

**DEPARTMENT OF GEOLOGY SCHOOL OF EARTH SCIENCES H N B
GARHWAL UNIVERSITY (A CENTRAL UNIVERSITY)**

M.Sc. Geology Course (4 – Semester) 2012-14

Candidates who have passed the three years B.Sc. examination with Geology as one of the major subject, or earned prescribed number of credits for a undergraduate degree through the examinations conducted by a University / autonomous institution or possesses such qualifications recognized by the University of HNB Garhwal as equivalent to an undergraduate degree, will be considered eligible for admission to the 4 – semesters M.Sc. course in Geology.

The M.Sc. course in geology shall be imparted to the students for two academic sessions consisting of four semesters. The odd semesters (1 & 3) will run from July to November and even semesters (2 & 4) December to April. Candidates will be examined and evaluated at the end of each semester in the different courses of theory and practical as per the credits given against each course. A semester shall normally extend over a period of 15 weeks i.e. 90 days and each week shall have 30 hours of instruction including lab / field work as applicable.

The core courses will be compulsory for all the students admitted to M.Sc. geology. There will be 18 core, 06 elective and 01 self study courses covering major branches of geology including practical, and two sessions of field training of 2 – 3 weeks duration, which are compulsory for all the students. The field training and the viva voce examinations will be conducted by at least two internal examiners during 2 & 4 semesters, 60% marks are allotted for lab work / report / thesis evaluation and 40% marks for viva voce / sessional / seminar presentation. The semester break can also be utilized for the geological field training.

The area of dissertation will be assigned to the students at the end of second semester. The final report must be submitted by the end of fourth semester with a seminar presentation before the faculty members and the board of examiners for the purpose of evaluation. During the course of completion of the dissertation work, the students will be required to complete various assignments given to them by their respective supervisors for the purpose of their evaluation. The dissertation shall be of 100 marks and shall be evaluated jointly by an internal and the external examiner for seminar presentation / viva voce. The sessional work is related to dissertation and to be awarded by the supervisor and external examiner.

In order to qualify for a two master degree, a student must acquire a minimum of 72 credits including a minimum of 18 credits in electives and one qualifying self study course of minimum 03 credits.

The details of courses, semester schedule, credits and maximum marks for each course are given below.

M.Sc. Geology Course (4-Semester)-2012-2014

Semester-1

Course No.	Core Courses	Credit	Marks
SOES/GEOL/C-001	General Geology and Geomorphology	3	60+40
SOES/GEOL/C-002	Structural Geology	3	60+40
SOES/GEOL/C-003	Mineralogy	3	60+40
SOES/GEOL/C-004	General and Invertebrate Palaeontology	3	60+40
SOES/GEOL/C-005	Precambrian Stratigraphy	3	60+40
SOES/GEOL/C-006	Practical- (For Course No. 001 to 005)	3	60+40
	Total	18	600

Semester-2

Course No.	Core Courses	Credit	Marks
SOES/GEOL/C-007	Crystallography	3	60+40
SOES/GEOL/C-008	Geotectonics	3	60+40
SOES/GEOL/C-009	Micropalaeontology, Vertebrate Palaeontology and Palaeobotany	3	60+40
SOES/GEOL/C-010	Phanerozoic Stratigraphy	3	60+40
SOES/GEOL/C-011	Geological field training tour	3	60+40
SOES/GEOL/C-012	Practical- (For Course No. 007 to 010)	3	60+40
	Total	18	600

Semester-3

Course No.	Core Courses/ Elective	Credit	Marks
SOES/GEOL/C-013	Igneous Petrology & Geochemistry	3	60+40
SOES/GEOL/C-014	Engineering Geology	3	60+40
SOES/GEOL/C-015	Practical- (For Course No C-013, 014)	3	60+40
SOES/GEOL/E-001	Sedimentary and Metamorphic Petrology	3	60+40
SOES/GEOL/E-002	Mineral exploration and Mining	3	60+40
SOES/GEOL/E-003	Practical- (For Course No E-001, 002)	3	60+40
SOES/GEOL/S-001	a. Petroleum Geology, b. Remote Sensing, c. Environmental Geology, d. Geoinformatics	3	100
	Total (excluding self study course)	18	600

Semester-4

Course No.	Core Courses/ Elective	Credit	Marks
SOES/GEOL/C-016	Geohydrology	3	60+40
SOES/GEOL/C-017	Ore genesis and Indian mineral deposits	3	60+40
SOES/GEOL/C-018	Practical- (for Course C- 016 to C-017 & E-004)	3	60+40
SOES/GEOL/E-004	Elective Course: Any one of the following a. Glaciology, b. Sedimentology c. Advance Micro-palaeontology, d. Quaternary Geology, e. Palaeoseismology	3	60+40
SOES/GEOL/E-005	Geological Field Training tour	3	60+40
SOES/GEOL/E-006	Project/ Dissertation	3	60+40
	Total	18	600
	Grand Total (excluding self study course)	72	2400 MM

Semester-1

SOES/GEOL/C-001: General Geology and Geomorphology

- I. Elementary idea of cosmogeny, Interior of earth, geochronology, theories of isostasy, ocean bottom topography.
- II. Geosynclines, their classification and evolution, orogeny and epeiorogeny, volcanoes, earthquakes, island arcs, rift valleys and grabens.
- III. Concepts of geomorphology, processes, cycle of erosion, landscape evolution, rock weathering, soil formation and classification of soils.
- IV. Glacial, aeolian, fluvial and costal landscapes of India, karst topography, landforms of Himalayas.
- V. Drainage development and slope morphometry, denudation chronology, morphogenetic regions, geomorphic hazards.

Books recommended

1. Thornbury, W.D. (1980): Principle of Geomorphology, Wiley Eastern Ltd. New York.
2. Holmes, A. (1992): Holmes Principles of Physical Geology, Chapman & Hall publ.
3. Halis, J.R. (1983): Applied Geomorphology.
4. Sharma, H.S. (1990): Indian Geomorphology, Concept Publishing Co. New Delhi.
5. Agrawal, L. C. Introduction to Geomorphology.
6. Gass, I.G. et al. (1982): Understanding the Earth, Artemis Press (Pvt.) Ltd. U.K.
7. Windley, B. (1973): The Evolving continents, John Wiley & Sons publ.
8. Condie, Kent. C. (1982): Plate Tectonics & Crustal Evolution, Pergamon Press .

SOES/GEOL/C-002: Structural Geology

- I. Definition and scope of structural geology, stress and strain relationship of elastic, plastic and viscous material, factors affecting the behaviour of rocks
- II. Theory of stress and strain, kinematic analysis, Mohr's Circles, strain and stress ellipsoids. Measurement of strain in deformed rocks.
- III. Classifications and mechanics of folds, boudins, cleavage, lineation.
- V. Structural behaviour of igneous rocks, diapirs and salt domes; introduction to petrofabrics

Books recommended

1. Davies, A.Z.: Structural Geology.
2. Ghosh, S. K.: Structural Geology, Fundamental and Modern Concepts, Pergamon Press.
3. Ramsay J. G. (1967): Folding and fracturing of Rocks, McGraw Hill Pub.
4. Ramsay J.G. & Huber M. I. (1983): The Techniques of Modern Structural Geology-I, Strain Analysis, Academic Press.
5. Ramsay J.G. & Huber M. I., (1987): The Techniques of Modern Structural Geology-II, Strain Analysis, Academic Press.
6. Hobbs, B.E., Means, W.D. & Williams, P.F. (1976): An outlines of Structural Geology, John Wiley and Sons publ.
7. Turner, F.J. & Weiss, L.E. (1963): Structural analysis of Metamorphic Tectonites, McGraw Hill publ.

SOES/GEOL/C-003: Mineralogy

- I. Structures and types of atoms, types of chemical bonding, co-ordination number, mineral assemblage.
- II. Structures and classifications of silicates.
- III. Systematic mineralogy (atomic structure, mineral chemistry, mode of occurrence) of carbonates, halides, hydroxides, native elements, oxides, phosphates, silicates and sulphides groups.
- IV. Mineralogy of uniaxial and biaxial crystals.
- V. Extinction, pleochroism, dispersion, interference figures, birefringence, optical indicatrix.

Books recommended

1. Dana, E.S. & Ford, W.E.: A Text book of Mineralogy, Wiley Eastern Ltd.
2. Berry, L.G., Mason, B. & Dietrich, R.V.: Mineralogy, CBS Publishers.
3. Kerr, P.F.: Optical mineralogy, McGraw Hill publ.
4. Moorhouse, W.W.: Optical Mineralogy.

SOES/GEOL/C-004: General and Invertebrate Palaeontology

- I. Type, mode of preservation, significance, nomenclature and collection of fossils.
- II. Origin of life, Organic evolution, migration, dispersal and extinction.
- III. Early Precambrian life, Ediacaran fossil assemblage and organo-sedimentary structures.
- IV. Morphology, geological history and brief evolutionary trend of brachiopoda, bivalve, gastropoda, cephalopoda, trilobita, echinoid, graptolite and bryozoa.

V. Type of environment and biotic distribution, zoogeographic provinace.

Books recommended

1. Clarkson, E. N.K. (1998): Invertebrate Paleontology and Evolution.
2. Smith, A.B. (1994): Systematic and fossil record- Documenting Evolutionary patterns.
3. Protheno, D.R. (1998): Bringing fossils to life- An introduction to Paleontology, McGraw Hill publ.
4. Boardman, R.S., Cheetham, A.M. & Rowell, A.J. (1988): Fossil Invertebrate, Black well.
5. Stearn, C.W. & Carroll, R.L. (1989): Paleontology-the record of life, John Willey publ.

SOES/GEOL/C-005: Precambrian Stratigraphy

- I. Principle of Stratigraphy & geological time scale, stratigraphic correlation, nomenclature of modern stratigraphic code.
- II. Tectonic division of India, brief idea of magnatostratigraphy & seismic stratigraphy, facies concept in stratigraphy-Walter's Law
- III. Precambrian stratigraphy of Extra-Peninsular India.
- IV. Precambrian stratigraphy of Peninsular India.
- V. Precambrian-Cambrian boundary with special reference to Indian examples

Books recommended

1. Danbar, C.O. & Rodgers, J. (1957): Principles of Stratigraphy, John Wiley & Sons.
2. Krumbein, W. C. & Sloss, L.L. (1963): Stratigraphy and sedimentation.
3. Freeman, W. H. & Kummel, Co. (1961): History of the earth.
4. Hollis D. Hedbug (Ed.) International stratigraphic guide - International subcommission on startigraphic classification of IUGS commission on stratigraphy John Wiley and Sons
5. Naqvi, S.M. & Rogers, J.J.W. (1987): Precambrian Geology of India, Oxford Univ. Press.
6. Schoch, Robert, M. (1989): Stratigraphy-Principles and Methods, Van Nostrand Reinhold, New York.
7. Kumar, R. (1984): Fundamentals of Historical Geology & Stratigraphy of India.
8. Krishnan, M.S. (1982): Geology of India and Burma, C.B.S. Publishers & Distributors, Delhi.
9. Valdiya, K.S. (2009): The Making Of India: Geodynamic Evolution. Macmillan Publishers India

SOES/GEOL/C-006: Practical

(SOES/GEOL/C-001): General Geology and Geomorphology

Marks-20

- I. Analysis of geomorphological features from various morphogenetic regions of India; preparation of geomorphological maps on different scales (1:2, 50,000 & 1:50,000).
- II. Preparation of longitudinal and cross valley profiles.
- III. Altimetric analysis, hypsometric analysis, exercises related to measurements of runoff dynamics, sediment and solute dynamics.
- IV. Morphometry of drainage basins, analysis of orientation structures.

(SOES/GEOL/C-002): Structural Geology

Marks-10

- V. Preparation and interpretation of geological maps and sections.
- VI. Structural problems concerning economic mineral deposits.

(SOES/GEOL/C-003): Mineralogy

Marks- 10

- I. Study of minerals in hand specimen
- II. Microscopic study of rock forming minerals using optical accessories.

(SOES/GEOL/C-004): General & Invertebrate Palaeontology

Marks-10

Study of important invertebrate fossil belonging to brachiopoda, bivalve, gastropoda, cephalopoda, trilobita and echinods

(SOES/GEOL/C-005): Precambrian Stratigraphy

Marks-10

- I. Exercise on stratigraphic classification and correlation of Precambrian rocks.
- II. Preparation of Paleogeographic maps and Stratigraphic columns.

Sessional and Viva-voice

Marks-40 (8 Marks each)

Semester- II

SOES/GEOL/C-007: Crystallography

- I. Introduction to space group, space lattices, lattice defects
- II. X-ray crystallography - historical development, Bragg equation.
- III. Description of 32 classes of crystal system.
- IV. Different types of crystal projections – spherical and stereographic, crystal imperfections.
- V. Twinning and twinning laws – common types of twins and their examples.

Books recommended

1. Sands, D.E. (1975): An Introduction to Crystallography, W.A. Benjamin Inc., N. Y.
2. Phillips, F.C.: Introduction to Crystallography.
3. Evans, R.C. (1964): Introduction to Crystal Chemistry, Cambridge Uni. Press.

SOES/GEOL/C-008: Geotectonics

- I. Concept of Plate Tectonics, tectonic history of India and origin of Himalaya.
- II. Major tectonic features of the oceanic and continental crust, continental drift-geological and geophysical evidence, mechanics, objections and present status.
- III. Gravity and magnetic anomalies at mid oceanic ridges, deep sea trenches and continental shield areas and mountain chains.
- IV. Palaeo-magnetism, sea floor spreading, island arcs, oceanic islands and volcanic arcs.
- V. Seismic belts of the earth, seismicity and plate movement and geodynamics of Indian plate.

Books recommended

1. Condie Kent, C. (1989): Plate Tectonics and Crustal Evolution.
2. W. J. Kious & Robert I.T.: This dynamic of Earth: the story of Plate Tectonics USGS publ.
3. Moores, E. & Twiss, R.J., 1995: Tectonics. Freeman publ.
4. Keary, P. & Vine, F.J. 1990: Global Tectonics. Blackwell scientific publ.
5. Storetvedt, K.N. 1997: Our Evolving Planet. Earth History in new perspective.
6. Valdiya, K.S. 1998: Dynamics Himalaya. Univ. Press.

SOES/GEOL/C-009: Micropalaeontology, vertebrate palaeontology and Palaeobotany

- I. History of micropalaeontology, Collection and preparation of micro fossils and vertebrates, significance of micro fossils.
- II. Vertebrate life through ages and landmarks in their evolution, evolutionary trends in man, horse and elephant
- III. Palynology: Morphology and significance of pollen and spores,
- IV. Palaeobotany: Morphology, distribution and significance of Gondwana flora
- V. Micro-palaeontology: morphology, Palaeo-ecology and geological distribution of foraminifera, conodonts, ostracodes, radiolaria and diatoms

Books recommended

1. Carroll, R.L. (1988): Vertebrate paleontology and evolution, Cambridge Univ. Press.
2. Stearn, C.W. & Carroll, R.L. (1989): Paleontology-the record of life, John Willey.
3. D.K., Sinha (2005): Micropaleontology application in Stratigraphy & palaeoceanography.
4. Romer, A.S. 1966. Vertebrate Paleontology, Chicago Univ. Press.
5. Armstrong, H. & Brasier M. (2005): Micro fossils. Black Well pub.
6. Haq B.U. & Boersma, A. (1998): Introduction to marine Micro-paleontology. Elsevier Pub.
7. Jenking D.G. (1993): Applied micropaleontology, Kluwer acad. Publ.

SOES/GEOL/C-010: Phanerozoic Stratigraphy

- I. Palaeozoic sequences of India with reference to type areas-their correlation with equivalent formations in other regions
- II. Gondwana Group: palaeogeography, palaeoclimate and stratigraphy of Indian sequence.
- III. Mesozoic and Cenozoic sequences of India, Deccan Volcanics, Quaternary stratigraphy.
- IV. Outline of Phanerozoic stratigraphic type sections of World
- V. Permian-Triassic, Cretaceous- Tertiary boundaries (with Indian examples), Reconstruction of palaeogeography and palaeoclimates.

Books recommended

1. Krumbein, W. C. & Sloss, L.L. (1963): Stratigraphy and sedimentation.
2. Freeman, W. H. & Kummel, Co. (1961): History of the earth.
3. Hollis D. Hedberg (Ed.) International stratigraphic guide. John Wiley and Sons Pub.
4. Schoch, Robert, M. (1989): Stratigraphy-Principles and Methods, Van Nostrand Reinhold, New York.
5. Kumar, R. (1984): Fundamentals of Historical Geology & Stratigraphy of India.
6. Krishnan, M.S. (1982): Geology of India and Burma, C.B.S. Publishers & Distributors, Delhi.
7. Valdiya, K.S. (2009): The Making Of India: Geodynamic Evolution. Macmillan Publishers India

SOES/GEOL/C-011: Geological field training tour

SOES/GEOL/C-012: Practical

(SOES/GEOL/C-007): Crystallography

Marks -15

Crystal model and projection

(SOES/GEOL/C-008): Geotectonics

Marks-15

Stereographic presentation of structural data

(SOES/GEOL/C-009): Micropalaeontology, vertebrate palaeontology and Palaeobotany Marks-15

Study of important Microfossils,

Study of Vertebrate fossils and Gondwana Flora

(SOES/GEOL/C-010): Phanerozoic Stratigraphy

Marks-15

- I. Study of palaeo-geographic maps of Phanerozoic
- II. Chronological study of important rocks

Sessional and Viva-voice

Marks 40 (10 marks each)

Semester-III

SOES/GEOL/C-013: Igneous Petrology & Geo Chemistry

- I. Magmatic differentiation – mechanisms and effects, magmatic crystallisation – Bowens reaction principle, crystallisation of bi-component magma, ternary magma (An-Al-Di system and An- Di – Fo, system).
- II. Gibbs phase rule – definition of phase, component and degree of freedom, application of Phase rule in bi-component and tri component magma.
- III. Texture and structures, classification of igneous rocks (only IUGS) , granite and other granitoid rocks and ophiolite
- IV. Petrogenesis and petrography of the following rocks:- Aplite, Anorthosite, Andesite, Basalt, Basanite, Carbonatite, Charnockite, Diorite, Dunite, Dacite, Dolerite, Essexite, Foidolite, Gabbro, Granite, Granodiorite, Hornblendite, Ijolite, Kimberlite, Komatiite, Lamprophyre, Monzonite, Pegmatite, Phonolite, Peridotite, Syenite, Trachyte, Tepherrite, Tonalite, Wehrlite.
- V. Geochemistry – definition and scope, cosmic abundance of the elements, geochemical classification of the elements, geochemical structure of the Earth, meteorite and their classification.

Books recommended

1. Gupta, A.K. (1998): Igneous Rocks Allied Publishers Ltd., New Delhi.
2. Jackson: Textbook of lithology.
3. Winter, J.D. (2001): An Introduction to Igneous and Metamorphic Petrology

4. McBirney, A.R. (1984): Igneous Petrology, Freeman Cooper & Co. California.
5. Phillips A.: Introduction to igneous and metamorphic petrology, Prentice Hall Pub.
6. Turner, F.J. & Verhoogen, J.: Igneous & Metamorphic petrology CBS Publications.
7. Bose, M.K. (1997): Igneous Petrology, World Press, Kolkatta.
8. Best, Myron G. (2002): Igneous and Metamorphic Petrology, Blackwell Science.

SOES/GEOL/C-014: Engineering Geology

- I. Engineering properties of rocks and physical characteristics of building stones and aggregates.
- II. Geological investigations for construction for river valley projects – dam and reservoir;
- III. Geotechnical evaluation of tunnels – type, methods and problems.
- IV. Landslides – classification, causes and preventive methods, landslide hazard zonation.
- V. Bridges – types and foundation problems, influence of geological conditions on foundation and design of buildings.

Books recommended

1. Attewell, P. B. & Farmer, J. W. (1976): Principles of engineering Geology, Chapman & Hall. Publ.
2. Bell, F. G. (1983): Fundamentals of engineering geology, Butterworths, London.
3. Barish, N. N. (1962): Economic analysis for engineering and managerial decisions.
4. Clarke: Reservoir engineering.
5. Coates, R. E. (1970): Rock Mechanics, Canadian deptt. Of Energy, Mines & Resources Ottawa.
6. Farmer, I. W. (1968): Engineering properties of rocks, E & F. N. Spon-Ltd.
7. Gupta, H. K. & Rastogi, B. K. (1976): Dams and Earthquakes, Elsevier and Scientific Pub. Co.
8. Hock, E. & Bray, J. (1978): Rock slope engineering, Instt. of mining and metallurgy, London.
9. Krynine D. P. & Judd W. R. (1998): Principles of engineering geology & geo-techniques.
10. Legget, R. F. & Karrow P. F. (1983): Hand Book of Geology in civil engineering.
11. Neil Duneon, (1969): Engineering geology and rock mechanics, London hill.
12. Zaruba, Q. and Mencl, V. (1976): Engineering geology, Scientific publishing Amsterdam.

SOES/GEOL/C-015: Practical

(SOES/GEOL/C-013): Igneous Petrology & Geo Chemistry

Marks -30

- I. Megascopic study of different types of igneous rocks.
- II. Microscopic study of important igneous rocks.

(SOES/GEOL/C-014): Engineering Geology

Marks -30

- I. Study of properties of common rocks with reference to their utility in engineering projects. Study of maps and models of important engineering structures, dam sites and tunnels. Interpretation of geological maps for landslides problems.
- II. Survey of a plot using Chain, Prismatic compass, Plane table, Dumpy level, Theodolite, Total station and Ground Penetrating Radar (Depending upon the availability of the instruments); their uses and precautions in handling.

SOES/GEOL/E-001: Sedimentary & Metamorphic Petrology

- I. Process of sedimentation, structure, texture and general classification of sedimentary rocks
- II. Sedimentary facies, depositional environments, provenance and palaeocurrent
- III. Petrogenesis and petrography of the following rock type- Argillite, Arkose, Breccia, Chalk, Chert, Claystone, Conglomerate, Diamictite, Coquina, Diatomite, Dolomite, Evaporite, Greywacke, Gritstone, Laterite, lime stone, Marl, Mudstone, Sandstone, Shale, Silt stone, Travertine, Turbidite, Wackestone
- IV. Metamorphic process, agent, grade and type of metamorphism, metamorphic zones, texture and fabrics; and law of thermodynamics and Gibbs Equation
- V. Metamorphic Facies : Zeolite, Prehnite-Pumpellyite, Blueschist, Greenschist - Amphibolite, Granulite, Eclogite
- VI. Petrogenesis and petrography of the following rocks- Amphibolite - Blueschist, Eclogite, basalt, gabbro, Gneiss - Gossan - Granulite, Greenschist, Hornfels, Marble, Migmatite, Mylonite, Pellite, Phyllite, Psammite, Quartzite, Schist, serpentinite, Skarn, Slate.

Books recommended

1. Pettijohn, F. J. Sedimentary rocks (McGraw-Hill, New Delhi)
2. Verma, V. K. And Prasad, C., Sedimentology (Harman Publishing House, New Delhi)
3. Folk, R. L. Petrology of sedimentary rocks, Hemphills, Austin, Texas.
4. Blatt, H., Middleton, G and Murray, R., Origin of Sedimentary Rocks, Prentice Hall
5. Reineck, H.E., and Singh, I. B. , Depositional Sedimentary Environments, Springer, verlag, N.Y.
6. Best, Myron G., Igneous and Metamorphic Petrology (C B S Publishers, New Delhi).

- Blatt, Harvey; Tracy, Robert J.; Owens, Brent (2005), Petrology: igneous, sedimentary, and metamorphic (New York: W. H. Freeman).

SOES/GEOL/E-002: Mineral Exploration and Mining Geology

- Prospecting for economic minerals, sampling assaying and evaluation of mineral deposits, geo-botanical techniques of prospecting.
- Geophysical methods of exploration – gravity, magnetic, electrical, seismic and radioactive methods.
- Brief outline of well-logging techniques, application of remote sensing in mineral exploration.
- Planning, exploration and exploratory mining of surface and underground mineral deposits involve diamond drilling, shaft sinking, drifting, cross cutting, winzing, stoping, room and pillaring, top-slicing, sub level caves and block caving.
- Cycles of surface and underground mining operations, coal mining and mining hazards.

Books recommended

- P.K. Banerjee and S. Ghosh (1997): Elements of prospecting for non-fuel mineral deposits.
- Bagchi, T.C., Sengupta, D.K. & Rao, S.L.V.N. (1979): Elements of Prospecting and Exploration.
- Sinha, R.K. & Sharma, N.L. (1976): Mineral Economics.
- Arogyaswami, R.N.P. (1996): Courses in Mining Geology

SOES/GEOL/E-003: Practical

(SOES/GEOL/E-001): Sedimentary & Metamorphic Petrology

Marks -40

- Study of sedimentary and metamorphic rocks in thin sections with emphasis on texture, structure and mineral composition.
- Study of sedimentary and metamorphic rocks in hand specimen.
- Graphic construction of ACF, AKF and AFM diagrams.

(SOES/GEOL/E-002): Mineral Exploration and Mining Geology

Marks -20

- Preparation of mineral maps of India.
- Graphical representation of production, export and import of important minerals.
- Calculation of grade and ore reserves.
- Interpretation of remote sensing data for mineral exploration.

SOES/GEOL/S-001: Self Study Course

(a) Petroleum Geology

- I. Physical and chemical properties of natural gas, oil and bitumen, their mode of occurrence, kerogen, shales, origin of petroleum.
- II. Reservoir rocks, their classification, important characters, structures and mechanics, migration of oil and gas, Gussove`s theory of oil and gas pools.
- III. Oil traps, their classification and characters. Surface indication of oil, geological, geophysical and geochemical prospecting for hydrocarbons.
- IV. Drilling and well logging for oil, well completion, secondary recovery.
- V. Geographical distribution of petroleum resources in world, Status of hydrocarbon exploration in India, important petroliferous basins of India,

(b) Remote Sensing Geology

- I. Scope and development of remote sensing techniques, advantage and limitations, physical principles- electromagnetic energy, electromagnetic spectrum, sources of remote sensing information; mechanism of ground reflection, transmission, absorption.
- II. Aerial photography, Photo interpretation, aerial mosaic, aerial photographs, types, geometry, stereoscopy and vertical exaggeration, calculation of heights; numerical problems on scale and flying heights.
- III. Geological applications- geomorphology, tectonic, structural and lithologic interpretation.
- IV. Interpretation of data in thermal infra-red systems, extra radiant energy, emissivity, radiant temperature, thermal infra-red imagery and digital image processing.
- V. Imaging system, various sensors, Landsat programmes- SKYLAB, HCMM, SPOT, IIRS, MOS etc.

(c) Environmental Geology

- I. Concepts and principles, Time scales of global changes in the ecosystems and climate, Environmental protection - legislative measures in India.
- II. Global warming, records of paleo-temperatures in the ice cores of glaciers, Increase of CO₂ in atmosphere due to exploitation of fossil fuel, volcanic eruption, afforestation etc.
- III. Natural and manmade hazards and soil degradation- their preventative measures, Water logging problems due to construction of dams, reservoirs, canals etc.

- IV. Impact of use of energy and land on the environment, Energy resources - uses, degradation, alternatives and management, Exploitation and conservations of minerals and other natural resources.
- V. Impact assessment of anthropogenic activities such as urbanization, open cast mining, river valley projects, disposal of radioactive waste, excess withdrawal of ground water, uses of fertilisers, dumping of ores, mine waste and fly-ash.

(d) Geoinformatics

- I. Principles of Remote Sensing
- II. Principles of Geographical Information Systems
- III. Principles of basic Geoinformatics: Principles of databases, Programming, Design and optimization of geodata processing, Image processing techniques and spatial data quality, geo-information sharing and distribution, web technology for GIS and mapping, and visualization and distribution of geospatial data.
- IV. Application of Geoinformatics to environmental assessment
- V. Application of Geoinformatics to disaster management

Books recommended

1. Bignot, G. et al. (1985): Elements of Micropaleontology, London.
2. Barrett, E.C. & Curtis, L. F.: Introduction to Environmental Remote Sensing.
3. Curran, P.J. (1988): Principles of Remote Sensing.
4. Drury, S.A. (1987): image Interpretation in Geology, Allen and Unwin
5. Lillesand, T.M. & Kiefer, R.W. (1987): Remote sensing and Image interpretation, John Wiley.
6. Siegal, B.S. & Gillespie, A.R. (1980): Remote Sensing in Geology, John Wiley.
7. Valdiya, K.S. (1987): Environmental Geology- Indian Context, Tata McGraw Hill.
8. Keller, E.A. (1978): Environmental Geology Bell and Howell, USA.
9. Bryant, E. (1985): Natural Hazards, Cambridge University Press.
10. Patwardhan, A.M. (1999): The Dynamic Earth System, Prentice Hall.
11. Subramaniam, V. (2001): Textbook in Environmental Science, Narosa International.
12. Bell, F.G. (1999): Geological Hazards, Routledge London.
13. Smith, K. (1992): Environmental Hazards, Routledge London.
14. Simon, K. haslett Ed. (2002): Quaternary Environmental Micropaleontology, Arnold Oxford University Press New York.
15. Braiser, et al. (1980): Micrifossils.

16. Jones, R.W. (1996): Micropaleontology in Petroleum exploration, Clarendon Press Oxford.
17. McCalpin, J. P., 1983. Palaeoseismology. Academic press.
18. Bull, William B., 2007. Tectonic Geomorphology of mountains. Blackwell publication.
19. Bull, William B., 2009. Tectonically active landscapes. Willey-Blackwell publication.
20. Burbank, D. W. and Anderson, Robert, S. 2001. Tectonic Geomorphology. Blackwell science Publication.
21. Armstrong, H. & Brasier M. (2005): Micro fossils. Black Well pub.
22. Haq B.U. & Boersma, A. (1998): Introduction to marine Micro-paleontology. Elsevier Pub.

IV Semester

SOES/GEOL/C-016: Geohydrology

- I. Origin, occurrence and distribution of groundwater, hydrological cycle, hydrological properties of rocks, water table fluctuations.
- II. Theory of groundwater flow, Darcy's law and its application, determination of permeability, types of well; unconfined, confined, steady, unsteady and radial flow conditions.
- III. Groundwater quality-physical and chemical properties of water, problems of arsenic and fluorides, groundwater contaminations.
- IV. Surface geophysical methods – electrical (resistivity), seismic, gravity and magnetic methods.
Subsurface geophysical methods – well logging.
- V. Groundwater problems and management, artificial recharge, groundwater legislation, groundwater regimes of India.

Books recommended

1. Bouver, H. (1978): Groundwater Hydrology, McGraw Hill.
2. Fetter, C.W. (1990): Applied Hydrogeology, CBS Pub. New Delhi.
3. Todd, D.K. (1988): Ground Water Hydrology, John Wiley & Sons, New York.
4. Davies, S.N. and De-West, R.J.N. (1966): Hydrology, John Wiley & Sons, New York.
5. Raghunath, H.M. (1983): Ground Water, Wiley Eastern Ltd. Calcutta.

SOES/GEOL/C-017: Ore genesis and Indian mineral deposits

- I. Processes of ore formation, structural and stratigraphic controls of mineralization, wall rock alteration, paragenesis, zoning, nature of mineralizing fluids, mineralization and tectonism.

- II. Indian distribution and characters of metallic ore deposits of copper, gold, lead and zinc, aluminium, magnesium, iron, manganese, chromium, tungsten, molybdenum.
- III. Indian distribution and characters of non metallic minerals: coal and petroleum, mica, asbestos, barite, graphite, gypsum, refractories, abrasives, ceramics, fertilizers, cement, paints-pigments and gem stones.
- IV. Metallogenic epochs and provinces of Indian subcontinent, mineral deposits of Indian oceans; strategic, critical and essential minerals.
- V. National mineral policy and mineral conservation; India's status in mineral production, international aspects, future prospects.

Books recommended

- 1. Chatterjee, K.K. (1993): An Introduction to Mineral Economics, Wiley Eastern Ltd.
- 2. Karanth, R.V. (2000): Gems and gem Industry in India, Geol. Soc. India, Bangalore.
- 3. Krishnaswamy, S. (1979): India's Mineral Resources, Oxford and IBH Co.
- 4. Tiwari, S. K.: Ore Geology, economic mineral and mineral economics Vol.-2.
- 5. Evans, A.M. (1993): Ore Geology and Industrial Minerals, Blackwell.
- 6. Stanton, R.L. (1972): Ore Petrology, McGraw Hill.
- 7. Barnes, H.L. (1979): Geochemistry of Hydrothermal Ore Deposits, John Wiley.
- 8. Guilbert, J.M. and Park, Jr.C.F. (1986): The Geology of Ore Deposits, Freeman.
- 9. Mookherjee, A. (2000): Ore Genesis-A Holistic Approach, Allied Publisher.
- 10. Jensen and Bateman Economic minerals
- 11. U.Prasad -Economic Mineral Deposits

SOES/GEOL/C-018: Practical

SOES/GEOL/C-016: Geohydrology

Marks -30

- I. Delineation of hydrological boundaries on water table, contour maps and estimation of permeability.
- II. Analysis of hydrographs and estimation of infiltration capacity.
- III. Chemical analysis of water in evaluation of aquifer parameters.
- IV. Step drawdown tests, electric resistivity sounding for delineation of fresh and saline aquifers.
- V. Study of geophysical well logs. Estimation of TDS using resistivity and SP logs.
- VI. Exercise on ground water exploration using remote sensing techniques.

SOES/GEOL/C-017: Ore genesis and Indian mineral deposits**Marks -30**

- I. Study of economic minerals in had specimen.
- II. Megascopic and microscopic characterization of coals bands. Completion of outcrops in the given maps and calculation of coal reserves, study of polished particulate mounds of coal. Microscopic examination of polished coal pellets.
- III. Study of geological maps and sections of important oilfields of India and world. Calculation of oil reserves. Study of geological section of U-Th bearing rocks of the country. Megascopic study of important uranium and thorium bearing mineral and rocks.
- IV. Preparation of mineral maps of India. Graphical representation of production, export and import of important minerals. Calculation of grade and ore reserves. Interpretation of remote sensing data for mineral exploration.

SOES/GEOL/E-004: Elective Course: Any one of the following**(a) Glaciology**

- I. Introduction, importance and implication of glaciological studies, Inventory of Himalayan glaciers, Identification system of glaciers.
- II. Glacial morphology, glacial deposits and paleoglacitaion, Hydrometry of glaciated basins, suspended sediment transport.
- III. Mass balance studies; Net balance, Ablation, accumulation and snow density measurements, Relationship of mass balance to climate, Snow melt processes.
- IV. Physiscs of ice and snow, Mechanics of snow/ice creep, Ice crystals, engineering properties of glacial material, glacial hydrochemistry.
- V. Application of remote sensing techniques in glaciology, Application of advanced surveying techniques, Global positioning system, geodetic techniques.

Practical

- I. Calculation of heat balance equation.
- II. Exercise on flow movement/discharge.
- III. Meteorological and microclimatic parameters.
- IV. Suspended sediment transport.
- V. Interpretation of glacial morphological maps.

(b) Sedimentology

- I. Sedimentary processes, classification of sedimentary rocks, sedimentary structures & texture.
- II. Methods of mechanical analysis, graphical and statistical representation of data, Mineralogical and chemical analysis of sedimentary rocks; methods of sampling, analysis of heavy minerals and clay minerals.
- III. Provenances, palaeocurrent and basin analysis, sedimentary facies, sedimentation models.
- IV. Depositional sedimentary environments, chemical environments, sedimentary cycle, analysis of micro flora and fauna.
- V. Sedimentary basins of India, economic application of sedimentology, deep sea polymetallic nodules.

Practical

- I. Size analysis.
- II. Shape analysis.
- III. Heavy mineral identification.
- IV. Palaeocurrent analysis.

(c) Advance Micro-palaeontology

- I. History, significance of micropalaeontology, sampling, treatment and separation of microfossils.
- II. Planktonic and benthonic foraminifera, morphology, significance, classification (family level), ultra-structure and biogeography.
- III. Calcareous Nannofossils and siliceous microfossils their morphology and significance.
- IV. Morphology, Palaeo-ecology, significance, classification and geological distribution of, conodonts, ostracodes, radiolaria and diatoms
- V. Morphology and significance of pollen and spores,

Practical

- I. Techniques of separation of microfossils from matrix.
- II. Study of important calcareous, siliceous and phosphatic microfossils.
- III. Study of larger foraminifera in thin section.
- V. SEM application in micro palaeontology.

(d) Quaternary Geology

- I. Definition of Quaternary, Quaternary stratigraphy – oxygen isotope stratigraphy, bio-stratigraphy and magneto-stratigraphy.
- II. Quaternary climates – glacial interglacial cycles, eustatic changes, proxy indicators of paleoenvironmental/paleoclimatic changes – land, ocean and cryosphere (ice core studies). Response of geomorphic system to climate, sea level and tectonics on variable time scales in the Quaternary.
- III. Quaternary dating methods – radiocarbon, uranium series, luminescence, amino acids, relative dating methods.
- IV. Quaternary stratigraphy of India –continental records (fluvial, glacial, aeolian, palaeosols and duricrust), marine records, continental-marine correlation of Quaternary record.
- V. Evolution of man and Stone age cultures, Plant and animal life in relation to glacial and interglacial cycles during Quaternary, Neotectonics and active tectonics.

Practical

- I. Exercises related to topographic maps(2D representation, contouring, land use gradients.
- II. Study of possible tectonic planes (lineaments) from topographic maps.
- III. Hazard Zonation Mapping.
- IV. Identification of various landscapes and drainage using satellite images and topographic maps

(e) Palaeo-seismology

- I. Introduction and scope, Identifying prehistoric earthquakes from primary and secondary evidence, prehistoric earthquake recurrence and dating, estimating the magnitude of prehistoric earthquakes, Field techniques in palaeoseismology, mapping of palaeoseismic landforms.
- II. Palaeoseismology in extensional and compressional environments, geomorphic evidence of palaeoearthquakes, dating of palaeoearthquakes,
- III. Palaeoseismology in strike-slip movements, use of liquefaction induced features for palaeoseismic analysis,
- IV. Use of landslides for palaeoseismic studies, Application of palaeoseismic data to seismic hazard assessment and neotectonic research
- V. Tectonic geomorphology of mountains: Concept for studies of the Himalaya; a rising mountain chain, fault scarps

Practical

- I. Exercise on identification of soft sedimentary deformation
- II. Identifying deformation features in the topographic maps of the given area
- III. Mapping different deformational features in given satellite images
- IV. Establishing the relative chronology of different tectonic land forms from given images and topographical maps

Books recommended

1. Bignot, G. et al. (1985): Elements of Micropaleontology, London.
2. Barrett, E.C. & Curtis, L. F.: Introduction to Environmental Remote Sensing.
3. Curran, P.J. (1988): Principles of Remote Sensing.
4. Drury, S.A. (1987): Image Interpretation in Geology, Allen and Unwin
5. Lillesand, T.M. & Kiefer, R.W. (1987): Remote sensing and Image interpretation, John Wiley.
6. Siegal, B.S. & Gillespie, A.R. (1980): Remote Sensing in Geology, John Wiley.
7. Valdiya, K.S. (1987): Environmental Geology- Indian Context, Tata McGraw Hill.
8. Keller, E.A. (1978): Environmental Geology Bell and Howell, USA.
9. Bryant, E. (1985): Natural Hazards, Cambridge University Press.
10. Patwardhan, A.M. (1999): The Dynamic Earth System, Prentice Hall.
11. Subramaniam, V. (2001): Textbook in Environmental Science, Narosa International.
12. Bell, F.G. (1999): Geological Hazards, Routledge London.
13. Smith, K. (1992): Environmental Hazards, Routledge London.
14. Simon, K. Haslett Ed. (2002): Quaternary Environmental Micropaleontology, Arnold Oxford University Press New York.
15. Braiser, et al. (1980): Micrifossils.
16. Jones, R.W. (1996): Micropaleontology in Petroleum exploration, Clarendon Press Oxford.
17. McCalpin, J. P., 1983. Palaeoseismology. Academic press.
18. Bull, William B., 2007. Tectonic Geomorphology of mountains. Blackwell publication.
19. Bull, William B., 2009. Tectonically active landscapes. Wiley-Blackwell publication.
20. Burbank, D. W. and Anderson, Robert, S. 2001. Tectonic Geomorphology. Blackwell science Publication.
21. Armstrong, H. & Brasier M. (2005): Micro fossils. Black Well pub.
22. Haq B.U. & Boersma, A. (1998): Introduction to marine Micro-paleontology. Elsevier Pub.

SOES/GEOL/E-005: Geological Field Training

Students will be required to visit geologically important areas including mines, dams, oil fields, fossiliferous sequences and laboratories/institutes of repute and submit a report thereon, under the supervision of a faculty member. The field work should be at least 15 days either in peninsular India or extra-peninsular India.

SOES/GEOL/E-006: Project oriented Dissertation

The area of dissertation shall be assigned to the students at the end of second semester based on the expertise available in the Department. The project oriented dissertation must be submitted by the end of fourth semester. During the course of completion of dissertation work the students will be required to complete various assignments given to them by their respective supervisors or the Head of Department for the purpose of their evaluation.

Beside classroom seminars, the students will have to present their dissertation work in the form of seminar before the board of examiners including the supervisors which will be followed by viva voce examination.

or

SOES/GEOL/E-006 Himalayan Geology

Unit-I: Introduction and Geographical Framework of the Himalayas; Geomorphology of Himalaya- mountains, glaciers, rivers, lakes, thermal springs/geysers; Elementary idea about glaciation in the Himalayas.

Unit-II: Geodynamic evolution of the Himalayas; Tectonics and stratigraphy of Outer, Lesser, Higher Himalayas, Tethys succession and the Indus Suture Zone; Neotectonism in Himalaya; Paleotectonics, paleogeography, and closure of the Tethys Sea.

Unit-III: Petrological composition of Himalaya; Himalayan granites and their geochronology; Elementary idea about Himalayan metamorphism; Brief account of the metallogeny and mineral deposits of the Himalayas.

Unit-IV: Geo-environmental aspects of Himalaya; Causes and mitigation of Natural and manmade hazards of Himalaya; Conservation and management of land and water resources of Himalaya with a special reference to Uttarakhand Himalaya.

Books Recommended

1. [Chakrabarti](#), BK, 2016. Geology of the Himalayan Belt: Deformation, Metamorphism, Stratigraphy, Elsevier Science.
2. Biyani, AK 2006. Dimensions of Himalayan Geology, SSPH Delhi
3. Gansser, A., 1959. Geology of the Himalayas.
4. Holmes Arthur, 1945. Principles of Physical Geology
5. Krishnan, M.S., 1982. Geology of India and Burma, 6th Edition. CBS Publ.
6. Rupke, and Sharma, A.K. Geology and sedimentation of the Kumaon Lesser Himalayas.
7. Saklani, P.S., 1992. Geology of the Lesser Himalayas. Today & Tomorrow Publ.
8. Sinha, A.K. Global tectonics and metallogeny of the Himalayas.
9. [Treloar](#) PJ and [Searle](#) MP, 2019. Himalayan Tectonics: A Modern Synthesis. Geological Society of London Special Publications.
10. Valdiya, K.S. and Jaishri Sanwal, 2017. Neotectonism in the Indian sub-continent, Elsevier

11. Valdiya, K.S., 1980. Geology of the Kumaon Himalayas. WIHG Publ.
12. Valdiya, K.S., 1998. Dynamic Himalaya, Universities Press, India Ltd.
13. Valdiya, K.S., 2004, Geology, environment and society, Universities Press, India Ltd.
14. Valdiya, K.S., 2016. The making of India: Geodynamic evolution, Springer
15. Wadia, D., 1973. Geology of India. McGraw Hill Book co.