

**DEPARTMENT OF GEOLOGY, FACULTY OF  
SCIENCE J.N.VYAS UNIVERSITY, JODHPUR**  
**Teaching Faculties**

<b>Name</b>	<b>Designation</b>	<b>Qualification</b>	<b>Specialization</b>
Dr. S.C. Mathur	<b>Professor &amp; Head</b>	M.Sc.,Ph.D.	Sedimentology, Paleontology
Dr. K.L. Shirvastva	Professor	M.Tech.,Ph.D.	Economic Geology, Mineral Exploration
Dr. M.S. Sisodia	Professor	M.Sc.Tech.,Ph.D.	Planetary Science, Sedimentology
Dr. S.K. Trivedi	Associate Professor	M.Sc.,Ph.D.	Sedimentology Mineral Exploration
Dr. (Mrs.) B. Tripathi	Associate Professor	M.Sc.,Ph.D.	Strutural Geology Metamorphic Petrology
Dr. S.R. Jakhar	Associate Professor	M.Sc.,Ph.D.	Paeontology
Dr. V.S. Parihar	Assistant Professor	M.Sc.,Ph.D.	Sedimentology Paleontology

**M. Sc. (PREVIOUS) EXAMINATION - 2015**  
**TEACHING AND EXAMINATION SCHEME**

	Pd/W	Exam(Hrs)	Marks	
<b>A. Theory Papers</b>				
Geology I: Structural Geology, Tectonics and Geol. 401 Remote Sensing in Geology	4	3	100	
Geology II: Sedimentology and Geomorphology Geol. 402	4	3	100	
Geology III : Mineralogy, Instrumentation & Geol. 403 Analytical Techniques and Geochemistry	4	3	100	
Geology IV: Palaeobiology and Stratigraphy Geol. 404	4	3	100	
<b>B. Practical and Field Training</b>			Total Marks:	200
Time: 6 Hours for Each group in separate days.			Max. Marks:	200
			Min. Pass Marks:	72
	Practical	Records	Total	Hrs.
<b>Group A</b>				
Structural Geology and Remote Sensing	30	05	6	
Sedimentology and Geomorphology	30	05	70	6
Viva-voce	05		05	
Total			75	
<b>Group B</b>				
Mineralogy, Geochemistry	30	05		6
Palaeobiology, Stratigraphy	30	05	70	6
Viva-voce	05		05	
Total			75	
<b>Group C</b>				
Seminar	10		10	
Geological Mapping (Training and report)	20		20	
General Geological Tour	20		20	
Total			50	
<b>Grant Total (A+B+C)</b>			<b>200</b>	

Note: The Examination will be carried out by two sets of examiners – one internal and one external member for each group on two separate days.

## **M. Sc. (PREVIOUS) EXAMINATION- 2015**

### **PAPER I: STRUCTURAL GEOLOGY, TECTONICS AND REMOTE SENSING IN GEOLOGY**

#### **Unit I**

Mechanical principles and properties of rocks and their controlling factors. Theory of rock failure. Concept of stress and strain. Two-dimensional strain and stress analyses. Types of strain ellipses and ellipsoids, their properties and geological significance. Strain markers in naturally deformed rocks. Mechanics of folding and buckling. Classification of folds. Fold development and distribution of strains in folds.

#### **Unit II**

Faults and Joints: Their nomenclature, age relationship, origin and significance. Causes and dynamics of faulting, strike-slip fault, normal faults, over thrust and nappe. Planar and linear fabrics in deformed rocks, their origin and significance. Concepts of petrofabrics and Symmetry: objective, field and laboratory techniques. Graphic treatment types of fabrics, fabric elements and interpretation of fabric data on microscopic and mesoscopic scale. Use of Universal Stage in petrofabrics. Analysis of simple and complex structures on macroscopic and microscopic scale.

#### **Unit III**

Plate tectonics: recent advances, pros and cons. Dynamic evolution of continental and oceanic crust, Tectonics of Precambrian Orogenic Belts of India. Formation of mountain roots. Anatomy of orogenic belts. Structure and origin of the Alpine – Himalayan belt, the Appalachian- Caledonian belt, the Andes, the North American Cordillera. Study of Map Projections.

#### **Unit IV**

Principles of remote sensing: general idea about electromagnetic spectrum, aerial photographs and their geometry, photogrammetry: recent advances and applications. Satellite remote sensing. Global and Indian space missions. Different satellite exploration programs and their characteristics: LANDSAT, METEOSAT, SEASAT, SPOT, IRS. Image interpretation and digital processing techniques.

#### **Unit V**

Geological Studies: Image characters and their relations with ground objects based on tone, texture and pattern; principles of terrain analysis, evolution of ground water potential, rock type identification; and interpretation of topographic and tectonic features.

### **PRACTICAL**

Preparation and interpretation of geological maps and sections. Structural problems concerning economic mineral deposits. Recording and plotting of field data. Plotting and interpretation of petrofabrics data and resultant diagrams. Study of large-scale tectonic features of the Earth. Exercises on MSS, TM, FCC, IR, Thermal IR, Radar, and SPOT images for geological and geomorphological mapping and in (georesources) vegetation, water and mineral resource evolution. Making false color composites, and study of multi-spectral scans and spectral

patterns. Exercises on digital image processing. Study of environmental hazard maps.

### **BOOKS RECOMMENDED**

- Badgley, P.C., 1965: Structure and Tectonics. Harper and Row.  
Ramsay, J.G., 1967: Folding and Fracturing of Rocks. McGraw Hill.  
Hobbs, B.E., Means, W.D., and Williams, P.F., 1976: An Outline of Structural Geology. John Wiley.  
Davis, G.R., 1984: Structural Geology of Rocks and Region. John Wiley.  
Ramsay, J.G., and Huber, M.I., 1987: Modern Structural Geology, Vol. 1 & II. Academic Press.  
Price, N.J. and Cosgrove, J.W., 1990: Analysis of Geological structure. Cambridge Uni. Press  
Bayly B., 1992: Mechanics in structural Geology. Springer Verlag.  
Ghosh, S.K., 1995: Structural Geology Fundamentals of Modern Developments. Pergamon Press.  
Moores, E. and Twiss, R.J., 1995: Tectonics. Freeman.  
Keary, P., and Vine, F.J., 1990: Global Tectonics. Blackwell.  
Storetvedt, K.N., 1997: Our Evolving Planet: Earth 's history in new perspective. Bergen (Norway), Alma Mater Forlag.  
Valdiya, K.S., 1998: Dynamic Himalaya. Universities Press, Hyderabad.  
Summerfield, M.A., 2000: Geomorphology and Global Tectonics. Springer Verlag.  
Miller, V.C., 1961: Photogeology. McGraw Hill  
Sabbins, F.F., 1985: Remote Sensing – Principles and Applications. Freeman.  
Ray, R.G., 1969: Aerial Photograph in Geologic Interpretations. USGS Prof. Paper 373.  
Drury, S.A., 1987: Image Interpretation in Geology. Allen and Unwin.  
Moffitt, F.H. and Mikhail, E.M., 1980: Photogrammetry, Harper and Row.  
Lillesand, T.M. and Kieffer, R.W., 1987: Remote Sensing and Image Interpretation. John Wiley.  
Paine, D.P., 1981: Aerial Photography and Image Interpretation for Resource Management. John Wiley.  
Pandey, S.N., 1987: Principles and Applications of Photogeology. Wiley Eastern. New Delhi.  
Gupta, R.P., 1990: Remote Sensing Geology. Springer Verlag.

### **PAPER II: SEDIMENTOLOGY AND GEOMORPHOLOGY**

#### **Unit I**

Earth surface system: weathering, erosion process of transportation, deposition and post depositional changes. Sedimentary textures-grain size, shape, sorting, packing and orientation. Methods of study of grain size distribution parameters. Methods of study of grain shape and fabric. Mineralogical characteristics, separation and study of the heavy minerals Sedimentary structures.

## **Unit II**

Sedimentary environments and facies continental alluvial-fluvial, lacustrine, desert-aeolian and glacial sedimentary system. Shallows coastal and Tidal sedimentary system.. Marine and continental evaporites.

## **Unit III**

Diagenesis and Clastic petrofacies. Palaeocurrent, palaeoenvironmental, and basin analysis. Clastic and non clastic sedimentary rocks.

## **Unit IV**

Petrogenesis of important clastic and non clastic sedimentary rocks. Evolution of sedimentary basins: tectonics and sedimentation. Elementary idea of application of trace-elements and stable isotopes geochemistry to sedimentological problems.

## **Unit V**

Geomorphological studies : dynamics of geomorphology, geomorphic processes and resulting land forms. Geomorphological mapping based on genesis of landforms. Terrain evolution for strategic purposes.

## **PRACTICAL**

1. Field and laboratory techniques in sedimentary petrology: Recording of sedimentary structures, preparation of lithologs. Thin section preparation and staining techniques.
2. Study of primary, secondary and biogenic sedimentary structure in hand specimens in photographic atlas, field photographs and wherever possible on the outcrops in field.
3. Grain size analysis and granulometric analysis: Histogram, cumulative frequency distribution curve of grain size data. Computation of statistical parameters such as median, mean, standard deviation, skewness and kurtosis etc. and their interpretation.
4. Exercise related to palaeocurrent data.
5. Exercise related to analysis and interpretation of depositional sedimentary environments using actual case histories from western Rajasthan stratigraphic record.
6. Petrography of important clastic and non -clastic sedimentary rocks.
7. Microscopic study of heavy minerals and interpretation of provenance.
  
8. Study of nature of aerial photographs: resolution, mosaics, symbols, gully pattern and drainage analysis, image parallax. Determination of scale, height, dip, slope, vertical exaggeration and image distortion.

Allen J R L 1985, Principles of physical sedimentation, George Allen and Unwin

Allen P 1997, Earth surface processes, Blackwell

Nicholas G 1999, Sedimentology and stratigraphy, Blackwell.

Reading H G, 1996 Sedimentary environments, Blackwell.

Davis R A Jr, 1992, Depositional systems, Prentice Hall.

Einsele G 1992, Sedimentary basins, Springer Verlag.

Reineck H E and Singh I B, 1980, Depositional Sedimentary Environments, Springer Verlag.

Pronthero DR and Schwab F 1996, Sedimentary Geology, Freeman.

Miall AD 2000, Principles of sedimentary Basin Analysis, Springer Verlag

Pettijohn FJ, Potter PE and Seiver R 1990, Sand and Sandstone, Springer Verlag

Blatt H Murray GV and Middleton RC, 1980 Origin of Sedimentary rocks

Bhattacharya and Chakroborti C 2000, Analysis of sedimentary successions, Oxford IBH

Boggs Sam Jr 1995, Principles of sedimentology and stratigraphy, Prentice Hall  
Sengupta S 1997, Introduction to Sedimentology, Oxford IBH  
Babu SK and Sinha DK 1987 Practical Manual of Sedimentary Petrology, CBS Publisher

### **PAPER III : MINERALOGY, INSTRUMENTATION & ANALYTICAL TECHNIQUES AND GEOCHEMISTRY**

#### **Unit I**

Systematic mineralogy; atomic structure, mineral chemistry, properties. Their PT-stability and mode of occurrence of silicates.

#### **Unit II**

Systematic mineralogy; atomic structure, mineral chemistry, properties. Their PT-stability and mode of occurrence of native elements, sulfides, sulfosalts, oxides, hydroxides and carbonates.

Gem and semi-precious minerals.

#### **Unit III**

Crystallography: Space lattice, 32 crystal classes of symmetry

Instrumentation and Analytical Techniques

Sampling and sample preparation, thin section and polished section making. Sample etching, staining and modal count techniques. Techniques in photomicrography. Principles and geological application of cathodoluminescence, thermoluminescence, atomic absorption spectrophotometry, inductively coupled plasma-atomic emission spectrometry, X-ray fluorescence spectrometry, scanning and transmission electron microscopy, electron-probe microanalysis, X-ray diffractometry, thermal ionization and gas source mass spectrometry.

#### **Unit IV**

Origin and abundance of elements in the Solar system and in the Earth, and its constituents.

Atomic structures and properties of elements in the Periodic Table. Special properties of transition and rare earth elements. Geochemical classification of elements.

Radiogenic isotopes. Radioactive decay schemes of U-Pb, Sm-Nd, Rb-Sr, K-Ar, and growth of daughter isotopes. Radiometric dating of single minerals and whole rocks.

Stable isotopes: nature, abundance, and fractionation.

#### **Unit V**

Laws of thermodynamics; concept of free energy; activity, fugacity and equilibrium constant. Principles of ionic substitution in minerals; element partitioning in mineral/rock formation. Introduction to Planetary Science: Meteorites, Impact Craters, Life- its origin and occurrence. Elemental mobility in surface environment. Concept of geochemical-biogeochemical cycling and global climate.

### **PRACTICAL**

Microscopic study of rock forming minerals using optical accessories. Depending upon availability of facility, exercises in sample dissolution, determination of elemental composition of minerals and rocks by flame photometer and AAS, sample preparation for powder diffraction by XRD and interpretation of x-ray

diffractogram of common minerals and components of the bulk rocks. Exercises on thin section and polished section making, etching and staining. Calculation of mineral formulae from the concentration of various oxides in minerals. Calculation of normative mineralogy from rock composition. Calculation of weathering indices in soil and sediments. Calculation of age of rocks by radiometric data. Presentation of analytical data.

## **BOOKS RECOMMENDED**

- Deer, W.A., Howie, R.A. and Zussman, J., 1996: The Rock Forming Minerals Longman.
- Klein, C. and Hurlbut, Jr., C.S., 1993: Manual of Mineralogy. John Wiley.
- Putnis, Andrew, 1992: Introduction to Mineral Sciences. Cambridge University Press.
- Spear, F.S. 1993: Mineralogical Phase Equilibria and Pressure -Temperature. Time Paths. Mineralogical Society of America Publ.
- Phillips, Wm, R. and Griffen, D.T., 1986: Optical Mineralogy, CBS Edition.
- Hutchinson, C.S., 1974: Laboratory Handbook of Petrographic Techniques. John Wiley.
- Mason, B. and Moore, C.B., 1991: Introduction to Geochemistry, Wiley Eastern.
- Krauskopf, K.B., 1967: Introduction to Geochemistry. McGraw Hill.
- Faure, G., 1986: Principles of Isotope; Geology. John Wiley.
- Hoefs, J., 1980: Stable Isotope Geochemistry. Springer Verlag.
- Marshall, C.P. and Fairbridge, R.W., 1999: Encyclopaedia of Geochemistry. Kluwer Academic.
- Govett, G.J.S. (Ed), 1983: Handbook of Exploration Geochemistry. Elsevier.
- Phillips F C: An Introduction to Crystallography. Oliver Boyd.
- Nordstrom, O.K. and Munoz, J.L., 1986: Geochemical Thermodynamics, Blackwell.
- Henderson, P, 1987: Inorganic Geochemistry, Pergamon Press.

## **PAPER IV: PALAEOBIOLOGY AND STRATIGRAPHY**

### **Unit I**

Fossils and their preservations, Uses. Nomenclature : General and Species concept, biometrics and molecular systematics.

Organic evolution : Origin of life, Theories and evidences of organic evolution. Mechanism of evolution. Phylogenic and ontogenic analysis. Precambrian and Phanerozoic life . Growth and allometry. Functional morphology and evolutionary trends.

Palaeoecology : Concept of palaeoecology. Marine and terrestrial ecosystems. Mass extinctions. Limiting factors.

Development of Stratigraphy . International code of stratigraphic nomenclature. Stratigraphic principles and methods of correlation. Stratigraphic records.

Lithostratigraphy. Biostratigraphic: Biozone. Controlling factors, time significance, quantitative stratigraphy. Magnetostratigraphy, cyclostratigraphy, eventstratigraphy, pedostratigraphy, seismic stratigraphy and sequence stratigraphy. Geochronology and chronostratigraphy. Geophysical and chemostratigraphic correlation.

Geological timescale: Reasoning and equivalents of its divisions.

## **Unit II**

Study of classification, morphology, palaeoecology with special emphasis on Indian biostratigraphy and evolutionary trend of following invertebrate fossil groups: Corals Echinoidea, Lamellibranchia, Cephalopoda, Gastropoda, Brachiopoda; Trilobita and Graptoloids.

## **Unit III**

Applied Micropalaeontology: Foraminifera. Introduction to palynology. Ostrocods. Conodonts and Nanoplanktones. Vertebrates of Siwalik. Evolutionary histories of man, elephant and horse. Gondwana flora and its significance and its distribution. Spores and pollen grains.

## **Unit IV**

Detailed stratigraphy of Precambrian cratons of India with special reference to following Super-Groups- Aravalli, Dharwar, Cuddapah, Delhi, Vindhyan and their equivalents.

## **Unit V**

Detailed study of phanerozoic stratigraphy of India with special reference to Rajasthan.

## **PRACTICAL**

Recognition of fossil groups in an assorted assemblage and identification of their classes. Study of important fossils from Indian stratigraphic horizons. Measurement of dimensional parameters and preparation of elementary growth-curves and scatter-plots. Exercises on stratigraphic classification and correlation. Exercises on interpretation of seismic records for stratigraphy Study of palaeogeographic maps of all geological periods.

## **BOOKS RECOMMENDED**

- Kathal, P. K., 1998: Microfossils and their applications. CBS Pub. And distributor. 4596/ 1A, 11 Dariyaganj. Delhi-2.
- Woods, H., 1985: Paleontology invertebrate. 8<sup>th</sup> edition. CBS Pub. And distributor, Delhi.
- Raup : Principles of paleontology. 2<sup>nd</sup> edition. CBS Pub. and distributor.
- Moore, R. C., Lalicher, C. G., Fisher, A. C.: Invertebrate fossils. McGrawhill.
- Colbert, E. H.: Evolution of the vertebrates. John wiley & sons.
- Schrock, R. R. and Twendhofel, W. H.: Principles of invertebrate paleontology. McGraw Hill.
- Krishnan, M. S., 1982. Geology of India and Burma. 6<sup>th</sup> edition. CBS Pub. And distributor, Delhi.
- Kumar Ravindra, 1985: Fundamentals of historical Geology and stratigraphy of India. Iley Eastern Ltd., New Delhi.
- Weller, J. M., 1960: Stratigraphic principles and practice. Universal Book Stall. Delhi. (5, Dariyaganj Ansari road)
- Dunber, C. O. and Roadger, J.: Principles of Stratigraphy. John wiley and Sons.
- Eicher, D. L.: Geological Time. Prentice Hall.
- Rodger and Naquvi.
- Clarkson, E.N.K., 1998: Invertebrate Paleontology and Evolution. 4<sup>th</sup> edition. Blackwell.



- Stern, C. W. and Carrol, R. L., 1989: Paleontology-The Record of Life. John Wiley.
- Smith, A. B., 1994; Systematics and the Fossils Record – Documenting Evolutionary Pattern. Blackwell.
- Prothero, D. R., 1998: Bringing Fossils to Life-An Introduction to palaeobiology. McGraw Hill.
- Pomeroy, C., 1982: The Cenozoic Era: Tertiary and Quaternary. Ellis Harwood Ltd.
- Goodwin, A.M., 1991: Precambrian Geology: The Dynamic Evolution of Continental Crust. Academic Press.
- Boggs, Sam Jr., 1995: Principles of Sedimentology and Stratigraphy. Prentice Hall.
- Doyle, P. and Bennett. M.R., 1996: Unlocking the Stratigraphic Record. John Wiley.
- Brenner, R.E. and McHargue, T.R., 1988: Integrative Stratigraphy: Concepts and Applications. Prentice Hall.
- Naqvi, S.M. and Rogers, J.J.W., 1987: Precambrian Geology of India, Oxford Univ.Press.
- Pascoe, E.H., 1968. A Manual of Geology of India and Burma, Vol.I-IV, Govt of India Press.

# M. Sc. (FINAL) EXAMINATION 2016

## TEACHING AND EXAMINATION SCHEME

Pd/W Exam(Hrs) Marks

### A. Theory Papers

Geology V: Ore Geology and Fuel Geology 4 3 100  
Geol. 501

Geology VI: Mining Geology, Engineering Geology  
and Exploration

Geol. 502 4 3 100

Geology VII : Hydrogeology and Environmental Geology

Geol. 503 4 3 100

Geology VIII: Igneous and Metamorphic Petrology

Geol. 504 4 3 100

B. Practical and Field Training Total Marks: 200

Time: 6 Hours for Each group in separate days. Max. Marks: 200

Min. Pass Marks: 72

Practical Records Total Hrs.

#### Group A

Ore Geology, Fuel Geology 30 05 6  
Mining Geology and Exploration

Engineering Geology and Survey 30 05 70 6

Viva-voce 05 05

Total 75

#### Group B

Hydrogeology and Environmental Geology 30 05 6

Igneous and Metamorphic Petrology 30 05 70 6

Viva-voce 05 05

Total 75

#### Group C

Seminar	10	10
General Geological Tour	20	20
Mining and Hydrogeological Training	20	20
Total		50

**Grant Total (A+B+C) 200**

Note: The Examination will be carried out by two sets of examiners – one internal and one external member for each group on two separate days.

## **PAPER V: ORE GEOLOGY AND FUEL GEOLOGY**

### **Unit I**

Brief history of development of economic Geology and modern concept of ore genesis. Spatial and temporal distribution of Ore deposit in the World. Material of mineral deposits and their formation. Principle ore mineral groups. Methods of goethermometry and geobarometry in Ore Geology. Ore texture Para genesis and zoning of Ore and their significance. Chemical composition of Ores and host rock: bulk chemistry, major, minor, trace and rare earth elements. Stable and radiogenic isotopes. Ore microscopy: Optical principle and properties of Ore minerals. Fluid inclusion in ores: Principle, applications and limitations. Earths evolutionary history and evolutionary trends of Ore deposits. Precambrian and present Plate tectonics and genesis of Ore deposits. Classification of Ore forming processes.

### **Unit II**

Ore forming processes of igneous associations with possible Indian example, Magmatic deposits associated with acidic, basic and ultra basic rocks. Mineralization associated with Komatiite (Gold), Kimberlite (Diamond), Carbonates (R.E.E), Peridotites (Cr, Ni and PGE), Granite (W and Sn) and Pegmatite's (mica, uranium, gems and R.E.E), Cyprus type Cu-Zn deposit and Kuroko type Pb-Zn-Cu deposit. Porphyry copper.

Pegmatites: As a rock and economic deposit forming process. Simple and complex pegmatite and their genesis. Indian pegmatite belts.

Skarn and greisens deposits, contact metasomatism: role of invaded and intrusive rock. Characteristic of the deposits. Hydrothermal process and deposits. Origin and nature of hydrothermal solutions. Wall rock alteration, crustification and comb structures. Cavity filling and metasomatic replacement type of deposits. Hypo-, Meso-, Epi-, Tele-, Xeno and Lepto thermal deposits.

Volcanogenic process and deposits: characteristics, mode of occurrence and genesis MN nodules.

Metamorphosed deposits and metamorphism as Ore forming process.

### **Unit III**

Economic mineral deposit forming process of sedimentary association (with possible Indian examples) Sedimentation: Chemical and Clastic sedimentation chemical perception of iron and Manganese deposit. Factors controlling economic concentration and their mutual dependence.

Residual concentration: characteristic of the process and controlling factors. Bauxite, classification and Indian deposits of bauxite. Blue bust Ore. Residual Cr and Ni /Au profiles.

Mechanical concentration: Eluvial, Alluvial, Wind and Beach placers, Placer gold, diamonds and thorium.

Oxidation and Supergene Sulphide enrichment: formation of solvent, dissolution migration and deposition of metals. Gossans: Type and importance.

Biogenic deposits and process.

Stratiform and Strata bound Ore deposits (Mn, Fe and Base metals).

Contemporary Ore forming systems: black smokers, mineralized crust, Mn nodules and Red sea.

#### **Unit – IV**

Metallic deposits of India, geology and genesis of important iron, manganese, chromium, nickel, tin, tungsten, gold, lead, zinc, copper and aluminum deposits.

#### **Unit- V**

**Coal:** Definition and origin of kerogen and coal. Sedimentology of coal bearing strata. Rank, grade and type of coal. Indian and international classifications. Chemical characterization, proximate and ultimate analysis. Macroscopic ingredients and microscopic constituent and concept of ‘maceral’ and micro litho types.

Coal petrology, and its applications in solving industrial and geological problems. Preparation of coal for industrial purposes, coal carbonization (coke manufacture) coal gasification and coal hydrogenation. Application of coal petrology in hydrocarbon exploration.

Coal bed methane: a new energy resource. Maturation of coal and generation of methane in coal beds. Coal as reservoir. Fundamentals of coal bed methane exploration and production.

Coal forming epochs in the geological past. Geological and geographical distribution of coal deposits in India. Detail geology of some important coalfields of India.

Methods of coal prospecting and estimation of coal reserves. Coal production and problems of coal industry in India.

**Petroleum:** Its composition and different fractions. Origin, nature and migration (primary and secondary) of oil and gas. Transformation of organic matter into kerogen, organic maturation, thermal cracking of kerogen.

Characteristics of reservoir rocks and traps (structural, stratigraphic and combination).

Oil field fluid – water, oil and gas occurrence. Prospecting for oil and gas, drilling and logging procedures.

Oil bearing basins of India and the world. Geology of the productive oil fields of India. position of oil and natural gas in India, future prospects and the economic scenario .

**Atomic fuel:** Mode of occurrence and genesis of atomic minerals in nature. Atomic minerals as source of energy. Methods of prospecting and productive geological horizons in India.

Nuclear power stations of the country and future prospects. Atomic fields and environments.

#### **PRACTICAL**

Megascopic study of structures and fabrics of different ores and their associations. Mineralogical and textural studies of common ore minerals under ore-microscope and petrological study of other industrial and non-metallic minerals. Exercises in the determination of reflectivity and microhardness of common ore minerals.

Megascope characterization of banded coals. Proximate analysis of coal. Completion of outcrops in the given maps and calculation of coal reserves. Preparation of polished particulate mounts of coal. Microscopic examination of polished coal pellets (identification of macerals in coal). Megascope and microscopic study of cores and well cuttings. Study of geological maps and sections of important oilfields of India and world. Calculation of oil reserves. Study of geological sections of U- Th bearing rocks of the country. Megascope study of some uranium and thorium bearing minerals and rocks.

## **BOOKS RECOMMENDED**

- Gokhle KVGK and Rao T.C. 1973 Ore deposits of India their distribution and processing. Thomson and press (India) Limited. Delhi.
- Krishnaswami S. 1979. Indian Mineral Resources. Oxford & IBH pub. Comp. Delhi
- Shcheglov A.D.1976 Fundamentals of metallogenic analysis Mir Pub. Moscow.
- Levenson A.I. 1985 Geology of petroleum II ed. CBS Pub. Delhi.
- Maynard J.B. 1983 “ Geochemistry of sedimentary ore deposits” . Springer Verlag.
- Jensen and Bateman A.M. Economic Mineral Deposits John Wiley and Sons .
- Smirnov V.I. Geology of Mineral Deposits Mir pub. Moscow.
- Evan A.M.1993 Ore Geology and Industrial Minerals , Black well . Scientific Pub.
- Park C.F. and Mac Diarmid R.A. Ore deposits , W.H. Freeman .
- Hutchinson Economic Mineral Deposits and their tectonic settings .
- Mukherjee A. 2000 Ore genesis – A holistic approach, Allied Pub.
- Gilbert J.M. and Park Jr. and C.F. 1986 The Geology of Ore deposits , Freeman.
- Sawkins F.J. 1984 Metallic Deposits in relation to plate tectonics .Springer Verlag.
- Torling D.H. 1981 Economic Geology and Geotectonics Blackwell Science Pub.
- Klemm D.D. and Schneider H.G. 1977 Time and Stratabound Ore deposits . Springer Verlag.
- Stanton R.L.1972 Ore Petrology Mc Graw Hill.
- Craig J. M. and Vaughan D.J. 1981 Ore petrology and Mineralogy John Wiley .
- Huge Frund. Application of Ore Microscopy .
- Cameroon . Ore Microscopy.
- Ramdhani P. 1969 The Ore Mineral and their intergrowth.Pergamon Press.
- Wolf K.S. 1976 – 1981 Hand book of Stratabound and Stratiform Ore deposits. Elsevier(vol. 1 to vol. 8).
- Babu S.K and Sinha D.K.practical manual of exploration and prospecting CBS Pub.and distributor. Shahadara Delhi – 32
- Satya Narayan Swami B.S. 2000 Engineering Geology
- Dhanpatrai and cop.Limited.1710 Nai Sarak Delhi-6

## **PAPER VI: MINING GEOLOGY, ENGINEERING GEOLOGY AND EXPLORATION**

### **Unit I**

Industrial Mineral

Deposits: Refractory, abrasives, ceramics and glass making materials, fertilizers, paints and pigment materials cement, materials and gemstones. Study of following

with reference to origin mode of occurrence ,distribution in India and uses; mica, asbestos, pyrite, barites,g gypsum, bentonite, garnet, corundum, kyanite, sillimanite, graphite, talc, fluorite, beryl, zircon and rock phosphate.

## **Unit II**

(i) Exploration : Basic aim of exploration

Classification of methods of exploration. Surface exploration and Sub Surface exploration. Aerial photography and remote sensing Interpretative characteristics of Aerial photographs and their application in identification of Geomorphology , Structures and Lithology for exploration.

(ii) Sampling : Sampling in mining geology. Different types of samples, and their collection, Treatm

ent and handling of samples, precautions, Ore reserves estimation, Different types of Reserves and their estimation, Calculation of grade and tonnage, Methods for averaging of assays, Elements of blasting and effect of lithological and structural features on fragmentation.

(iii) Ore guides and controls; Ore Shoots target rings and intersecting loci, Regional and local guides to ore, Physiographic guides, Lithological and stratigraphic guides, Structural guides and fracture pattern.

Mineralogical guides , Bottoming and zoning of mineral deposits.

## **Unit III**

Geophysical Exploration

Variation of Gravity over the surface of the earth. Principle of gravimeters. Gravity field surveys. Various type correction applied to gravity data. Preparation of gravity anomaly maps and their interpretations in term of shape size and depth. Geomagnetic field of the earth . Magnetic properties of rocks . Working principle of magnetometers. Field surveys and data collection . Preparation of magnetic anomaly maps and their quantitative interpretation. Magnetic anomalies due to single pole and dipole. Introduction to Aeromagnetic survey. Three dimensional current flow, potential due a point current source .

Resistivity Method: Basic principles , various type of electrode configurations, Field procedure: profiling and sounding . Applications of electrical methods in ground water prospecting and civil engineering problems.

Seismic Methods : Fundamental principle of wave propagation , refraction and reflection surveys for single interface , horizontal and dipping cases.

Concept of seismic channel and multi-channel recording of seismic data. End- on and spread shooting technique . CDP method of data acquisition , sorting , gather stacking and record section. Seismic velocity and interpretation of seismic data.

Application in mineral and petroleum exploration . Description of borehole environment. Brief outline of various well- logging techniques . Principles of electrical logging and its application in petroleum, groundwater and mineral exploration .

(ii) Geochemical explorations : Principles and methods of geochemical prospecting, methods of geochemical exploration , applicability and precautions in geochemical exploration .pedo,Litho, Geo and hydrogeochemical explorations .

(iii) Boring: principles of boring ; selections of sites for boreholes ; surface layout ; method of percussive (solid hollow and ropes), rotary , (diamond, chilled shot,

clay and other system), details of equipments , properties of drilling mud , Core recovery wire line core barrel : interpretations of bore hole data, bore hole logging, maintenance of records , difficult boring , controlled directional drilling , deflection of boreholes, Difficulties in boring , Fishing tool and their uses.

#### **Unit IV**

Application of rock mechanics in mining. Planning, exploration and exploratory mining of surface and underground mineral deposits involving diamond drilling, shaft sinking, drifting, cross cutting, winzing, stopping, room and pillaring, top-slicing, sub-level caving and i;>lock caving. Cycles of surface and underground mining operations. Exploration for placer deposits. Open pit mining.

Ocean bottom mining. Types of drilling methods. Mining hazards: mine inundation, fire and rock burst.

#### **Unit V**

Role of engineering geology in civil construction and mining industry. Various stages of engineering geological investigation for civil engineering projects. Engineering properties of rocks; rock discontinuities. Physical characters of building stones. Metal and concrete aggregates.

Geological consideration for evaluation of dams and reservoir sites. Dam foundation rock problems. Geotechnical evaluation of tunnel alignments and transportation routes, method of tunneling; classification of ground for tunneling purposes; various types of support.

Mass movements with special emphasis on landslides and causes of hill slope instability. Earthquakes and seismicity, seismic zones of India. Aseismic design of building. Influence of geological conditions on foundation and design of buildings.

Case history of engineering projects and geological causes for mishaps and failures of engineering structures.

#### **PRACTICAL**

Study of gravimeter, magnetometer and seismographs. Resistivity survey. Interpretation of underground structure on the basis of seismic data. Study of properties of common rocks with reference to their utility in engineering projects. Study of maps and models of important engineering structures as dam sites and tunnels. Interpretation of geological maps for landslide problems.

#### **BOOKS RECOMMEDED**

Evan A.M. 1993 Ore Geology and Industrial minerals. Blackwell .Sci. Pub,Dev M. Nonmetallic and Industrial minerals.

Gokhle and Rao. Ore deposits

Lamey cc Metallic and Industrial mineral deposits.

Mc Kinstry H.E. 1962 Mining Geology 2<sup>Ed</sup> . Asia Pub. House.

Lewis R.A. and Clark G.A. 1967 Elements of Mining 3<sup>Ed</sup> . John Wiley

Young. G.J. Elements of Mining Mc Graw Hill.

Babu and Sinha

Arogyaswami R.N.P. Courses in Geololgy I.B.H.

Sharma, P.V.,1986 : Geophysical method in Geology. Elsevier.

Sharma , P.V., 1997 : Environmental and Engineering Geophysics, Cambridge University Press.

Volgelsang, D., 1995 : Environmental Geophysics – A practical Guide . Springer Verlag.  
Dobrin , M.B., 1976 Introduction of Geophysical Prospecting. McGraw Hill.  
Parasnis , D.S. , 1975 : Principles of Applied Geophysics. Chapman and Hall.  
Stanislave, M., 1984 Introduction to Applied Geophysics . Reidel Pub.  
Hawks and Webb : Geochemical Exploration.  
Krynine D.P. and Judd W.R. 1998 : Principles of Engineering Geology and Geotectonics . (McGraw Hill.) CBS Edition.  
Schul J.R. and Cleaves A.B. Geology in Engineering . J. Wiley and Sons.

## **PAPER VII: HYDROGEOLOGY AND ENVIRONMENTAL GEOLOGY**

### **Unit I**

Ground water: origin, types, importance, occurrence, reservoirs and movement. Renewable and non-renewable groundwater resources; Hydrologic properties of rocks: porosity, permeability, specific yield, specific retention, hydraulic conductivity, transmissivity, storage coefficient. Hydrographs. Flownets, Water table contour maps, hydrostratigraphic units, hydrogeology of arid zones and wetlands. Hydrogeology of Rajasthan.

Ground water quality, estimation and methods of treatment for various uses, Groundwater quality map of India. Water contaminants and pollutants: problem of arsenic and fluoride.

### **Unit II**

Well hydraulics: confined, unconfined, steady, unsteady and radial flow. Water level fluctuations: causative factors and their measurements. Methods of pumping test and analysis of test data, evaluation of aquifer parameters.

Artificial recharge of groundwater, Consumptive and conjunctive use of surface and groundwater, problem of overexploitation, groundwater legislation.

### **Unit III**

Water well technology: Development and maintenance of wells. Water management in rural and urban areas, salt water intrusion in coastal aquifers, remedial measures.

Surface and subsurface geophysical and geological methods of groundwater exploration, hydrogeomorphic mapping using various remote sensing techniques. Radio isotopes in hydrogeological studies.

### **Unit IV**

Time scales of global changes in the ecosystems and climate. Carbon di-oxide in atmosphere, limestone deposits in the geological sequences, records of palaeotemperatures in ice cores of glaciers. Global warming caused by CO<sub>2</sub> increase in present atmosphere due to indiscrete exploitation of fossil fuels, volcanic eruptions and afforestation. Conservation of mineral resources and impacts of mining

Cenozoic climate extremes- impact on human evolution.

### **Unit V**

Water resources– Hydrogeological considerations, problems and management. Impact assessment of degradation and contamination of surface water and ground water quality due to industrialization and urbanization. Water logging problems due to the indiscrete construction of canals, reservoirs and dams. Soil profiles and soil quality degradation due to irrigation, use of fertilizers and pesticides.



Influence of neotectonics in seismic hazard assessment. Preparation of seismic hazard maps. Distribution, magnitude and intensity of earthquakes.

## **PRACTICAL**

Delineation of hydrological boundaries on water-table contour maps and estimation of permeability. Analysis of hydrographs and estimation of infiltration capacity. Chemical analysis of water. Pumping test: time-drawdown and time-recovery tests and evaluation of aquifer parameters. Step drawdown tests, Electric resistivity sounding for delineation of fresh and saline aquifers. Study of geophysical well logs. Estimation of TDS using resistivity and SP logs. Exercises on groundwater exploration using remote sensing. Study of seismic and flood-prone areas in India. Analyses for alkalinity, acidity, pH and conductivity (electrical) in water samples. Classification of ground water for use in drinking, irrigation and industrial purposes. Presentation of chemical analyses data and plotting chemical classification diagram. Evaluation of environmental impact of air pollution groundwater, landslides, deforestation, cultivation and building construction in specified areas.

## **BOOKS RECOMMENDED**

Todd, O.K., 1980: Groundwater Hydrology. John Wiley.  
Karanth K.R. Hydrogeology, Tata McGraw Hill  
Karanth K.R. Hydrogeology II, Tata McGraw Hill  
Driscoll F.G., 1989: Groundwater and Wells II Edition Johnson Division/Scientific Publishers  
Davies, S.N. & De Wiest, A.J.M., 1966: Hydrogeology. John Wiley.  
Freeze, A.A. & Cherry, J.A., 1979: Ground Water. Prentice Hall.  
Valdiya, K.S., 1987: Environmental Geology -Indian Context. Tata McGraw Hill  
Keller, E.A., 1978: Environmental Geology, Bell and Howell, USA  
Bryant, E., 1985: Natural Hazards, Cambridge University Press.  
Patwardhan, A.M., 1999: The Dynamic Earth System. Prentice Hall  
Subramaniam, V., 2001: Textbook in Environmental Science, Narosa International.  
Bell, F.G., 1999: Geological Hazards. Routledge, London.  
Smith, K., 1992: Environmental Hazards. Routledge, London.

## **PAPER VIII: IGNEOUS AND METAMORPHIC PETROLOGY**

### **Unit I**

Physics of magma generation in the mantle, their constitution and composition. Factors affecting magma and evolution of magma. Phase equilibrium of single, binary and ternary (Albite-Anorthite, Diopside-Anorthite, Albite-Orthoclase, Forsterite-silica and leucite-silica system) and ternary (Diopside- Albite-Anorthite, Diopside, Forsterite-Silica and Albite-Orthoclase- Silicic systems), its relation to magma genesis and crystallization behaviour.

### **Unit II**

Criteria for classification of the igneous rocks. Norms -CIPW, and Niggli values, Rock suite, series: petrographic provinces and associations.

### **Unit III**

Petrogenesis of major igneous rock types such as ultramafic/komatiite, basaltic, granitic and alkaline rocks.

### **Unit IV**

Mineralogical Phase rule of closed and open systems, Graphical representation and compositional plotting, ACF and A KF diagrams.

Factors of metamorphism with special reference to composition of fluid phase, classification of metamorphic zones, Glaucophane schist, eclogite and granulite facies. Nature of metamorphic reactions and pressure-temperature conditions of metamorphism.

### **Unit V**

Isoreactiongrad, Schreinmakers rule and construction of petrogenetic grids .

Metamorphic differentiation. Anatexis, Migmatites Regional metamorphism and paired metamorphic belts. Pressure-temperature-time paths. Ultra-high temperature, ultra-high pressure and ocean floor metamorphism.

## **PRACTICAL**

Megascopeic and microscopic study of igneous lithotypes. Calculation of CIPW Norms, Preparation of variation diagrams.

Megascopeic and microscopic study of metamorphic rocks of different facies. Time relationship between deformation and recrystallisation. Graphic construction of ACF, AKF and AFM diagrams. Estimation of pressure and temperature from important models of geothermobarometry. Interpretation of reaction textures.

## **BOOKS RECOMMENDED**

Turner, F.J. 1980: Metamorphic Petrology, McGraw Hill, New York.

Yardley, B. W. 1989: An Introduction to Metamorphic Petrology. Longman New York.

Bucher, K. and Frey, M. 1994: Petrogenesis of Metamorphic Rocks, Springer - Verlag.

Philippot, A, 1992: Igneous and Metamorphic Petrology. Prentice Hall.

Best, M.G., 1986: Igneous Petrology, CBS Publ.

McBirney, A.A., 1993: Igneous Petrology. Jones & Bartlett Publ.

Kretz, A., 1994: Metamorphic Crystallization, John Wiley.

Bose, M.K., 1997; Igneous Petrology. World Press.

Perchuk, L.L. and Kushiro, I. (eds), 1991: Physical Chemistry of Magmas. Springer Verlag.

## M. Sc. (Pr) Geology Examination, 2011-2012

### TEACHING AND EXAMINATION SCHEME

	Pd/W	Exam. (Hrs)	Marks	
A. Theory Papers				
Geology I Geol. 401	Structural Geology, Tectonics and Remote sensing in Geology.	4	3	100
Geology II Geol. 402	Sedimentology and Geomorphology	4	3	100
Geology III Geol. 403	Mineralogy, Instrumentation and analytical techniques and Geochemistry.	4	3	100
Geology IV Geol. 404	Palaeobiology and stratigraphy	4	3	100

B. Practical and Field Training Total Marks: 200

Time: 6 Hours for Each group in separate days. Max. Marks: 200  
Min. pass Marks: 72

	Practical	Record	Total	Hrs.
Group A				
Structural Geology & Remote sensing	30	5	70	6
Sedimentology and Geomorphology Viva-voce	30	5	5	
Total			75	
Group B				
Mineralogy, Geochemistry Palaeobiology, stratigraphy Viva-voce	30	5		6
	30	5		
	5			
Total			75	
Seminar	10		10	
Geological Mapping (Training and report)	20		20	
Geological Tour	20		20	

Total	50
Grant Total	200

Note: The Examination will be carried out by two sets of examiners- one internal and one external member for each group on two separate days.

### **M. Sc. (Final) Geology Examination, 2012-2013**

#### TEACHING AND EXAMINATION SCHEME

	Pd/W	Exam. Hrs.	Marks
A Theory Papers			
Geology V Geol. 501	Ore Geology and Fuel Geology 4	3	100
Geology VI Geol. 502	Mining Geology, Engineering Geology and Exploration 4	3	100
Geology VII Geol. 503	Hydrogeology and Environmental Geology 4	3	100
Geology VIII Geol. 504	Igneous and Metamorphic petrology 4	3	100

B. Practical and Field Training Total Marks: 200

Time: 6 Hours for Each group in separate days. Max. Marks: 200  
Min. pass Marks: 72

	Practical	Record	Total	Hrs.
Group A				
Ore Geology, Fuel Geology, Mining Geology, Exploration	30	5	70	6
Engineering Geology and Survey Viva-voce	30 5	5	5	
Total			75	
Group B				
Hydrogeology, Environmental Geology Igneous and Metamorphic petrology Viva-voce	30 30 5	5 5	70 5	6
Total			75	
Seminar	10		10	
Geological Tour	20		20	
Mining and Hydrogeological Training	10+10		20	
Total			50	

Grand Total

200

Note: The Examination will be carried out by two sets of examiners- one internal and one external member for each group on two separate days.