Department of Geology
University of Lucknow

Syllabus for
1-Year M.Sc. programme
As per
New Education Policy 2020

For session 2025-2026 onwards

Programme outcomes (POs):

- ✓ The 1-Year M.Sc. programme with Geology as a Major Subject is designed with the objective of educating students for success as a geo-scientist having employability in government sector, public sector, private sector, research institutes, or further qualifying JAM, NET, GATE or other national examinations so as to pursue further study including Doctoral studies.

- ✓ The students are likely to get regular placements in GSI, ONGC, CIL, etc. apart from reputed private organizations related to oil industries, mineral exploration & mining industries and organizations working in the fields of exploration using remote sensing & GIS Techniques.

- ✓ The holistic development of students helps them in getting placements in various national institutes like BSIP, WIHG, PRL, NGRI etc.

Programme Specific Outcomes (PSOs):

- ✓ Graduates of the PG program in Geology will develop a comprehensive understanding of Earth's materials, processes, and resources. They will acquire advanced skills in mineral identification and analysis using modern techniques like XRD and SEM, enabling them to classify and characterize mineral specimens effectively. They will interpret structural and tectonic complexities through stress-strain analysis and field-based observations, applying these insights to regional and global geodynamics.

- ✓ Expertise in mineral resource exploration and evaluation will equip students to design and execute geochemical and geophysical surveys and assess the economic viability of deposits. Proficiency in hydrogeological principles will allow them to evaluate groundwater systems, manage resources, and ensure sustainable utilization. Knowledge of geophysics, geostatistics, and GIS will empower students to integrate spatial data for analyzing surface and subsurface processes.

- ✓ Advanced understanding of stratigraphy, palaeontology, and remote sensing will aid in reconstructing Earth's history and addressing challenges in geological mapping. By applying concepts of fuel geology, disaster management, and engineering geology, students will address energy needs, mitigate natural hazards, and contribute to infrastructure development. Field training and laboratory work will reinforce practical skills, ensuring readiness for research or professional roles in geology and allied sciences.

Department of Geology
Syllabus for 1-Year M.Sc. programme
(for session 2025-26)
As per PG Ordinance 2024

Year	Semester	Paper	Course Name	Credit	Total
1	I	GCC 101	Mineral Science	4	20
		GCC 102	Advanced Structural Geology & Tectonics	4	
		GCC 103	Mineral Resources and Exploration Techniques	4	
		GEL 104a	Hydrogeology	4	
		GEL 104b	Fundamentals of Geophysics		
		GEL 105a	Fuel Geology	2	
		GEL 105b	Disaster Management		
		GVC 101 Valued-Added Credited Course (Intradepartmental)	Laboratory Works and Geological Field Training	2	
	II	GCC 201	Palaeontology	4	20
		GCC 202	Stratigraphy	4	
		GCC 203	Remote Sensing, GIS and Surface processes	4	
		GEL 209a	Geodynamics	4	
		GEL 209b	Geostatistics and Geophysics		
		GEL 210a	Engineering Geology	2	
		GEL 210b	Groundwater Resource Management		
		GID 201 Interdepartmental course	Fundamentals of Geology	2	

Paper I: GCC 101 Mineral Science

UNIT I

Fundamentals of Mineral Chemistry: Co-ordination number and bonding forces; Principles of ionic substitution in minerals: Partition coefficient; Surface, Magnetic and Electrical properties of minerals: Twinning and Crystal imperfections.

UNIT II

Repetition theory; Symmetry elements, Symmetry classes and crystal systems; Hermann- Mauguin symbols; Plane lattices, Unit cell, Bravais lattices and space groups; Polymorphism, isomorphism, and mineraloids.

UNIT III

X-Ray Crystallography; Bragg's Law; Single crystal diffractometry; Powder diffractometry; Silicate mineralogy; Tectosilicates; Nesosilicates, Sorosilicates, Cyclosilicates, Inosilicates, Phyllosilicates.

UNIT IV

Mineralogy of phosphates, carbonates, sulphides and halide groups; Clay Minerals: Properties and occurrences; Gems and semi-precious stones.

UNIT V

Polarising microscope; optical properties of minerals in plane-polarised light and under crossed polars; Uniaxial and Biaxial minerals; Interference Figures; Optical Sign, Axial Angle and Indicatrix; Optical properties of common rock-forming minerals: quartz, feldspar, garnet, biotite, muscovite, augite, olivine, hornblende.

Course outcome:
The students will be able to understand the evolution of the early Earth from proto- planetary material and its differentiation to present day state. Further this will provide the foundation for other branches of earth sciences. It will also help in gaining insight as to how geochemical processes operate within the earth. Using advanced techniques, the students will be able to better understand the atomic configuration of various mineral families.

Suggested Readings:

1. Putnis A. 1992. Introduction to Mineral Sciences, Cambridge publication.
2. Cornelis Klein and Barbara Dutrow, 2007. The manual of Mineral Science, Wiley Publication
3. Berry, L.G., Mason, B. and Dietrich, R.V. 1985. Mineralogy: Concepts, Descriptions and determinations. CBS Publishers
4. Dana, E.S. and Ford, W.E. 2002. A text book of Mineralogy (Reprint)
5. Deer, W.A., Howie, R.A. & Zussman, J. 2013. An Introduction to the rock forming minerals, ELBS and Longman.
6. Gribble C.D. 2005. Rutley's elements of Mineralogy, Springer.
7. Kerr, P.F. 1977. Optical Mineralogy McGrew Hill
8. Nesse, D.W. 1986. Optical Mineralogy, McGraw Hill
9. Perkins, D. 2013. Mineralogy, Prentice Hall
10. Phillips, F.C (1971). Introduction to Crystallography. Longman Group Publication.

Paper II: GCC 102 Advanced Structural Geology and Tectonics

UNIT I

Mechanical properties of rocks, Stress and its components; stress in two and three dimensions; Mohr diagrams and its significance; Strain and types of strain; Strain in two and three dimensions; Estimation of strain in naturally deformed rocks.

UNIT II

Mechanics of folding and buckling; Ramsay's classification of folds; Superposed folding, β and π diagrams.

UNIT III

Types of tectonites; Types of rock cleavages and lineations; Time relationship between crystallisation and deformation.

UNIT IV

Causes and dynamics of faulting; Fault geometries: normal, strike-slip and thrust, Geometry and rock types of shear zones.

UNIT V

Structural and tectonic evolution of the Himalaya; Global Plate-tectonics – types of plate boundaries; Triple junctions; Suspect terrains; Mantle Plumes, Plume mechanism; Anatomy of mountain belts.

Course outcome:
Due to the dynamic instability of the lithosphere, continuous and discontinuous deformation takes place within the rocks in solid or semi-solid state, at different scales, which manifests in a variety of complex structures in these rocks. The present course will teach the students how to gain an insight into underlying deformation processes and mechanisms through an accurate geometric and kinematic analysis of these natural structures.

Suggested Readings:

1. Bailey, B., 1992. Mechanics in Structural Geology, Springer.
2. Davis, G. H. and Reynolds, S. J., 1996. Structural Geology of rocks and regions, John Wiley and Sons.
3. Ghosh, S. K., 1993. Structural Geology: Fundamentals, and modern developments, Pergamon Press.
4. Leyson, P: R. and Lisle, R. J., 1996. Stereographic projection techniques in structural geology, Cambridge University Press.
5. Passhier, C. and Trouw, R. A. J, 2005. Microtectonics. Springer, Berlin.
6. Pollard, D. D. and Fletcher, R. C., 2005. Fundamentals of structural geology, Cambridge University Press.
7. Ramsay, J. G. and Huber, M. I., 1983. Techniques of Modern Structural Geology: vol. I & Academic Press.

9. Ramsay, J. G, 1967. Folding and Fracturing of Rocks, McGraw-Hill Book Company, New York.
10. Rowland, S. M., Duebendorier, E. and Schiefelbein, I. M., 2007. Structural analysis and synthesis: a laboratory course in structural geology, Blackwell pub.
11. Suppe, J., 1985The Principles of Structural Geology, Prentice-Hall, Inc., New Jersey.
12. Twiss, R. J. and Moores, E.M., 2007. Structural Geology. Freeman.
13. Van der Pluijm, B. A. and Marshak, S., 2004. Earth structure: an introduction to structural Geology.

Paper III: GCC 103 Mineral Resources and Exploration Techniques

UNIT I

Processes of formation of ores; Magmatic deposits: Chromite deposits, Ni-Cu sulphide deposits, PGE sulfide deposits, LREE in carbonatite, REE in Pegmatite, Diamond in Kimberlite and Lamproite; Deposits formed by Sedimentary and Surficial Processes: Placer deposits, Sedimentary iron deposits, Lateritic Bauxite deposits.

UNIT II

Hydrothermal ore deposits in magmatic and orogenic environments: Porphyry deposits, Greisen deposits, Skarn deposits, Volcanogenic Massive Sulfide (VMS) deposits, Iron oxide– copper–gold (IOCG) deposits;
Hydrothermal ore deposits in sedimentary environments: Mississippi Valley-type (MVT) Cu– Pb–Zn deposits, SEDEX Pb–Zn–Ag deposits, Stratiform Sediment-Hosted Copper Deposits, Gold deposits, Uranium Deposits.

UNIT III

Metamorphism of ore deposits; Textures and structures of ore and gangue minerals; Concept of ore-bearing fluids; Wall rock alteration; Zoning of ore-deposits; Fluid inclusions in ore; Application of stable isotopes in ore-deposit geothermobarometry; Metallogenic epochs and mineral deposits; metallogeny and plate tectonics.

UNIT IV

Stages of mineral exploration; Guides for Prospecting; Methods of mineral exploration: Geological, Geochemical, Geobotanical and Geophysical methods; Application of remote sensing in mineral exploration.

UNIT V

Morphology of ore deposits; Surface and sub-surface mining; Ore-dressing; National Mineral Policy; United Nations Framework Classification (UNFC); Law of the sea; Distribution of metallic and non-metallic minerals in India.

Course outcome:

The objectives of this course are to: (a) familiarize the students with the processes involved in the formation of various types of ore deposits. (b) to understand the genetic controls exerted by physical and chemical processes on ore formation in various geologic settings, and (c) to introduce economic and policy issues related to minerals and their national importance.

Suggested Readings:

1. Ridley, John. (2013). Ore deposit geology. Cambridge University Press.
2. Barnes, H.L., 1979. Geochemistry of Hydrothermal Ore Deposits, John Wiley.
3. Mookherjee, A, 2000. Ore Genesis – A Holistic Approach. Allied Publisher.
4. Craig, J. R., and D. J. Vaughn. 1994. Ore microscopy and ore mineralogy.
5. Pracejus, Bernhard. 2015. The ore minerals under the microscope: an optical guide. Vol. 3. Elsevier.
6. Arndt, N. and Ganino, C. 2012. Metals and Society: An Introduction to Economic Geology. Springer.
7. Robb, L. 2005. Introduction to Ore forming Processes. Blackwell.
8. Pohl, W.L. Economic Geology: Principles and Practice. 2011. Wiley-Blackwell.
9. Edwards, R. and Atkinson, K. 1986. Ore Deposit Geology: and its influence on mineral exploration.
10. Prasad, Umeshwar. Economic Geology: 2000. Economic Mineral Deposits. CBS publishers and distributors.
11. Bateman, A., and Jensen, M.L. 1950. Economic mineral deposits. Wiley.

Paper IV: GEL 104a Hydrogeology

UNIT I

Introduction to Hydrogeology and the Hydrological Cycle: Hydrological cycle, Role of groundwater in the hydrological cycle, Occurrence of Groundwater: Origin and age of water, Rock properties affecting groundwater, Vertical distribution of groundwater, Types of aquifers, springs, and geological formations as aquifers; Hydrogeological properties of water-bearing materials: Porosity, permeability, transmissibility, storage coefficient, specific yield, and specific retention; Groundwater level and its fluctuations.

UNIT II

Groundwater Quality and Pollution: Groundwater Quality: Quality criteria for different uses, Graphical presentation of water quality data, Estimation and methods of water treatment for various uses, Problem of arsenic and fluoride and remedial measures for their treatment, Quality problems in India, Groundwater pollution.

UNIT III

Groundwater Exploration and Well Technology: Techniques of groundwater exploration, Groundwater-river interactions, Water Well Technology: Well types, drilling methods, construction design, development, and maintenance of wells, Water management in rural and urban areas, Coastal water and its management.

UNIT IV

Groundwater Recharge and Conservation: Artificial recharge of aquifers, Recharging by surface water and rainwater harvesting, Consumptive and conjunctive use of surface and groundwater, Problem of overexploitation of groundwater, Groundwater legislation.

UNIT V

Specialized Groundwater Topics and Applications: Groundwater in arid zones, Groundwater in hard rocks and non-indurated sediments – their management, Types and characteristics of aquifers, Genetic classification of water, Darcy's law, Water-bearing characteristics of rocks, Saline water intrusion, Types of wells.

Course outcome:
The scientific understanding of the geological parameters is important for construction of Tunnels, Dam and Highway. The course focuses on the role of geology for suitable construction of engineered structures for the society.
Water is a basic life supporting system. The rise in global population and the quest for better living standards has greatly stressed the water resources. The course content primarily focuses on groundwater. Thus, this course aims to enable students to acquire knowledge about the occurrence, movement and exploration of the groundwater resources.

Suggested Readings:
1. Todd, D.K. (1988): Ground Water Hydrology, John Wiley & Sons, New York.
2. Davies, S.N. and Dc-West, R.J.N. (1966): Hydrogeology, John Wiley & Sons, New York.
3. Ground Water and Wells (1977): UOP, Johnson, Div. St. Paul. Min. USA
4. Hiscock, K.M. and Bense, V.F., 2014. Hydrogeology: Principles and Practice 2nd Edition,
5. Wiley-Blackwell
6. Raghunath, H.M. (1983): Ground Water, Wiley Eastern Ltd., Calcutta
7. Driscoll, F.G. (1988): Ground Water and Wells, UOP, Johnson Div. St. Paul. Min. USA

Paper IV: GEL 104b Fundamentals of Geophysics

UNIT I

Introduction to Seismic waves; Seismic waves through earth's interior; Geoid, Isostasy: Modern Concepts.

UNIT II

Gravity–Densities of Rocks and Gravity Anomalies; Geomagnetism and Palaeomagnetism, Magnetic survey;

UNIT III

Electrical Properties: Resistivity surveying; Vertical Electrical Sounding (VES); Electrical Imaging.

UNIT IV

Spontaneous (Self) Potential Method; Induced Polarisation; Magneto-telluric Surveying (MT), Ground Penetration Radar.

UNIT V

Apparent Polar Wonder, Continental Drift; Plate Motion, Geothermics; Heat Flow pattern of the Earth

Course outcome:
The course is designed to make students understand the physical properties of planet 'Earth'. It will make them aware of the basic principles of geophysical investigation for understanding background and anomaly in different physical properties. The course will help in understanding the interior of the earth and inculcate knowledge about its resources.

Suggested Readings:

1. Dobrin, M. B and Savit, C. H., 1988. Introduction to Geophysical Prospecting, McGraw-Hill.
2. Grant, F.S. and West, G.F., 1965. Interpretation Theory in Applied Geophysics McGraw Hill, New York.
3. Murthy, L. Y. R. and Mishra, D. C., 1989. Interpretation of Gravity and Magnetic Anomalies in Space and Frequency Domain, AEG publication, Hyderabad, India
4. Nettleton, L. L., 1976. Gravity and Magnetics in Oil Prospecting, McGraw Hill.
5. Parasnis, D. S., 1966. Mining Geophysics, Elsevier.
6. Patra, H. P. and Mallick, K., 1980. Geosounding Principles, 2: Time-Varying Geoelectric Soundings (Methods in Geochemistry and Geophysics, 14B). Elsevier.
7. Telford, W. M., Geldart, L.P. and Sheriff, R. E., 1990. Applied Geophysics, Cambridge
8. Lowri, W. Fundamentals of Geophysics, Cambridge University Press.
9. Alan E. Mussett, Khan, M. A. 2000. Looking into the earth: An introduction to geological geophysics, Cambridge University Press.
10. Telford, W. M., Geldart, L. P. and Sheriff, R. E., 1990. Applied geophysics. Cambridge University Press.

Paper V: GEL 105a Fuel Geology

UNIT I

Definition and origin of coal. Sedimentology of coal bearing strata, types of seam discontinuities and structures associated with coal seams. Chemical characteristics of coal. Lithotypes, microlithotypes and maceral groups of coal.

UNIT II

Classification of coal in terms of Rank, Grade and Type. Classification for coking and non-coking coals. Elementary Idea about coal preparation, characterization of coal for carbonization, gasification-hydrogenation. Coal as a source rock in petroleum generation.

UNIT III

Coalbed methane – a new energy resource. Elementary idea about generation of methane in coal beds, coal as a reservoir and coalbed methane exploration. Underground Coal Gasification: definition, concept and development, environmental benefits.

UNIT IV

Geological and geographical distribution of coal and lignite deposits in India. Coal exploration and estimation of coal reserves. Indian coal reserves and production of coal in India.

UNIT V

Radioactive mineral deposits. Geological characteristics and genesis of major types of Uranium and Thorium deposits and their distribution in India. Black sand deposits of Kerala and Tamil Nadu.

Suggested Readings:

1. Isabel Suárez-Ruiz John Crelling. 2008. Isabel Suárez-Ruiz John Crelling. 2008. Applied Coal Petrology: The Role of Petrology in Coal Utilization, Academic Press.
2. Taylor, G.H., Teichmuller, M., Davis, A., Diessel, C.F.K., Littke, R. and Robert P., 1998: Organic Petrology, Gebruder Borntraeger, Stuttgart.
3. Chandra, D., Singh, R.M. Singh, M.P., 2000: Textbook of Coal (Indian context). Tara Book Agency, Varanasi.
4. Singh, M.P. (Ed.) 1998: Coal and organic Petrology. Hindustan Publishing Corporation, New Delhi.
5. Scott, A.C., 1987: Coal and Coal-bearing strata: Recent Advances. The geological Society of London, Publication no. 32, Blackwell scientific Publications.
6. Stach, E., Mackowsky, M-Th., Taylor, G.H., Chandra, D., Teichumullelr, M. and Teichmuller R., 1982: Stach Texbook of Coal petrology. Gebruder Borntraeger, Stuttgart.
7. Durrance, E.M. 1986: Radioactivity in Geology-principles and application. Ellis Hoorwool.
8. Dahlkamp, F.J., 1993: Uranium Ore Deposits. Springer Verlag.
9. Boyle, R.W., 1982: Geochemical prospecting for Thorium and Uranium deposits, Elsevier.

Paper V: GEL 105b Disaster Management

UNIT I

Introduction on Disaster; Different Types of Disaster: A) Natural Disaster such as: flood, drought, cyclone, earthquakes, landslides, GLOF, avalanche, extreme weather events; B) Man- made Disaster such as: Fire, Dam failure, Industrial Pollution, Nuclear Disaster, Biological Disasters.

UNIT II

Disaster Management Act 2005; Prime Minister's 10-point agenda on Disaster Risk Reduction; Sendai Framework on Disaster Risk Reduction; Geo-meteorological hazard risk assessment; Climate change and Geo-meteorological hazard risk; Risk and Vulnerability Analysis: concept and analysis of risk; Risk Reduction; Vulnerability: Its concept and analysis, Strategic Development for Vulnerability Reduction.

UNIT III

Disaster Preparedness: Concept and Nature, Disaster Preparedness Plan, Prediction, Early Warnings and Safety Measures of Disaster; Role of Information, Education, Communication, and Training; Buildings for seismic hazards.

UNIT IV

Disaster Response: Introduction, Disaster Response Plan Communication, Participation, and Activation of Emergency Preparedness Plan, Search, Rescue, Evacuation and Logistic Management, Role of Government, International and NGO Bodies; Relief and Recovery, Medical Health Response to Different Disasters.

UNIT V

National Disaster Management Plan; Reconstruction and Rehabilitation as a Means of Development, Damage Assessment, Post Disaster effects and Remedial Measures; Community Based Disaster Risk Management (CBDRM); Psychological Response and Management (Trauma, Stress, Rumour and Panic); Long-term Counter Disaster Planning, Role of Educational Institute; Disaster management: initiatives and actions in India.

Course outcome:

The course outcome of this course is to make aware of both the Natural and Artificial disaster, their management techniques and familiarize the students with the foundations and the recent trends in disaster management.

Suggested Readings

1. Ahmad, A. (2010): Disaster Management: Through the New Millennium, Anmol Publications, New Delhi.29
2. Bryant Edwards (2005). Natural Hazards. Cambridge University Press, U.K.
3. Bureau of Indian Standards (2002). Indian Standards: Criteria for Earthquake Resistant Design of Structures, Part I, Fifth Revision.
4. Burton, I., Kates, R.W. and White, G.F. (1993). Environment as Hazard, 2nd edition, Guilford Press, New York.
5. Central Water Commission (1989). Manual of Flood Forecasting, New Delhi.
6. Goel, S.L., (2006): Encyclopedia of Disaster Management, Deep and Deep Publications, New Delhi.
7. Gosh, G.K., (2012): Disaster Management, A.P.H. Publishing Corporation, New Delhi 8.
8. Government of India, (2004): Disaster Management in India -A Status Report.
9. Government of India (1997). Vulnerability Atlas of India (New Delhi: Building Materials and Technology Promotion Council, Ministry of Housing & Urban Poverty Alleviation).
10. Government of India, (2005): Disaster Management in India, http://www.unisdr.org/2005/mdgs-drr/national-reports/Indiareport.pdf.
11. Gupta, H.K., (2003): Disaster Management, Universities Press (India) Private Limited, Hyderabad.
12. Kapur, A (2005). Disasters in India: Studies of Grim Reality, Rawat Publications, Jaipur.
13. Kapur, A. (2010). Vulnerable India: A Geographical Study of Disasters, Sage Publications, New Delhi.
14. NDMA (2009): National policy on Disaster Management, http://nidm.gov.in/PDF/policies/ndm_policy2009.pdf.
15. Bell, F.G., 1999. Geological Hazards, Routledge, London.
16. Bryant, E., 1985. Natural Hazards, Cambridge University Press.
17. Patwardhan, A.M., 1999. The Dynamic Earth System. Prentice Hall.
18. Smith, K., 1992. Environmental Hazards. Routledge, London.
19. Subramamam, V 2001. Textbook in Environmental Science, Narosa International.

Paper VI: GVC 101 Value-Added Credited Course (Intradepartmental) Laboratory works and Geological Field Training

Study of the physical properties of rock forming minerals in hand specimens, with special reference to their origin and distribution. Stereographic projections and calculation of axial elements of zircon, apophyllite, beryl, calcite, barytes, orthoclase and hornblende. Study of X- ray diffractograms.
Interpretation of geological maps and sections; Structural problems using stereographic methods; π and β diagrams.
Study of the optical properties of rock forming minerals in thin sections. Megascopic and microscopic study of important igneous rocks. Calculation of C.I.P.W. norms and Niggli values.
Every student shall be required to keep and maintain up-to-date record of practical work during the session, properly signed by the teachers concerned and submit it to the Head of the Department at the time of their Practical Examination. Marks shall be assigned for these practical records.
Delineations of hydrological boundaries on water table contour maps and estimation of aquifer properties as hydraulic conductivity. Storage coefficient and Transmissivity. Analysis of hydrographs for various components. Chemical and Physical analysis of water and presentation of data for uses in irrigation, drinking and industry. Evaluation of Pumping Tests data for Aquifer parameters. Interpretation of Geophysical data for fresh and Saline Ground water.
Excursion would be conducted by faculty members and if required the research students may accompany the faculty members. The marks would be given by faculty member/s on the basis evaluation of student on the basis of Activity and performance in during field work, Field diary.

Paper I: GCC 201 Palaeontology

UNIT I

Bivalvia, Gastropoda and Cephalopoda: Classification, Hard and soft part morphology, Evolution and modes of life.

UNIT II

Brachiopoda and Echinoidea: Classification, Hard and soft part morphology, evolution and mode of life.

UNIT III

Trilobita and Cnidaria: Classification, Hard and soft part morphology, evolution and geological history; biological affinities and evolution of Graptolithina.

UNIT IV

Evolution of elephant, horse and man and their fossils localities in India; Evolution and extinction of Dinosaurs; Siwalik Vertebrate fauna.

UNIT V

Biostratigraphy; Palaeobiogeography; Palaeoecology; Devonian flora, Gondwana flora, and Deccan Inter-trappean flora; Trace fossils.

Course Outcomes:

Making students understand the evolution of life in geological past is an important aspect of geology. Palaeontology, the study of fossils includes the study of vertebrate and invertebrate fossils, micro-fossils, plant fossils, trace fossils their evolution and distribution in time and space. These aspects are fundamental not only to geology and stratigraphy but inter-disciplinary fields of botany, zoology and branches of science.

The study of Palaeontology encompasses the aspects of appearance, evolution and extinction of life through the geologic time. The knowledge of palaeontology would enable the students to understand the biological changes that occurred in the history of the earth and relate them with their field observations. The students will acquire skills of describing fossils and their taxonomic classification. They will also be introduced to the application of palaeontology and the use of fossils in hydrocarbon exploration, establishing biostratigraphy, inferring palaeoecology, palaeobiogeography, palaoeneurology of the geological past.

Suggested Readings

1. Cowen, R. (2000) History of Life, Blackwell Science.
2. E. N. K. Clarkson (2013) Invertebrate palaeontology and Evolution, Blackwell Science
3. Rhona M. Black, (1989) The Elements of Palaeontology, Cambridge University Press
4. Michael Benton, (2005) Vertebrate Palaeontology, Blackwell Publishing
5. Patrick Wyse Jackson, (2019) Introducing Palaeontology: A Guide to Ancient Life, Dunedin Academic Press Ltd.
6. Raymond Enay (2012) Palaeontology of Invertebrates, Springer-Verlag.
7. Peter Doyle, Understanding Fossils: An Introduction to Invertebrate Palaeontology.
8. Morley Davies (2008) An Introduction to Palaeontology, Read Books.
9. Sreepat Jain (2017) Fundamentals of Invertebrate Palaeontology: Macrofossils, Springer India
10. Roland Goldring, (2014) Field Palaeontology, Routledge
11. Johansson, C. Z., Underwood, M. Richter, (2019) Evolution and development of Fishes, Cambridge University Press.
12. Pratul Kumar Saraswati, M.S. Srinivasan, (2016) Micropaleontology: Principles and Applications, Springer International Publishing Switzerland.
13. 13. Michael Benton, David A. T. Harper, (2009) Introduction to Paleobiology and the Fossil Record, Wiley-Blackwell.
14. 14. Colbert, E.H. and Minkoff, Eli C. (2001) Evolution of vertebrates, Wiley Liss

Paper II: GCC 202 Stratigraphy

UNIT I

Fundamental concept and History of Stratigraphy; Principles of stratigraphy, Geological time scale; Brief ideas of Lithostratigraphy, Biostratigraphy, Chronostratigraphy; Magnetostratigraphy; Event Stratigraphy and stratigraphic correlation.

UNIT II

Physical and structural subdivisions of the Indian subcontinent; Geological evolution of the Indian Cratons (Dharwar, Bastar, Singhbhum, Aravalli and Bundelkhand).

UNIT III

Indian Mobile belts (Eastern Ghat Mobile Belt-EGMB, Southern Granulite Terrane-SGT, Central Indian Tectonic Zone-CITZ, Aravalli –Delhi Belt). Indian Proterozoic sedimentary Basins (Stratigraphy of Vindhyan, Cuddapah and the Lesser Himalaya); Precambrian-Cambrian boundary.

UNIT IV

Palaeogeography and important events of the Palaeozoic Era, Palaeozoic succession of India; Permian-Triassic Boundary; Paleogeography and important events of the Mesozoic Era, Stratigraphy of Mesozoic era (Triassic of Spiti, Jurassic of Kutch and Cretaceous successions of Cauvery basin). Gondwana Supergroup.

UNIT V

Cretaceous-Tertiary (K–T) boundary, Palaeogene and Neogene global events, Tertiary successions in India, Tertiary-Quaternary boundary, Holocene epoch and Anthropocene.

Course outcome

The course is intended to familiarise the student with stratigraphic principles and nomenclature, major stratigraphic units, methods of stratigraphic correlation, depositional environments and tectonostratigraphic framework of various lithostratigraphic and biostratigraphic units of India spanning Archaean to Holocene, and mass extinction events.

Suggested Readings:

1. Doyle, P. and Bennett, M.R., 1996. Unlocking the Stratigraphic Record, John Willey.
2. Dunbar, C.O. and Rodgers, J., 1957. Principles of Stratigraphy. John Wiley & Sons.
3. Krishnan, M.S., 1982. Geology of India and Burma, C.B.S. Publishers, Delhi
4. Naqvi, S.M. 2005. Geology and Evolution of the Indian Plate: From Hadean to Holocene4 Ga to 4 Ka. Capital Pub., New Delhi.
5. Pascoe, E.H., 1968. A Manual of the Geology of India & Burma (Vols.IN), Govt. of India Press, Delhi.
6. Pomerol, C., 1982. The Cenozoic Era - Tertiary and Quaternary. Ellis Harwood Ltd., Halsted Press.
7. Schoch, R.M., 1989. Stratigraphy: Principles and Methods, Van Nostrand Reinhold, New York. 9.
8. R. Vaidyanathan & M. Ramakrishnan, 2008. Geology of India, Geological Society of India

Paper III: GCC 203 Remote Sensing, GIS and Surface Processes

UNIT I

Concepts of remote sensing; Electromagnetic spectrum and its interaction with the atmosphere and earth surface objects; Atmospheric windows; Platforms; Sensors: active and passive; Sensors on LANDSAT, SPOT, and IRS.

UNIT II

Concepts of Photogrammetry; Types of aerial photographs; Principles of photo and image interpretation techniques: photo elements, geotechnical elements. Microwave remote sensing, Thermal Image.

UNIT III

Concept of GIS; Raster, and Vector; Data types; Layer analysis; Application of GIS in Geology: Disaster Management and Hydrogeology; Principles and usage; Introduction to GPS.

UNIT IV

Introduction to Digital image processing: Concepts and characteristics; Sources of the digital image: Image enhancement, Radiometric enhancement techniques, and classification; Spatial enhancement techniques, Contrast stretching: Linear and non-linear methods, Low and High Pass Filtering: Image smoothing: Edge enhancement and detection, Gradient filters, Directional and non-directional filtering.

UNIT V

Principle of uniformitarianism; origin, differentiation, and internal structure of the Earth; earthquakes and volcanoes; continental drift, sea-floor spreading, isostasy, plate tectonics, Origin and classification of mountains; geological action of glacial, fluvial, aeolian agencies and associated erosional and depositional landforms; Landforms associated with extrusive and intrusive earth's processes; weathering processes and products.

Course Outcomes:

Remote Sensing is a state of art technology, being effectively used to monitor and assess the earth's resources. The students when exposed to the basics of remote sensing will be able to develop skills of interpreting the visual and digital satellite data and make their use in understanding the various physical processes operative on earth's surface. This along with application of GIS, will help the students in preparation of various thematic maps useful in mineral exploration, flood monitoring, landuse landcover mapping, earth resource management etc. The students will also learn the major changes that have taken place in the most recent Quaternary time period.

Suggested Reading:

1. T. M. Lillesand and P. W. Kiefer, 2016, Remote Sensing and Image Interpretation. Wiley
2. R. P. Gupta, 2016, Remote Sensing Geology, Springer 3.
3. F. F. Sabins, 2007, Remote Sensing, Principal, and Interpretation Waveland Pr Inc 4. P.
4. R. Wolf and B. A. Dewitt, 2004, Elements of Photogrammetry with applications in GIS.
5. G. Joseph and C. Jeganathan, 2018, Fundamentals of Remote Sensing: Universities Press

(India) Private Limited.
6. M.A. Summerfield. 2013, Global Geomorphology, Routledge.
7. V. S. Kale and A. Gupta. 2018, Introduction to Geomorphology, The Orient Black. swan.
8. B.J. Skinner and S.C. Porter. 1995, The Blue Planet: An Introduction to Earth System Science, John Wiley & Sons.
9. G.R. Thompson and J. Turk. 1998, introduction to Physical Geology, Saunders College Publishers, Fott Wolth.
10. P. McL. D. Duff, A. 1993, Holmes, Holme's Principles of Physical Geology, Fourth Edition. Stanley Thornes (Publishers) Ltd.

Paper IV: GEL 209a Geodynamics

UNIT I

Phase transitions and seismic discontinuities in the Earth; seismic waves and relation between Vp, Vs and density.

UNIT II

Seismic and petrological Moho; heat flow and heat production of the crust.

UNIT III

Rheology of rocks and fluids (Newtonian and non-Newtonian liquids); rock magnetism and its origin; polarity reversals.

UNIT IV

Polar wandering and supercontinent cycles; continental drift, sea floor spreading; gravity and magnetic anomalies of ocean floors and their significance.

UNIT V

Mantle plumes and their origin; plate tectonics-types of plate boundaries and their inter-relationship.

Course outcomes:

As a student of geology, all of us are interested to know the absolute time during which a particular geological event happened in geological past. By opting for the present course, the student will learn the basic techniques and processes of determining numerical ages and dates for earth materials and that of various geological events. The students will be taught different methods of dating, the dating material, limitations and their applications.

Suggested Readings:

1. Faure, G., 1986. Principles of Isotope Geology, John Wiley & Sons
2. Das H. A., Faanhof A., Van Der Sloot, H. A., 1989. Radioanalysis in Geochemistry, Elsevier Publishers
3. Dickin Alan P., 2018. Radiogenic isotope geology, Cambridge University Press
4. Turcotte DL, Schubert G. Geodynamics. 2nd ed. Cambridge University Press; 2002.
5. Gupta, N. (editor), Tandon, S.K. Geodynamics of the Indian Plate: Evolutionary

Perspectives - Springer Geology.

Paper IV: GEL 209b Geostatistics and Geophysics

UNIT I

Definition and Scope of Geostatistics; Random Functions and Regionalized Variables; Semivariogram Function and its Interpretation; Mathematical Models of Semivariograms; Kringing: Basic Concepts and applications in Geology.

UNIT II

Role of Geology in Geostatistical Modeling; Exploration Database Development; Integrated Geostatistical Modeling Process; Mineral Inventory Estimation; Grade-Tonnage Relations; Geostatistics in the Mineral Industry; Limitations and Challenges in Geostatistics.

UNIT III

Introduction to Seismic waves; Seismic waves through earth's interior; Geoid, Isostasy: Modern Concepts. Gravity–Densities of Rocks and Gravity Anomalies.

UNIT IV

Geomagnetism and Palaeomagnetism, Magnetic survey. Electrical Properties: Resistivity surveying; Vertical Electrical Sounding (VES); Electrical Imaging. Spontaneous (Self) Potential Method; Induced Polarisation.

UNIT V

Magneto-telluric Surveying (MT), Ground Penetration Radar. Apparent Polar Wonder, Continental Drift; Plate Motion, Geothermics; Heat Flow pattern of the Earth.

Course outcome:

The course is designed to make students to analyze geological data using geostatistical methods, including semivariograms and kriging, for resource evaluation and develop geostatistical models for mineral inventory estimation and understand their applications in the mineral industry. The course will make the students understand the physical properties of planet 'Earth'. It will make them aware of the basic principles of geophysical investigation for understanding background and anomaly in different physical properties. The course will help in understanding the interior of the earth and inculcate knowledge about its resources.

Suggested Readings:

1. Gandhi, S.M. and Sarkar, B.C. 2016. *Essentials of Mineral Exploration and Evaluation.* Elsevier.
2. Haldar, S.K. 2018. *Mineral Exploration: Principles and Applications.* Elsevier.
3. Dobrin, M. B and Savit, C. H., 1988. *Introduction to Geophysical Prospecting,* McGraw-Hill.
4. Grant, F.S. and West, G.F., 1965. *Interpretation Theory in Applied Geophysics* McGraw Hill, New York.
5. Murthy, L. Y. R. and Mishra, D. C., 1989. *Interpretation of Gravity and Magnetic Anomalies in Space and Frequency Domain,* AEG publication, Hyderabad, India

6. Nettleton, L. L., 1976. *Gravity and Magnetics in Oil Prospecting.* McGraw Hill.
7. Parasnis, D. S., 1966. *Mining Geophysics,* Elsevier.
8. Patra, H. P. and Mallick, K., 1980. *Geosounding Principles, 2: Time-Varying Geoelectric Soundings (Methods in Geochemistry and Geophysics, 14B).* Elsevier.
9. Telford, W. M., Geldart, L.P. and Sheriff, R. E., 1990. *Applied Geophysics,* Cambridge
10. Lowri, W. Fundamentals of Geophysics, Cambridge University Press.
11. Alan E. Mussett, Khan, M. A. 2000. Looking into the earth: An introduction to geological geophysics, Cambridge University Press.
12. Telford, W. M., Geldart, L. P. and Sheriff, R. E., 1990. *Applied geophysics.* Cambridge University Press.

Paper V: GEL 210a Engineering Geology

UNIT I

Behaviour of rock on application of stresses: Stress and its type; Strain and its type Application of Strain and stress curve; Mohr's Circle and Stress Transformation.

UNIT II

Tunnels and types; Stress conditions in tunnels; Site selection for tunnel excavation and support;

UNIT III

Slope Stability and Site selection for the construction of roads in hilly terrains.

UNIT IV

Dams and their types; Geotechnical problems associated with dams; Site selection for dam construction, construction materials.

UNIT V
Geotechnical problems associated with bridges.

Course outcome:

The scientific understanding of the geological parameters is important for construction of Tunnels, Dam and Highway. The course focuses on the role of geology for suitable construction of engineered structures for the society.

Water is a basic life supporting system. The rise in global population and the quest for better living standards has greatly stressed the water resources. The course content primarily focuses on groundwater. Thus, this course aims to enable students to acquire knowledge about the occurrence, movement and exploration of the groundwater resources.

Suggested Readings:

1. D. P. Krynine and W. R. Judd. 1957. Principles of Engineering Geology and Geotechnics, CBS publishers and distributors pvt. Ltd.
2. Bhawani Singh and R. K. Goel. 1999. Rock Mass Classification: A Practical

Approach in Civil Engineering. Elsevier Science
3. Davies, S.N. and De-West, R.J.N., 1966. Hydrogeology, John Wiley & Sons, New York.
4. Driscoll, F.G., 1988. Ground Water and Wells, UOP, Johnson, Div. St. Paul. Min. USA.
5. Fetter, C.W., 1984. Applied Hydrogeology, McGraw-Hill Book Co., New York.
6. Fitts, C.R., 2006. Groundwater Science, Academic Press.
7. Freeze, R.A. and Cherry, J.A., 1979. Groundwater, Englewood Cliffs, New Jersey: Prentice-Hall.
8. Karanth K.R., 1987. Groundwater: Assessment, Development and Management, Tata McGraw-Hill Pub. Co. Ltd.
9. Raghunath, H.M., 1987. Ground Water, Wiley Eastern Ltd., Calcutta.
10. Schward and Zhang, 2003. Fundamentals of Groundwater, John Willey and Sons.
11. Todd, D.K., 2004. Ground Water Hydrology, John Wiley & Sons, New York.

Paper V: GEL 210b Groundwater Resource Management

UNIT I

Groundwater: Definition and distribution; availability of freshwater; Aquifer: types; Aquitards; Springs: types and classification, Thermal and Mineral Springs, Spring Hydrograph Analysis, Groundwater in coastal areas and Brackish groundwater: Saltwater intrusion, Inland Brackish water.

UNIT II

Groundwater development; Effect of climate change on groundwater; Groundwater quality: natural groundwater constituents, groundwater contamination and contaminants; drinking water standards; fate and transport of contaminants; groundwater treatment.

UNIT III

Groundwater Recharge: Rainfall-Runoff-Recharge relationship, evapotranspiration, Infiltration and water movement through Vadose Zone, Factors affecting groundwater recharge, methods for estimating groundwater recharge.

UNIT IV

Groundwater Management: Concept of groundwater sustainability, Groundwater quality and quantity, Integrated Water Resources Management, monitoring of groundwater, Data management and GIS, Protection of Groundwater Resources, Modelling and optimization, Artificial Aquifer Recharge.

UNIT V

Groundwater Restoration: risk assessment, remedial investigation and feasibility study, Source-Zone Remediation, Dissolved Phase Remediation, Measuring success of Remediation.

Course outcome:

The main objectives of this course are to make aware of conditions which affects the quality and quantity of groundwater and at the same time to know the methods available for its management, restoration and sustainably utilise the groundwater resource.

Suggested Readings

Neven Kresic (2009): Groundwater resources: sustainability, management and restoration, McGraw Hill, New York.

Todd, D.K. (1988): Ground Water Hydrology, John Wiley & Sons, New York.

Paper VI: Interdepartmental Course GID 201: Fundamentals of Geology

UNIT I

Solar System; Rotation and Revolution of earth; Origin and evolution of the earth; The layered structure of the earth: Core, Mantle and Crust; Earthquake and Volcanoes; Ring of Fire.

UNIT II

Physiographic subdivisions of India: Peninsula, Ganga Plain and Extra Peninsula (Himalaya), Thar desert of India, Sunderban Delta; Coastal plains; Andaman-Nicobar and Lakshadweep Islands; Fundamentals of Structural Geology; Deformational Structure: Fold, Fault, Joint, Unconformity.; Global Tectonics and Tectonic framework of India.

UNIT III

Introduction to Stratigraphy; Petroleum Geology and hydrocarbon resources; Introduction to Palaeontology: Invertebrate fossils, Vertebrate fossils and Trace fossils. Elements of Sedimentology Basin evolution; Sedimentary rock types and resources; Sedimentary Cycle.

UNIT IV

Fundamentals of Mineralogy, Crystallography and rock forming minerals; Usage of Minerals; Introduction to Igneous Petrology: Plutonic, Volcanic, Mafic and Ultramafic rock types; Metamorphism; Metamorphic Grade and Metamorphic facies. Engineering properties of rocks.

UNIT V

Concepts of Remote Sensing and application to geology; Natural disasters and geo- hazards; Medical Geology; Water-Cycle; Groundwater; Vertical distribution of water; Water quality; Effect of Geological environment on Human Health; Ganga River and Namami-Ganga Project; Anthropogenic impact on environment.

Course Outcomes:

This course content has been specially formulated to address the non-Geology students the fundamental concepts of Earth, its internal and external domains, resources, evolution and its dynamics. The contents also address the environmental issues arising out anthropogenic activities and its impact on the natural earth system.

Suggested Readings:

1. Putnis A. Introduction to Mineral Sciences, Cambridge publication, 1992.
2. Neil Britt, 2011. Geology for Beginners: Beginners Guide to Geology, Kindle edition

Valdiya, K.S, 2014. Environmental Geology: Ecology resource and Hazard Management, McGraw Hill Higher Education.

3. Mathur, S.M., 2008. Elements of Geology, Published by PHI Learning.

Department of Geology
University of Lucknow
Syllabus for 1-Year M.Sc. programme
(for session 2025-26)
As per PG Ordinance 2024

Year	Semester	Paper	Course Name	Credit	Total
1	I	GCC 101	Mineral Science	4	20
		GCC 102	Advanced Structural Geology & Tectonics	4	
		GCC 103	Mineral Resources and Exploration Techniques	4	
		GEL 104a	Hydrogeology	4	
		GEL 104b	Fundamentals of Geophysics		
		GEL 105a	Fuel Geology	2	
		GEL 105b	Disaster Management		
		GVC 101 Valued-Added Credited Course (Intradepartmental)	Laboratory Works and Geological Field Training	2	
	II	GCC 201	Palaeontology	4	20
		GCC 202	Stratigraphy	4	
		GCC 203	Remote Sensing, GIS and Surface processes	4	
		GEL 209a	Geodynamics	4	
		GEL 209b	Geostatistics and Geophysics		
		GEL 210a	Engineering Geology	2	
		GEL 210b	Groundwater Resource Management		
		GID 201 Interdepartmental course	Fundamentals of Geology	2	

Department of Geology
University of Lucknow
Syllabus for 2-Year M.Sc. programme
(for session 2025-26)
As per PG Ordinance 2024

Year	Semester	Course Code	Course Name	Credit	Total
1	I	GCC 101	Mineral Science	4	20
		GCC 102	Igneous Petrology	4	
		GCC 103	Structural Geology and Tectonics	4	
		GCC 104	Laboratory Works	4	
		GCC 105	Petroleum Geology	2	
		GVC 101 Valued-Added Credited Course (Intradepartmental)	Geochemistry	2	
	II	GCC 201	Sedimentology	4	20
		GCC 202	Palaeontology	4	
		GCC 203	Metamorphic Petrology	4	
		GCC 204	Laboratory Works & Geological Field Training	4	
		GCC 205	Engineering Geology	2	
		GID 201 (Interdepartmental Course)	Fundamentals of Geology	2	
2	III	GCC 301	Stratigraphy	4	20
		GCC 302	Remote Sensing, GIS and Surface Processes	4	
		GCC 303	Economic Geology & Mineral Exploration	4	
		GEL 301 A	Marine Geology & Quaternary Science	4	
		GEL 301 B	Geostatistics and Geophysics		
		GEL 302 A	Environmental Geology	2	
		GEL 302 B	Disaster Management		
		GIN 301	Internship and Geological Field Training	2	
	IV	GCC 401	Hydrogeology	4	20
		GEL 401 A	Geochronology and Geodynamics	4	
		GEL 401 B	Groundwater Resource Management		
		GEL 401 A	Climatology and Climate Change	4	
		GEL 401 B	Geoheritage, Geoparks & Geotourism		
		GDW 401	Dissertation	8	