

MAHARAJA GANGA SINGH UNIVERSITY, BIKANER

**SCHEME OF EXAMINATION AND
COURSES OF STUDY**

SYLLABUS

FACULTY OF SCIENCE

M.SC.

GEOLOGY



M.Sc. Previous Examination - 2021

M.Sc. Final Examination – 2022

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Scheme of Teaching, Examination and Courses of Study (Syllabus) in Geology

M.Sc. (P) – 2021 & M.Sc. (F)- 2022

There will be four theory Papers of three hours duration, carrying 75 marks each and practicals of 16 hours duration, distributed in 4 days in M.Sc. Previous and four theory Papers of three hours duration, carrying 75 marks each and practicals of 16 hours duration, distributed in 4 days in Final of M.Sc. (Final) in the annual examination of MGS University, Bikaner.

In accordance with the nature of the practicals in Geology and in conformity with other University Departments of Geology, a batch of practical in M.Sc. (Previous and Final) shall consist of not more than six students.

In each of M.Sc. Geology classes (i.e. Previous and Final), there will be two compulsory Geological Field-Training Programmes as prescribed in the syllabus for all students. Students, not attending the training programmes shall not be eligible to appear in the annual University examination.

Teaching and Examination Scheme

Paper No.	Theory Paper (Nomenclature)	Theory Hours per week	Practical Hours per week	Theory Exam. Hours	Maximum Marks
I	Structural Geology ,Geotectonics & Geomorphometry	6	6	3	75
II	Geochemistry, Crystallography& Mineralogy	6	6	3	75
III	Stratigraphy & Palaeontology	6	6	3	75
IV	Economic Geology & Mineral Economics	6	6	3	75

Minimum Passing Marks in theory: – 108 out of Total 300 Marks.

DISTRIBUTION OF MARKS AND TIME DURATION FOR PRACTICAL EXAMINATION

(Practicals: Exam Duration- 16 Hours, distributed in 2 Parts in 4 days.)

Max Marks: 150

Min Pass Marks: 54

Part-I - Geochemistry, Crystallography & Mineralogy and
.Economic Geology

8 Hrs in 2 days 75Marks

- General Geological Tour and Submission of Report and Viva- voce

Part-II - Structural Geology, Geotectonics & Geomorphometry and
Stratigraphy &Palaeontology

8 Hrs in 2 days 75Marks

-Geological Mapping of a selected Area & Submission of report and Viva- voce

Paper I- Structural Geology, Geotectonics & Geomorphometry

Note: – Each Theory paper is divided into 5 units. The question paper is divided into three parts,Part A,Part B and Part C. Part A (20 Marks) is compulsory and contain one question containing 10 parts ,two from each unit, each question is of 2 marks (Answer limit 50 Words). Part B (25 Marks) is compulsory and contains five questions with internal choice,one from each unit.Candidate is required to attempt all five questions, each question is of Five marks each (Answer limit 200 words). Part C (30 Marks) contains five questions one from

each unit, Candidate is required to attempt three questions; each question is of 10 Marks (Answer limit 500 hundred words).

Unit - I

Mechanical Principles- Analysis of stress, component of stress, stress ellipsoid. Types and Analysis of deformation, strain ellipsoid. Homogeneous and inhomogeneous deformation, progressive strain, strain paths. Factors controlling behaviour of rock materials. Determination of Strain in deformed rocks. Ductile behaviour of rocks.

Unit - II

Morphology of folds. Geometric and genetic classification of folds. Mechanism of folding. Superimposed folding and interference patterns. Structural analysis in terrains with multiple deformations. Types of Linear structures and their tectonic significance. Deformation of linear structures.

Unit - III

Types and origin of Cleavages; cleavage fans and axial plane cleavage; refraction of cleavage; relation of cleavage to major structures. Fractures and Joints- their nomenclature, age relationship, origin and significance.

Nomenclature of faults; minor structures associated with faults; effects of faulting on outcrop pattern; classification of faults; mechanics of faulting; recognition of faults.

Geometry & mechanics of shear zones; shear zone structures; shear zone indicators; folding in shear zones. Mylonites and pseudotachylite.

Unit - IV

Crust: composition, seismic, gravity and magnetic characters. Crustal types: shields, platforms, mountain chains, rift valleys, mid oceanic ridges, trenches, island arcs and ocean basin.

Heat flow; Gravity & Magnetic Anomalies. Crustal Provinces. Mantle: different zones; seismic characters; gravity anomalies; Core.

Orogeny and epeirogeny. Tectonic theories: Isostasy, Geosynclines; Sea-floor spreading, Palaeomagnetism.

Continental drift. Plate Tectonics. Structure and evolution of the Himalaya and Indogangetic alluvial plains.

Unit - V

Fundamental concepts of Geomorphology. Analysis of geomorphic process: Exogenic, Endogenic and Extra-terrestrial Processes. Concept of morphogenetic regions. Fluvial geomorphic Cycle: Streams and valleys, Classification of valleys; Stages in drainage system evolution, their pattern, textural implications; rejuvenation.

Peniplaination concept. Erosional and depositional features associated with fluvial cycles.

Landforms, their types and nature of development. Landforms in relation to structure and tectonics.

Karst topography.

Glaciers: types & characteristics. Erosional and depositional features associated with glacial cycles.

Arid cycles: origin and types of desert, eolian landforms; expansion and control of desertification in India.

Geomorphology of coasts. Geomorphology of shorelines and ocean floors, geomorphometric analysis and modeling. Major geomorphological sub division of India, their characteristics and evolution.

Suggested Books:

1. Ragan, D.M. – Structural Geology (J. Wiley & Sons)
2. Badgley, P.C. – Structural Geology for Exploration Geologists (Oxford Univ. Press)
3. Spencer, E.W. – Introduction to the Earth's Crust (McGraw Hill)
4. Wylie, P.J. – Dynamic Earth (J. Wiley & Sons)
5. Billings, M.P. – Structural Geology
6. Hobbs, B.E. Means, W.D. & Williams P.F. – An outline of Structural Geology (J.Wiley & Sons)
7. Ramsay, J.G. – Folding & Fracturing of Rocks (McGraw Hill)
8. Holmes A.– Physical Geology (Nelson)
9. Strahler – Physical Geology.
10. Summerfield, M.A. – Geomorphology and Global Tectonics. Springer Verlag.
11. Moores, P. and Twiss, R.J., - Tectonics. Freeman.
12. Davis, G.R.,- Structural Geology of Rocks and Region. John Willey.
13. Ramsay, J.G. and Huber, M.I. – Modern Structural Geology. Vol I &II. Academic Press.
14. Price, N.J.and Cosgrove, J.W.- Analysis of Geological Structure. Cambridge University Press.
15. Ghosh, S.K. - Structural Geology Fundamentals of Modern Developments. Pergamon Press.
16. Bloom, A. – Geomorphology (Prentice Hall)
17. Thornbury, W.D. – Principles of Geomorphology (J. Wiley & Sons)
18. Lobeck, A.K. – Geomorphology (Mc-Graw Hill)

Paper II– Geochemistry, Crystallography & Mineralogy

Note: – Each Theory paper is divided into 5 units. The question paper is divided into three parts, Part A, Part B and Part C. Part A (20 Marks) is compulsory and contain one question containing 10 parts ,two from each unit, each question is of 2 marks (Answer limit 50 Words). Part B (25 Marks) is compulsory and contains five questions with internal choice, one from each unit. Candidate is required to attempt all five questions, each question is of Five marks each (Answer limit 200 words). Part C (30 Marks) contains five questions one from each unit, Candidate is required to attempt three questions; each question is of 10 Marks (Answer limit 500 hundred words).

Unit -I

Elements of Geochemistry. Geochemical classification of elements. geochemical cycle, geochemical anomaly, geochemical tracers and indicators. Isotope Geochemistry: stable isotopes, oxygen isotopes, sulphur isotopes, carbon isotopes, hydrogen isotopes.

Unit -II

Crystallography: crystal growth, symmetry operations. Laws of crystallography. Goniometry. Thirty two crystal classes. Crystal projections: spherical, stereographic and gnomonic. Twinning. Space lattices. Elements of symmetry in internal structure. X– Ray crystallography: Bragg's equation; powder and single crystal methods, Laue method.

Unit -III

Mineralogy; classification of mineral kingdom. Physical & Optical properties of minerals; determination of refringence, birefringence; vibration direction, interference figures, optic sign, optic axial angle; indicatrix; dispersion; universal stage and Berek compensator.

Systematic Mineralogy of native elements, sulphides, sulfosalts, oxides, hydroxides and carbonates.

Unit -IV

Silicate structures. Detailed study of the following rock forming mineral groups with respect to their chemical constitution, crystal structure & forms, physical and optical properties, mode of origin, association, occurrence and alteration:

Neso silicates– Olivine group, Garnet group, Kyanite, Andalusite, Sillimanite.

Soro silicates– Epidote group. Cyclo Silicate- Beryl, Tourmaline, Axinite, Cordierite

Ino- silicates– Pyroxene group, Pyroxinoid group and Amphibole group.

Unit -V

Detailed study of the following rock forming mineral groups with respect to their chemical constitution, crystal forms, physical and optical properties, mode of origin, association, occurrence and alteration:

Phyllo silicates– Mica group, Chlorite, Talc.

Tecto silicates– Feldspar group, Feldspathoid group, Zeolite group, Quartz, and other forms of Silica.

Gem minerals: gem properties and varieties.

Suggested Readings:

1. Phillips, F.C. – An Introduction to Crystallography (ELBS)
2. Burger, M.J. – Elementry Crystallography (J. Wiley & Sons)
3. Evans, R.C. – Crystal Chemistry (Cambridge University Press)
4. Dana, E. Ford W.E. – A Text book of Mineralogy (Asia Public House)
5. Deer, Howie & Zussman – Introduction to Rock Forming Minerals (ELBS)
6. Winchel & Winchel – Elements of Optical Mineralogy (ELBS)
7. Mason, B. – Principles of Geochemistry (McGraw Hill)
8. Kraushopf – Introduction to Geochemistry (McGraw Hill)
9. Fyfe – Geochemistry (Clereton Press Oxford)
10. Read, H.H. – Rutley's Elements of Mineralogy (Thomas Murby & Co.)
11. Mason, Berry – Minerology. (Asian Pub.)
12. Sharma, N.L. – Determinative Tables (ISM, Dhanbad).
13. Klein, C. and Hurlbut, Jr., C.S.,- Manual of Mineralogy. (J. Wiley & Sons)
14. Mason, Brian - Principles of Geochemistry.
15. Mason, B. and Moore, C.B. - Introduction to Geochemistry. Wiley Eastern.
16. Krauskopf, K.B. - Introduction to Geochemistry. McGrew Hill.
17. Faure, G. - Principles of Isotope Geology. John Wiley.
18. Govett, G.J.S. - Hand Book of Exploration Geochemistry. Elsevier.

Paper III – Stratigraphy & Palaeontology

Note: – Each Theory paper is divided into 5 units. The question paper is divided into three parts, Part A, Part B and Part C. Part A (20 Marks) is compulsory and contains one question containing 10 parts, two from each unit, each question is of 2 marks (Answer limit 50 Words). Part B (25 Marks) is compulsory and contains five questions with internal choice, one from each unit. Candidate is required to attempt all five questions, each question is of Five marks each (Answer limit 200 words). Part C (30 Marks) contains five questions one from each unit, Candidate is required to attempt three questions; each question is of 10 Marks (Answer limit 500 hundred words).

Unit - I

Development of stratigraphy and founding of geologic systems, Stratigraphic relationships- lithosome, shape, vertical and lateral relationship. Principles of stratigraphic classification. Principles of correlation. Time stratigraphic units. Standard stratigraphic scale and its equivalents in Indian sub- continent.

Code of stratigraphic nomenclature. Geochronology: Radio isotopes and measuring geological time.

Early history of the Earth. Nature of early crust; Formation and Evolution of greenstone, granite and granulite terrains.

Origin of life. Evolution of life. Evidences of Evolution of life. Nomenclature of organisms. Classification of organisms. Distribution, migration, dispersal and extinction of animals and plants. Palaeozoogeographic provinces. Major events in Precambrian and Phanerozoic life.

Fossil: Techniques of collection, preparation, preservation & nomenclature of fossils.

Elements of palaeoecology. Dating of rocks and fossils. Imperfection of geological records.

Unit - II

Precambrian geochronology and early crustal evolution. Archaean and Proterozoic tectonic patterns.

Precambrian provinces of India – their stratigraphy and correlation. Precambrian- Cambrian boundary problem. Succession, fauna, flora, sedimentation, palaeogeography, age problems and regional correlation of the Palaeozoics of Indian sub- continent. Nomenclature, extent, division, succession, sedimentation, structures, palaeogeography; flora, fauna and regional correlation of the following: Triassics, Jurassics, Cretaceous of India. Cretaceous –Tertiary (K-T) boundary problem.

Unit – III

Detailed study of Gondwana Supergroup: Succession, fauna, flora, sedimentation, palaeogeography, age problems and regional correlation of the Gondwana Group of rocks, Deccan Traps: Succession, fauna, flora, age problems and regional correlation, Intertrappean and Infratrappean beds.

Tertiary of Extra Peninsular India with special reference to Assam Lesser Himalayas. Tertiary of coastal region -Tertiaries of Rajasthan. Neogene- Quarternary boundary Problem. Quarternary Geology of Rajasthan.

Unit – IV

Palaeobotany –Study of Indian flora of the past with special reference to the Gondwana plant life.

Micropalaeontology, micro fossils–their classification, techniques of collection, separation, preparation and preservation. Environmental & geological significance of micro– fossils.

Foraminifera: Morphology, classification and geological history. significance of foraminifera in palaeo-ecological studies & oil exploration. Ostracoda : Morphology, classification, ecology and geological history.

Conodonts: Morphology, classification, ecology and geological history. Nannofossils: morphology and geological distribution. Elementary ideas about Pollens and Spores.

Invertebrate Palaeontology-Graptolites: their systematic position, evolution and geological history.

Anthozoa: Morphology and geological history of Tetracoralla, Hexacoralla and Tabulata; appearance of septa in Tetracoralla.

Echinoidea: Change in symmetry, variation in oculogenital system; ambulacral areas and compound plates, classification and geological history. Trilobita: Growth stages, evolutionary trends and geological history.

Unit -V

Brachiopoda: Variation in Brachial skeleton, pedicle opening and commissure, classification and geological history. Bivalvia: Evolution of hinge and dentition, adaptive modification, classification and geological history. Gastropoda: Forms, twisting of nervous system, aperture, classification and geological history. Cephalopoda: variation in shape of Conch of nautiloidea, ornamentation and siphuncle of ammonoidea and geological history.

Vertebrate Palaeontology– classification of vertebrates and their sequence through geological time.

Introductory knowledge of Pisces, Amphibia, Reptilia, Aves and Mammalia. Study of Indian vertebrate fauna with special reference to Siwaliks. Evolutionary trends of Horse, Elephant, Man and Giraffe

Suggested Readings:

1. Krumbein and Sloss – Stratigraphy and Sedimentation (WH Freeman & Co.)
2. Dunbar, C.O. & Rodgers, J. – Principles of Stratigraphy (J.Wiley & Sons)
3. Krishnan, M.S. – Geology of India & Burma (CBS)
4. Pascoe, E.H. – A Manual of Geology of India & Burma (GSI)
5. Ravindra Kumar – Introduction of Historical Geology and Principles of Stratigraphy (CBS)
6. Rankama, K. – The Geologic Systems-The Pre cambrian Vol.-III Ed.(J. Wiley & Sons)
7. Eicher, Don, L. – Geologic Time (Prentice Hall)
8. Sinha Roy, S. Malhotra, G & Mohanty, M. – Geology of Rajasthan (Geol. Soc. Ind.)
9. Naqvi, S.M. and Rogers, J.J. – Precambrian Geology of India Shrock & Twenhofel – Principles of Invertebrate Palaeontology (McGraw Hill)
10. Moore, Laliker & Fisher – Invertebrate fossils (McGraw Hill)
11. Colbert, E.H. – Evolution of the Vertebrates (J.Wiley & Sons)
12. Woods, H. – Invertebrate Palaeontology (CBS)
13. Glaessener, M.F. – Principles of Micropalaeontology(Hafner Press)
14. Cushman, J.A. – Foraminifera (Cambridge University Press)
15. Pockorny – Principles of Zoological Micropalaeontology Vol. I & II
16. Kathal, P.K. – Microfossils & their applications (CBS).
17. Jain and Anantharaman – Introduction to Palaeontology Vishal Publications. Jalandhar.
18. Black, R.M. - The Elements of Palaeontology. Cambridge University Press.

Paper IV – Economic Geology & Mineral Economics

Note: – Each Theory paper is divided into 5 units. The question paper is divided into three parts, Part A, Part B and Part C. Part A (20 Marks) is compulsory and contains one question containing 10 parts, two from each unit, each question is of 2 marks (Answer limit 50 Words). Part B (25 Marks) is compulsory and contains five questions with internal choice, one from each unit. Candidate is required to attempt all five questions, each question is of Five marks each (Answer limit 200 words). Part C (30 Marks) contains five questions one from each unit, Candidate is required to attempt three questions; each question is of 10 Marks (Answer limit 500 hundred words).

Unit I

Magma and its relation with the mineral deposits. The development of the modern theories of ore deposition. Physical and chemical characteristics of ore bearing fluids and their genesis. Migration of ore bearing fluids and deposition of ores. Fluid inclusion. Geothermometry and isotope studies in relation to ore deposits. Concept of ore microscopy. Classification of ore deposits, stratiform and stratabound ore deposits. Structural controls of mineralisation. Metallogenic epoch and provinces; Global metallogeny related to crustal evolution.

Unit- II

Study of the processes of formation of mineral deposits:
Magmatic concentration, Sublimation, Contact metasomatism, Metamorphism, Hydrothermal, Sedimentation, Bacteriogenic, Submarine exhalative & Volcanogenic, Evaporation, Residual and Mechanical concentration, Oxidation and supergene sulphide enrichment.

Unit- III

The study of metallic mineral deposits with reference to geology, mode of occurrence, origin, uses and distribution in India of Gold, Copper, Lead-Zinc, Iron, Manganese, Aluminium, Magnesium, Chromium and strategic minerals of India.

Unit- IV

The study of non-metallic mineral deposits with reference to geology, mode of occurrence, origin, uses and distribution in India of Mica, Asbestos, Barytes, Gypsum, Limestone Garnet, Corundum, wollastonite, calcite, quartz, feldspar, clays, Kyanite, Sillimanite, Graphite, Talc, Fluorite, Beryl and Rock phosphate, Gem minerals and radio-active minerals. Non-metallic minerals used in refractories, abrasives, ceramics, glass making materials, fertilizers, natural paints & pigments and cement

Classification of Energy Resources and Geoenergy Resources.

Mineral fuels: Coal- nature, characteristics, Rank, grade and type of coal. Classification of coal.

origin, distribution, classification and commercial uses of coal. Coal fields of India, conservation and utilisation of coal. Coal based industries in India. Coal bed methane.

Geothermal resources: classification of geothermal waters, geothermal system, geothermal regions of India and world, geothermal water deposits associated with thermal springs, industrial uses of Geothermal Energy.

Unit- V

Mineral Economics: Concept and scope of mineral economics. Global status of Indian Mineral Resources.

Peculiarities inherent in mineral industry

Mining & Mineral Legislation of India: Categories of minerals for grant of concessions; Minor & Major Minerals; Procedure for obtaining Mineral concessions. Claim system. Restrictions. Termination, surrender & Determination of Mining Lease. Royalty & Dead Rent. Various Laws & Acts related to Mines & Minerals. Mineral taxation & Incentive Measures. Marketing.

Suggested Readings:

1. Bateman, A.M. – Economic Mineral Deposits (J. Wiley & Sons)
2. Smirov, V.I. – Geology of Mineral Deposits (M.R. Pub)
3. Park C.F. and McDiarmid R.A. – Ore Deposits (W.H. Freeman & Co.)
4. Stanton R.L. – Ore Petrology (McGraw Hill)
5. Krishnaswami – Mineral Resources of India (CBS)
6. Sinha, R.K. – Treatise on Industrial Minerals of India.
7. McKinstry, H.E. – Mining Geology (Asia Pub. House)
8. Stach, E. et al. – Coal Petrology. Gebruder Borntraeger, Stuttgart
9. Lybach, L., Muffer, L.J.P. – Geothermal systems (J. Wiley & Sons)..
10. S. Eanga Raja Rao – Coal Preparation and use (Oxford IBM Pub. Co.)
11. Armstrong, H.C. – Geothermal Energy (Span London)
12. Singh, R.D. – Principles and Practices of Modern coal Mining.
13. Taylor, G.H. et al. – Organic Petrology. Gebruder Borntraeger, Stuttgart.
14. Chandra, D., Singh, R.M. and Singh, M.P., - Text Book of Coal. Tara Book Agency, Varanasi.
15. Dahlkamp, F.J. - Uranium Ore Deposits. Springer verlag.

M.Sc. (Previous) Practicals

Maximum Marks: 150

Exam Duration: 16 Hrs in 4 days for 4 Parts of Practicals

Part I:

(Practicals of Geochemistry, Crystallography, Mineralogy and Stratigraphy & Palaeontology and Submission of Report and Viva-voce on General Geological Tour)

Marks: 75

Exam Duration: 8 Hours in 2 days

Geochemistry, Crystallography & Mineralogy

25 Marks

1. Identification of important rock forming minerals by physical examination.
2. Identification of important rock forming minerals by optical examination.
3. Determination of 2V and pleochroic schemes of important rock forming minerals.
4. Identification and description of crystal models in hand specimens.
5. Construction of Stereographic projections and determination of axial Ratio.
6. Problems related to stereographic projection of crystals.

Economic Geology & Mineral Economics

25 Marks

1. Study of economic minerals in hand specimens, their distribution and genesis.
2. Determination of important ore minerals under reflected light.

3. Distribution of important minerals in the maps of India and Rajasthan

Practical Record

5 Marks

Viva Voce

5 Marks

Field Work: General Geological Field Training Programme (2 weeks duration)

15 Marks

The report of the field work has to be submitted and viva voce will be conducted during the practical exam.

Part II:

(Practicals of Structural Geology, Geotectonics & Geomorphology and Economic Geology & Mineral Economics and Submission of report and Viva- voce on Geological Mapping of a selected Area)

Marks: 75

Exam Duration: 8 Hours in 2 days

Geomorphology, Geotectonics & Structural Geology

30 Marks

1. Solution of structural problems by stereographic and orthographic projection methods.
2. Identification of structural elements and their chronology in hand specimens.
3. Completion of outcrop patterns.
4. Study of Geological Maps, Preparation of Geological sections, determination of Thickness of beds, Geological History.
5. Completion of outcrops on maps.
6. Study of topographic maps and their interpretation.
7. Representation of geomorphic features.
8. Geomorphic surveys, leveling and contouring.

Stratigraphy & Palaeontology

20 Marks

1. Study of rocks in Hand specimens from Precambrian terrain of India.
2. Showing boundaries of the Precambrian terrains of India on map.
3. Stratigraphic and Palaeogeographic maps with special reference to India.
4. Identification of stratigraphic rocks in hand specimen.
5. Preparation of Lithology and their correlation, correlation problems.
6. Identification, drawing and description of common representatives of Fossil groups covered in theory syllabus.
7. Sketching of evolutionary trends of important fossils groups.

Practical Record

5 Marks

Viva Voce

5 Marks

Field Work: Geological mapping of selected area (Two weeks duration)

15 Marks

and report there on.