenic) and anthropogenic contaminants; Saline water intrusion in Aquifers- Ghyben-Herzberg relation between Fresh and Saline water

### **Unit-4**

**(15 lectures)**

#### **Groundwater Exploration and Water Well Construction**

Geologic and hydrogeologic methods of exploration; Role of remote sensing in groundwater exploration; Hydrogeomorphic and lineament mapping;

#### Surface and subsurface methods for investigation of groundwater:

Surface investigation of groundwater- seismic, gravity, geo-electrical and magnetic

Sub-surface geophysical methods – resistivity logging and SP

Yield characteristics of wells; Pumping tests- methods, data analysis and interpretation

Types of water wells and methods of construction; Design, development, maintenance and revitalization of wells.

### **List of Recommended Reference Books**

1. Appelo, C. A. J., & Postma, D. (2005). *Geochemistry, Groundwater and Pollution* (2nd ed.). Rotterdam: A. A. Balkema.
2. Assad, F.A., LaMoreaux, P.E., & Hughes, T. H., (2004) *Field methods for Geologists and Hydrogeologists*. Springer-Verlag, Berlin.
3. Brassington, R., (2006) *Field Hydrogeology* (3<sup>rd</sup> ed). John Wiley & Sons, Chichester
4. Fetter, C. W. (1988). *Applied Hydrogeology* (Second). USA: Merrill Publishing Company.
5. Ingebritsen, S.E., Stanford, W.E & Neuzil, C.E. (2006) *Groundwater in geologic processes*. 2nd ed., Cambridge
6. Karanth, K. R. (1987). *Ground Water assessment, development and Management*. New Delhi: Tata McGraw-Hill.
7. Nath, S.K, Patra, H.P, Shahid, S. (2000) *Geophysical Prospecting for Groundwater*. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi
8. Ragonath, H.M., (1992) *Groundwater*. Wiley Eastern Ltd. New Delhi
9. Sen, Z. (2015). *Practical and Applied Hydrogeology*. Amsterdam: Elsevier Inc.
10. Todd, D. K. (2008). *Groundwater Hydrology* (3rd ed.). John Wiley & Sons (Asia) Pte. Ltd

### **Practical Course:**

#### **Hydrogeology**

Groundwater contour maps and flow nets

Analysis of rainfall data,

Groundwater quality analysis and graphical representation

Application of remote sensing and GIS in groundwater exploration and management.

Resistivity data interpretation

Groundwater flow problems

**M.Sc-II Geology Course: SGEO0903**

**Title: Geophysical Prospecting**

**Learning Objectives:** To understand basic concepts, scope and applications of geophysical prospecting. To learn methods of logging and log interpretation.

**Unit-1**

**(15 Lectures)**

**Introduction**

Introduction to Geophysical Prospecting and historical background  
Overview of Geophysical Prospecting methods

**Seismic Methods**

Fundamentals of Seismic prospecting  
Seismic instruments, measurements and field operations  
Seismic refraction method  
Seismic reflection method  
Geological interpretation of refraction and reflection data

**Unit-2**

**(15 Lectures)**

**Gravity Methods**

Fundamentals of Gravity prospecting  
Instruments, measurements and field operations  
Geological interpretation of Gravity Data

**Magnetic Methods**

Fundamentals of Magnetic prospecting  
Instruments, measurements and field operations  
Geological interpretation of Magnetic Data

**Unit-3**

**(15 Lectures)**

**Electrical Methods**

Electrical properties of rocks and minerals  
Methods employing Natural Electrical sources:  
    (a) Self-potential (b) Telluric and Magnetotelluric  
Resistivity method  
Induced Polarization method  
Geological interpretation of Electrical Data

**Electromagnetic Methods**

Fundamentals of electromagnetic surveys  
Instruments and field settings  
Geological interpretation of EM Data

## **Unit-4**

**(15 Lectures)**

### **Radioactivity methods**

Fundamentals of radioactivity surveys

Instruments and field settings

Geological interpretation of Radioactivity Data

### **Geophysical Well Logging**

Introduction to well logging

General aspects well logging and historical background

Common logging methods:

- |                       |                        |                 |
|-----------------------|------------------------|-----------------|
| (a) Resistivity log   | (b) Self-potential log | (c) Sonic log   |
| (d) Neutron log       | (e) Gamma-ray log      | (f) Density log |
| (g) Well bore seismic | (h) Image logs         |                 |

Well-log interpretation

### **List of Recommended Reference Books:**

1. Dobrin, Milton B. (1960): Introduction to Geophysical Prospecting, McGraw-Hill Book Company, Inc.
2. Milsom, J. and Asger, E. (2011): Field Geophysics, 4th edition, Wiley and Sons Ltd.
3. Committee on Geodesy, National Research Council (1995): Airborne Geophysics and Precise Positioning: Scientific Issues and Future Directions, National Academics Press.
4. Gadallah, M. and Fisher, R. (2009): Exploration Geophysics, Springer-Verlag Berlin Heidelberg.
5. Kalyan Kumar Roy (2008): Potential Theory in Applied Geophysics, Springer-Verlag Berlin Heidelberg.
6. Kearey, Brooks and Hill (2002): An Introduction to Geophysical Exploration, Third Edition, Blackwell Science.
6. W. M. Telford, L. P. Geldart and R. E. Sheriff (2004): Applied Geophysics, Second Edition, Cambridge University Press.

### **Practical Courses:**

1. Calculations and interpretation based on Seismic Data
2. Calculations and interpretation based on Gravity Data
3. Calculations and interpretation based on Electrical Data
4. Exercises on Log interpretation
5. Exercises on Log correlation

**M.Sc-II Geology Course: SGEO0904**

**Title: Coal and petroleum geology**

**Learning Objectives:** To understand origin, properties, classification of coal and petroleum. Learning exploration methods, and coal/petroleum bearing rock formations in India.

**Unit-1**

**(15 lectures)**

**Generation and migration of petroleum**

Physical and chemical properties of petroleum

i) Natural gases

ii) Gas hydrates

iii) Crude oil

Classification of petroleum

Generation and migration of petroleum

Origin of petroleum: Organic or Inorganic

Modern organic processes on the earth's surface

Formation of kerogen

Petroleum migration

Petroleum system

**Unit-2**

**(15 lectures)**

**Reservoir and cap rocks**

The Reservoir

Porosity, Permeability, Capillary pressure, Relationship between Porosity, Permeability and

Texture, Effects of diagenesis on reservoir quality

Reservoir continuity and characterization

Reserve calculations and Production methods

**Traps and Seals**

Nomenclature of a trap

Distribution of petroleum within a trap

Seals and cap rock

Classification of traps

**Unit-3**

**(15 lectures)**

**Origin and distribution of coal**

The origin of coal

Sedimentation of coal and coal bearing sequences

Structural effects on coal

Age and occurrence of coal

Plate tectonics

Stratigraphy



Coal as a substance  
Physical description of coal  
Coalification (Rank)  
Coal quality  
Classification of coals

#### **Unit-4**

**(15 lectures)**

#### **Sampling and analysis of coal**

Coal sampling and analysis

*In situ* coal sampling

Non *in situ* coal sampling

Coal analysis

Geology and coal mining

Underground mining

Open cast or surface mining

#### **List of Recommended Reference Books**

1. Thomas L. (2012), Coal Geology, Wiley India Pvt. Ltd.
2. Francis W. (1964), Coal its formation and composition, Edward Arnold (Publishers) Ltd.
3. Deshpande B.G. (1992), The world of petroleum, Wiley Eastern Ltd. New Delhi.
4. Selley R.C. (1998), Elements of petroleum geology, Academic Press.
5. Ashcroft, W. (2011), A geologist's guide to seismic reflection, John Wiley and sons
6. Leverson, A.I (2006): Geology of Petroleum, CBS publications

#### **Practical course**

##### **Coal and petroleum geology**

Isopach and isolith maps

Outcrop completion, fault and borehole problems

Reserve estimation problems

Seismic profile interpretation

Borehole correlation