M.Sc. Geology **Prospectus No. 20141217**

संत गाडगे बाबा अमरावती विद्यापीठ

SANT GADGE BABA AMRAVATI UNIVERSITY

विज्ञान विद्याशाखा
(FACULTY OF SCIENCE)

अभ्यासक्रमिका
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विज्ञान पारंगत सत्र ३ व ४ परिक्षा २०१४-१५

PROSPECTUS
OF
MASTER OF SCIENCE IN
GEOLOGY
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M.Sc.Part-I (Sem-I to IV)

Prospectus No.20141217

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Syllabus Prescribed for
M.Sc. Semester-I to IV (Geology)

Sr.No.	Paper No.	Name of the Theory Paper	Clock Hrs/week	Marks
Semester-I				
1	I	Mineralogy	4	100 (80+20*)
2	II	Structural Geology and Tectonics	4	100 (80+20*)
3	III	Geochemistry and Analytical Techniques	4	100 (80+20*)
4	IV	Palaeobiology	4	100 (80+20*)
Semester-II				
1	V	Igneous Petrology	4	100 (80+20*)
2	VI	Metamorphic Petrology	4	100 (80+20*)
3	VII	Sedimentology	4	100 (80+20*)
4	VIII	Geomorphology and Field Geology	4	100 (80+20*)
Semester-III				
1	IX	Stratigraphy	4	100 (80+20*)
2	X	Ore Geology and Mining Geology	4	100 (80+20*)
3	XI	Hydrogeology	4	100 (80+20*)
4	XII	Exploration Methods	4	100 (80+20*)
Semester-IV				
1	XIII	Remote Sensing and GIS		100 (80+20*)
2	XIV	Environmental Geology and Engineering Geology	4	100 (80+20*)
3	XV	Indian Mineral Deposits and Mineral Economics	4	100 (80+20*)
4	XVI	Petroleum and Coal Geology	4	100 (80+20*)

***Internal assessment marks for theory paper**

Sr. No.	Practical No.	Practical	Clock Hrs/week	Marks
1	I	Mineralogy and Structural Geology (40+40) + Practical Record (7) + Viva-Voce (5) + Assignment (8)	09	100
2	II	Geochemistry, Palaeobiology (40+40) + Seminar (8) + Practical Record (7) + Viva-Voce (5)	09	100
3	III	Igneous and Metamorphic Petrology (50+30) + Practical Record (7) + Viva-Voce (5) + Seminar (8)	09	100
4	IV	Sedimentology, Geomorphology and Field Geology (30+25+25) + Field Tour & submission of Report (8) + Practical Record (7) + Viva-Voce (5)	09	100
5	V	Stratigraphy, Ore Geology and Mining Geology (25+30+25) + Practical Record (7) + Viva-Voce (5) + Assignment (8)	09	100
6	VI	Hydrogeology and Mineral Exploration (45+25) + Seminar (8) + Practical Record (5) + Viva-Voce (5)	09	100
7	VII	Remote Sensing, Engineering and Environmental Geology (25+25+30) + Practical Record (7) + Viva-Voce (5) + Field Tour & submission of Report (8)	09	100
8	VIII	Project Work (40) + Submission of Report (20) + Presentation (20) + Seminar (8) + assignment (7) + Viva-Voce (5)	09	100

SYLLABUS PRESCRIBED FOR M.SC. PART-I
SEMESTER - I
PAPER - I
MINERALOGY

Unit-I : Chemistry of Minerals : elements, compound, mixture;atoms and molecules, atomic structures ,atomic number, atomic weight, atomicbinding valency, ; Physical, electrical, magnetic and radioactiveproperties of minerals; Silicate structures..

Unit-II : Optical properties of minerals : birefringence, pleochroism,interference figure, order of colours, extinction angle, opticaxis; Uniaxial and biaxial minerals; Optic orientation,disperson and optical anomalies; Optical accessories. and its uses

Unit-III : Systematic mineralogy, atomic structure, mineral chemistry,physical & optical properties, and mode of occurrences of garnet, epidote, pyroxene, amphibole, mica, and feldspar groups.

Unit-IV : Systematic mineralogy, atomic structure, mineral chemistry,physical and optical properties and mode of occurrences of feeldspathoid, quartz, aluminosilicate groups and carbonates, sulphates, oxides minerals etc.

Unit-V : Systematic mineralogy, atomic structure, mineral chemistry, physical properties, optical properties and mode of occurrences of native elements, sulphosalts, phosphates, and hydroxides; Gems and Semiprecious minerals;Radioactive minerals

Books

(1) Deer, W.A., Howie, R.A. and Zussman, J., 1996 : The Rock Forming Minerals, Longman.

(2) Klein, C. and Hurlbut, Jr., C.S., 1993 : Manual of Mineralogy, John Wiley.

(3) Putnis, Andrew, 1992 : Introduction to Mineral Sciences. Cambridge University Press.

(4) Spear, F.S. 1993 : Mineralogical Phase Equillibria and Pressure - Temperature - Time Paths.

Mineralogical Society of America Publ.

(5) Phillips, W, R. and Griffen, D.T., 1986 : Optical Mineralogy, CBS Edition.

(6) Hutchinson, C.S., 1974 : Laboratory Handbook of Petrographic Techniques. John Wiley.ô

(7) L.G. Berry, Brain Mason - Mineralogy 1985 CBS Pub. New Delhi.

(8) Paul E Kerr, Optical Mineralogy 4th Edn McGraw Hill.

(9) E.S. Dana, Text book of Mineralogy 4th Ed 2005

(10) William H. Blackburn, Principles & Mineralogy 1992 Universal book stall.New Delhi.

(11) Gail Kay Haines. The Elements franklin Watts Ltd. London

(12) C.D.Gribble; A.J. Hall Optical Minerology prinnciple & practice 1993 Research press New Delhi.

(13) William E ford Danaj Text book of Minerology 4th Edn CBS New Delhi

(14) Dexter Perkins - Mineralogy 2nd Edn PHI New Delhi

(15) Winchell**, A.N.** Elements of Optical Mineralogy, John Wiley, 1962

PAPER - II
STRUCUTRAL GEOLOGY AND TECTONICS

Unit-I : Deformation: Mechanisms of rock deformation, Theories of rock failure, Behaviour of minerals and rocks under deformation conditions; Stress - Concept of stress, forces and stress, normal and shear stress, stress components, principal stresses, stress trajectories;
Strain - Concept of strain, measurement of strain, principal strain axes and strain ellipsoid, volume changes during deformation, relationship between stress and strain;
Effect of confining Pressure, Temperature, Pore-fluid pressure, and strain rate in rocks.

Unit-II : Faults and fractures: Rock fractures, Fault geometry and nomenclature, Classification, Mechanism of Faulting, Features associated with fault planes, Fault associations, Joints, Thrust system, Extensional fault system, Strike-slip-fault system, Shear zones.

Unit-III : Folds: Fold geometry and nomenclature, Fold orientation, Classification of folds, Mechanism of folding, and Relationship between faults, folds and ductile shears.

Classification of folds based on layer shape, Buckling, Oblique shear or flow folding, Kinking and formation of chevron folds, Foliation, Lineations and fabrics.

Unit-IV : Igneous bodies - Significance of igneous bodies in structural geology, Structures found within igneous bodies, Structural classification of igneous bodies.
Emplacement of igneous intrusions - Dilational emplacement of dikes and sills, emplacement of cone-sheets and radial dikes, Mode of emplacement of large intrusions, Large scale structures.

Unit-V : Tectonics: Major Sturucture of earth - continents and oceans, mountain ranges, oceanic ridges and trenches; Present day tectonic activity; Stable and unstable tectonic zones.
Plate tectonics - Concept of lithosphere plates, nature of plate boundaries- constructive and distructive, subduction Zone, geometry of plate motion, driving mechanism for plate motion.
Seafloor spreading and Plate Tectonics; Island arcs, Oceanic islands and volcanic arcs; Isostasy, orogeny and epeirogeny; Seismicity and plate movements.

Practicals :

Preparation and interpretation of geological maps and sections.
Stereographic projections of structural data.
Study of minor structures in hand specimens.

Books :

(1) Ramsay, J.G. (1967): Folding and fracturing of rocks, McGraw Hill.

(2) Ramsay, J.G. and Huber, M.I. (1983): Techniques of Modern Structural Geology, Vol. I, Strain Analysis, Academic Press.

(3) Ramsay, J.G. and Huber, M.I. (1987): Techniques of Modern Structural Geology, Vol. II, Folds and Fractures, Academic Press.

(4) Ramsay, J.G. and Huber, M.I. (2000): Techniques of Modern Structural Geology, Vol. III (Application of continuum mechanics), Academic Press.

(5) Ramsay, J.G. and Huber, M.I. 1987: Modern Techniques in Structural Geology, Vol.I & II. Academic Press.

(6) Turner, F.J. and Weiss, L.E. (1963): Structural analysis of Metamorphic Tectonites, McGraw Hill.

(7) Billings M. P.: Structural Geology, CBS publication.

(8) Park, R. G. (1989): Fundamentals of Structural Geology.

(9) Paor, D. (1996): Structural Geology and Personal computer, Pergamon Press.

(10) Rowland, S. M. and Duebendorfer, E. M. (1994): Structural Analysis and synthesis, Pergamon Press.

(11) Hatcher, R. D. (1990): Structural Geology principals, concepts and problems.

(12) Ragan, D. M. (1985): Structural Geology ï An introduction to Geometrical Techniques, John Wiley.

(13) Price, N.J. and Cosgrove, J.W. 1990 : Analysis of Geological Structure, Cambridge University Press.

(14) Bayly, B., 1992: Mechanics in Structural Geology : Springer Verlag.

(15) Ghosh S.K. 1995: Structural Geology Fundamentals of Modern Developments, Pergamon Press.

(16) Moores, E and Twiss, R.J. 1995: Tectonics, Freeman.

(17) Keary, P. and Vine, F.J. 1990: Global Tectonics, Freeman.

(18) Storetvedt, K.N., 1997: Our Evolving Planet Birthõs History in New Perspective, Bergen (Norwary), Alma Matter Fortag.

(19) Valdiya, K.S. 1998: Dynamic Himalaya Universities Press, Hydrabad.

(20) Summerfield, M.A. 2000: Geomorphology and Global Tectonics, Springer Verlag.

(21) Badgley, P.C. 1965: Structure and Tectonics, Harper and Row.

(22) Ramsay, J.G. 1967: Folding and Fracturing of Rocks, McGraw Hill.

(23) Hobbs, B.E.Means, W.D. and Williams, P.E. 1996: An Outline of Structural Geology, John Wiley.

(24) Davis, G.R. 1984: Structural Geology of Rocks and Region, John Wiley.

(25) Skinnel B.: Dynamic Earth Introduction to Physical Geology 5Ed.

(26) Condie, Kent. C. (1982): Plate Tectonics and Crustal Evolution, Pergamon Press Inc.

(27) Hobbs, B.E., Means, W.D. and Williams, P.F. (1976): An outline of Structural Geology, John Wiley and Sons, New Delhi.

(28) Gass I.G. (1982): Understanding the Earth. Artemis Press (Pvt) Ltd. U.K.

(29) Windley B. (1973): The Evolving continents, John Wiley and Sons, New York.

PAPER - III
GEOCHEMISTRY AND ANALYTICAL TECHNIQUES

Unit-I : Origin and abundance of elements in the Earth and its constituents. Atomic structure and properties of elements in the periodic table. Special properties of transition and rare earth elements. Distribution coefficients.

Unit-II : Geochemical composition of the Earth. Geochemical classification of elements. Weathering indices Radiogenic isotopes, radioactive decay scheme of U-Pb, Sm-Nd, Rb-Sr, K-Ar.

Unit-III : Growth of daughter isotopes, radiometric dating of single minerals, whole rocks, stable isotopes, nature, abundance. Law of thermodynamics, concept of free energy, fugacity and equilibrium constant.

Unit-IV : Principles of ionic substitution in minerals, elements partitioning in mineral and rock formation. Eh-pH diagram and mineral stability in Eh-Ph diagrams, Geochemical cycle and concept of biogeochemical exploration.

Unit-V : Sampling techniques. Thin section and polished section making. Dissolution procedure in Geological and environmental samples; Principles and geological applications of UV-VIS Spectrophotometry, atomic absorption spectrometry, inductively coupled plasma Spectrophotometry, X-Ray diffraction, scanning electron microscopy, electron microprobe analysis.

Practicals:

Calculation of mineral formulae from the concentration of various oxides in minerals. Calculation of gain and loss in weathering from the chemical analysis of rocks, calculation of weathering indices in soil and sediments, graphic presentation of analytical data.

Books:

(1) Mason, B. and Moore, C.B. 1991 : Introduction to Geochemistry, Wiley Bastern.

(2) Krauskopf, K.B. 1967 : Introduction to Geochemistry, McGraw Hill.

(3) Faure, G. 1986 : Principles of Isotope Geology, John Wiley.

(4) Hoefs, J. 1980 : Stable Isotope Geochemistry, Springer Verlag.

(5) Marshal, C.P. and Fairbridge, R.W. 1999 : Encyclopaedia of Geochemistry, Khuwer Academic.

(6) Govett. G.J.S. (Ed.) 1983 : Handbook of Expleist on Geochemistry : Blsevier.

(7) Nordstorm, D.K. and Munoz, J.L. 1986 : Geochemical Thermodynamics, Blackwell.

(8) Henderson, P., 1987 : Ingorganic Geochemistry, Pergamon Press.

(9) Andre Autheir Dynamical Theo of XRD oxford Press.

(10) Walther, Essentials of Geochemistry, HB Problem 2005

(11) Bloss, F.D. (1971): Crystallography and Crystal Chemistry, Holt, Rinehart, and Winston, New York.

(12) Evans, R.C., (1964): Introduction to Crystal Chemistry, Cambridge Univ. Press.

(13) Klein, C. and Hurlbut, C.S. (1993): Manual of Mineralogy, John Viley and Sons, New York.

(14) Rollinson, H.R. (1993): Using geochemical data: Evaluation, Presentation, Interpretation. Longman U.K.

(15) Shikazono, N. (2003): Geochemical and Tectonic Evolution of Arc-Backarc Hydrothermal Systems - Implication for the Origin of Kuroko and Epithermal Vein-Type Mineralizations and the Global Geochemical Cycle, Eslevier Science

(16) Advances in Analytical Geochemistry, Volume 1, Edited by M. W. Rowe and M. Hyman, JAI Press Inc., Greenwich, Connecticut, U.S.A., (1993)

(17) Modern Analytical Geochemistry [Paperback] Robin Gill (Ed), 1997 Addison Wesley Longman

(18) Encyclopedia of Geochemistry, Marshall, C.P.; Fairbridge, Rhodes W. (Eds.) 1999,XXXVI,714 p.Springer.

PAPER - IV
PALAEOBIOLOGY

Unit-I : Fossil: mode of preservation, physico-chemical condition for Fossilization, types of fossils, significance of fossils; Fossil record and geological time scale, Preparation and nomenclature of fossils, Classification of organisms

Unit-II : Morphology, classification, geological history and evolution of mollusca-bivalve, gastropad, cephatopod; brachiopoda, echinodermata.

Unit-III : Morphology, classification, geological distribution and significance of arthropoda, hemichordata, foraminifera, ostracoda and conodonts; Gondwana flora and its significance; Geological distribution and extinction of dinosaures

Unit-IV : Taphonomy, Limiting environmental factors, Modern concepts of origin of life. Chemical and biological evolution; Precambrian life.

Unit-V : Evolution: Mechanism of evolution - mutation, adaptation, isolation, variation; Species concept and speciation; Palaeontological evidence of evolution;

Practical : Identification and classification of fossils belonging to major phylums.

Books :

(1) Clarkson, E.N.K., 1998 : Invertebrate Palaeontology and Evolution. IV Ed. Blackwell.
(2) Stearn, C.W. & Carrol. R.I., 1989 Palaeontology; The Record of Life, John Wiley.
(3) Smith, A.B., 1994 : Systematics and the Fossils, Record-Documenting Evolutionary Patterns. Blackwell.
(4) Prothero, D.R., 1998 : Bringing Fossils to Life- An Introduction to Palaeobiology, McGraw Hill.
(5) Pomerol, C. 1982 : the Cenozoic Era : Tertiary and Quaternary. Ellis Harwood Ltd.
(6) Goodwin, A.M. 1991 : Precambrian Geology : The Dynamic Evolution of Continental Crust, Academic Press.

M.Sc. PART - I SEMESTER - II
PAPER - V
IGENEOUS PETROLOGY

Unit-I : Study of textures, structures and their genetic significance. Forms of igneous bodies and their mode of emplacement.

Unit-II : Criteria for classification of the Igneous rocks. Norms CIPW and Niggli values - Johanson, IUGS. Petrographic Provinces and associations.

Unit-III : Nature and evolution of magma; Introduction to mantle petrology and mantle metasomatism, Factors affecting magma and evolution of magma, Plate tectonics and generation of magmas,

Unit-IV : Phase equilibrium of single, binary and ternary silicate systems, its relation to magma genesis and crystallization in the light of modern experimental work, Partial melting, Crystal fractionation and Crustal contamination.

Unit-V : Petrogenesis of major igneous rock types such as ultramafic komatiite, basaltic, granitic and alkaline rocks, ophiolites, carbonatite, lamprophyre, and Kimberlites

Practicals: Megascopic and microscopic study of various acidic, basic and ultrabasic igneous rocks with emphasis on crystallization history, occurrence and association. Calculation of CIPW norms for various types of Igneous rocks.

Books:

(1) Best, Myron G. (2002): Igneous and Metamorphic Petrology, Blackwell Science
(2) McBirney, A.R. 1993 : Igneous Petrology; Jones and Barlet Publ.3rd Ed
(3) Bose, M.K. 1997 : Igneous Petrology; World Press.
(4) Perchuk, L.L. and Kushiro, I. (Eds.), 1991 : Physical Chemistry of Magmas, Springer Verlag.
(5) Philipotts, A. 1992 : Igeneous and Metamorphic Petrology, Prentice Hall.
(6) William, Turner and Bilbeat; Petrography - An Introduction to Study of Rocks in Their Sections.
(7) Hatch, Wells and Wells; Petrography of Igneous Rocks. 13 ed.
(8) Hall, A. (1997): Igneous Petrology, Longman
(9) Machenzee and Guilford, Atlas of Rock Forming Minerals in thin Sections.
(10) Cox, K.G., Bell, J.D. and Pankhurst, R.J. (1993): The Interpretation of Igneous Rocks, Champman and Hall, London.
(11) Chatterjee S.C. : Igneous & Metamorphic Petrology
(12) Turner F.J. and Verhoogen : Igneous & Metamorphic Petrology
(13) Ehlers and Bhatt : Petrology - Igneous, Sedimentary and Metamorphic.
(14) Bandentzelt Volcanology 2ed. HB Publish
(15) Bose, M.K. (1997): Igneous Petrology, World Press, Kolkata.
(16) Faure, G. (2001): Origin of Igneous Rocks, Springer.
(17) LeMaitre R.W. (2002): Igneous Rocks: A Classification and Glossary of Terms, Cambridge University Press.
(18) Sood, M.K. (1982): Modern Igneous Petrology, Wiley-Inter science Publ., New York.
(19) Srivastava, Rajesh K. and Chandra, R., (1995): Magmatism in Relation to Diverse Tectonic Settings, A.A. Balkema, Rotterdam.

(20) Wilson, M. (1993): Igneous Petrogenesis, Chapman and Hall, London.

(21) Winter, J.D. (2001): An Introduction to Igneous and Metamorphic Petrology, Prentice Hall, New Jersey.

(22) Ian S. E. Carmichael, Francis 1982 Igneous petrology, Elsevier Scientific Pub. Co.,

(23) Paul C. Hess, 1989,Origins of igneous rocks, Harvard University Press,

(24) Eric A. K. Middlemost, Magmas and magmatic rocks, Longman, 1985 - Nature

PAPER - VI
METAMORPHIC PETROLOGY

Unit-I : Agents of metamorphism, kinds of metamorphism, structure and texture of metamorphic rocks Mineralogical phase rule of closed and open systems. Detailed description of low, medium, high and very high pressures facies.

Unit-II : Characteristic metamorphic zones and subfacies, Nature of metamorphic reactions, Pressure-temperature conditions of metamorphism, Metasomatisam

Unit-III : Isoreaction grid, Schreinmakeôs rule and construction of petrogenetic grids; Metamorphic differentiation.

Unit-IV : Anataxis, Regional metamorphism and paired metamorphic belts in reference to plate tectonics.Origin of migmatites in the light of experimental studies.

Unit-V : Pressure, temperature and time paths; Ultra high temperature, ultra high pressure .Ocean floor metamorphism& its types Shock metamorphism, polymetamorphism

Practicals : Megascopic and microscopic study of metamorphic rocks of different facies. Graphic construction of ACF, AKF and AFM diagrams and their interpretation

Books :

(1) Turner, F.J. 1980 : Metamorphic Petrology, McGraw Hill; New York.

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

(3) Bucher, K. and Frey N. 1994 : Petrogenesis of Metamorphic rocks, Springer-Verlag.

(4) Kretz, R. 1994 : Metamorphic Crystallization, John Wiley.

(5) Philipotts, A. 1992 : Igneous and Metamorphic Petrology, Prentice Hall

(6) Best, M.G. 1986: Igneous and Metamorphic Petrology, CBS Publ.

PAPER - VII
SEDIMENTOLOGY

Unit-I : Process of sedimentation - surface processes and rock weathering, mineral stability and source of sediments; Grain size analysis- phi scale, grain size measurement, sieving technique, settling technique; Graphic presentation of grain size data - histogram, frequency curve, cumulative curve; statistical parameter of grain size - mode, mean, standard deviation, skewness, kurtosis.

Unit-II : Classification and composition of sandstone, limestone, mud rock and conglomerate. Diagenesis of sandstone and limestone. Origin and significance of trace fossils - preservational and behavioral classifications; Classification and significance of sedimentary structures.

Unit-III : Sedimentary environment and facies: alluvial-fluvial, desert, aeolian, glacial, shallow marine and deep marine.

Unit-IV : Palaeocurrent and basin analysis, Stromatolite origin and significance, Heavy mineral analysis, Preparation of litho logs, Rock and thin section staining, Cathodoluminescence, X-ray identification of clay minerals.

Unit-V : Tectonics and sedimentation of sedimentary basin - down warp basin, rift basin, interior basin, foreland basin, sub-duction basin, pull apart basin, delta type of basin, composite basin.

Practicals :

- Petrography and diagenesis of arenaceous, argillaceous and calcareous rocks.
- Identification of important heavy minerals.
- Exercise on granulometric data.

Books :

(1) Allen, J.R.L. 1985 : Principles of Physical Sedimentation, George Allen & Unwin.

(2) Allen, P. 1997 : Earth Surface Processes, Blackwell.

(3) Nichols, G. 1999 : Sedimentology and Stratigraphy, Blackwell.

(4) Reading, H.G. 1996 : Sedimentary Environment, Blackwell.

(5) Davis, R.A. Jr. 1992 : Depositional Systems, Prentice Hall.

(6) Einsele, G., 1992 : Sedimentary Basins, Springer Verlag.

(7) Reineck, H.E. and Singh, I.B. 1980 : Depositional Sedimentary Environments, Springer-verlag.

(8) Prothero, D.R. and Schwab, F., 1996 : Sedimentary Geology, Freeman.

(9) Miall, A.D. 2000 : Principles of Sedimentary Basin Analysis, Springer-Verlag.

(10) Blatt, H., Murray, G. V. and Middleton, R.C. 1980 : Origin of Sedimentary rocks.

(11) Bhattacharya, A. and Chakraborti, C., 2000 : Analysis of Sedimentary Succesions. Oxford-IBH.

(12) Boggs Sam Jr., 1995 : Principles of Sedimentology and Stratigraphy, Prentice Hall.

(13) Sengupta S., 1997 : Introduction to Sedimentology, Oxford-IBH.

(14) Bathurst, R.G.C. (1975) Carbonate Sediments and their Diagenesis, Elsevier Amsterdam 2nd edition

(15) Procedures in sedimentary petrology Carver R.E. (1971)Wiley-Interscience, New York

(16) Microfacies analysis of limestones Flugel, E. (1982) Springer, Berlin

(17) Petrology of sedimentary Rocks, Folk, R.L. (1974) Hemphills, Austin, Texas.

(18) Introductory Petrography of fossils, Horowits, H.S. and Potter, P.E., (1971) Springer, Berlin.,

(19) Sand and Sandston , Pettijohn, F.J. Potter, P.E. and Siever, R., (1973) Springer, Berlin.

(20) Calcareous Algae. Wray, J.L. , (1977) Elsevier, Amsterdam.

(21) Miscellanca- Trace Fossils and Problematica, In Teichert C.(Ed): Treatise on Invertebrate Palaeonotology. Part W. Supplement 1, Hantzschel, W (1975). Goel Soc. Am., New York and Univ. Kans, Press, Lawrence .

(22) Trace Fossils. Crimes, T.P (ed.) (1970) Liverpool: Seal House Press.

(23) Trace fossils-2 Crimes, T.P. and Marper, J.C. (1977) Livcapool: Seal House Press.

(24) Methods for the study of sedimentary structures Bouna, A.H.(1969) Willey Interscience, New York .

(25) Microscopic Sedimentary Petrology, Carozzi, A (1960) John Wiley, New York.

(26) Basics of Physical Stratigraphy and Sedinentology, Pritz, W.J.and MooreJ.N. (1988) John Wiley and Sons, Inc. New York.

(27) Terrigenous Clastic Depositional Systems. Galloway, E.E. and Hobday S.K. (1983) Springer, Verlag, New York.

(28) Mechanics of Sediment Transportation and Aluvial Stream Problems. Garde,R.J. and Ranga Raju, K.G.(1977) (A Halsted Press Book) John Wiley & Jons, Inc. New York.

(29) Facies Models, 2nd ed. Walker, R.G. (ed.) Geol. Assoc of Canada, Toronto, Ont.

(30) Atlas of Quartzs Sand Grain Surface Textures Krinsleym D.H. and Doornkamp, J.C. (1973) Cambridge Earth Science Series, Cambridge Uni., Press New York.

(31) Manual of Sedinientary Petroglaphy . Krumbein, W.C. and Pettijohn, F.J. (1983) Appleton Century Crofts, New York.

(32) Stratigraphy and Sedinentation Krumbein, W.C. and Sloss, L.L (1951) W.H. Freeman and Co., San Francisco 2nd ed. (1963)

(33) Fluvial Processes in Geomorphology, Leapold, L.B. Wolman, M.G. and Miller, J.P. (1964)Freeman, San Francisco.

(34) Fluvial Sedimentology. Miall A.D. (ed) (1978) Canadian society of petroleum Geologists. Calgory.

(35) Principles of Sedimentary Basin Analysis Miall, A.D.(1984) 2nd ed. (1989) Springer, New York.

(36) The Encyclopedia of Sedimentology, Fairbridge, F.W. and Bourgeois Joanne (eds) Dowden, Hutchinron & Ross, Stroudsburg.

(37) Paleacurrent and Basin Analysis. Potter, P.E. and Pettijohn, F.J. (1963), Sorubger- verlag, New York

(38) Sedinentology of shale, Potter P.E. Maymard J.B. and Pryor, W.A. (1980) Springer-verlag New York.

(39) An Introduction to Sedimentology. Selley, R.C.(1976) Academic Press London.

(40) Principles, Methods and Application of Particle size Analysis, Syvitski, J.P.M. (ed.) (1991) Cambridge university press, cambridge.

(41) Physical Processes of Sedimentation. Allen J.R.L. (1970) London: George Allen & Unwin.

(42) Particle Size Measurements. Allen, T (1968). London: Chapnan G Hall.

(43) Principles of Chemical Sedimentology, Berner, R.A. (1971) New York: McGraw- Hill.

(44) Early Diageneris: Theoritical Approach. Berner, R.A. (1980) Princeton, N.J. Princeton Univ. Press.

(45) Salt Deposits. Borchert, H. and Muri R.O. (1969) London : Van Norstrand Reinhold.

(46) Sedimentary structures. Collinson, J.D. and Thompron, D.B. (1982) London, George Allen G Unwin.
(47) Beach and Nearshore Sedimentation, Davis, R.A. and F thington, R.L.(1976) SEPM Soec. Pubn. no.24 Tulsa.
(48) Coastal Sedimentary Environments. Davis, R.A. (ed.) (1978) New York : Springer.
(49) Chemical Oceanography. Riley J.P. and Skerrow, G. (eds). London, Academic Press.
(50) The study of Trace Fossil, Frey, R.W. (1975) Berlin: Springer.
(51) Tidal Deposits. Ginsburg, R.N. (ed.) (1975) Berlin Springer.
(52) Desort Sedimatary Environments. Glennie, K.W. (1970) Amsterdan: Elsevier
(53) Clay Mineralogy, Grim, R.E. (1968) 2nd edn, New York: McGraw-Hill
(54) Nearshore Sediment Dynamics and Sedimentation. Hails, J and Carr, A (eds) (1975). London: Wiley
(55) Introduction to Geochemistry. kraeskpf. K. B. (1979) 2nd edn. New York : McGraw. Hill.
(56) Sedimentary Carbonate Minerals, Lippmann, F (1973) New York : Springer
(57) Recognition of Invertebrate Fossil Fragments in Rocks and Thin Sections. Majewrke, D.P. (1969) Leiden : Brill.
(58) Modern and Ancient Lake Sediments, Matter,W A and M.E. Tucker (eds) (1978) Int. Ass. sed. Spec. Pubn. No,2
(59) Recognition of Ancient Sedimentary Environments, Rigby J.K. and Hanblin W.K. (eds) SEPM Spec. Pubn. No.16
(60) Ecology and palaeoecology of narine environments, Schafer,W (1972) Edinbarg : Oliven & Boyd.
(61) A colour illustraled guide to carbonate rock constituents, textures, cements and porosites. scholle. P.A. (1978) Mem 27, Tulsa, Okla : AAPG.
(62) Fluvial Geomorphology, Morisawa M. (Ed) London, George Allen G., Unwin.

PAPER - VIII
GEOMORPHOLOGY AND FIELD GEOLOGY

Unit-I : Fundamental concepts of geomorphology; Geomorphic agents and processes - exogenetic, endogenetic and extraterrestrial; Rock weathering and mass wasting; Cycle of erosion, rejuvenation and peneplaination, Karst topography.

Unit-II : Fluvial Geomorphology ï Drainage system and pattern; Morphometric analysis- basic principles and techniques of river basin analysis; Stream meandering, River terraces analysis and their significance, Fluvial land forms.

Unit-III : Geomorphic features of India. Arid, eolian, glacial, volcanic and coastal land forms; Ocean floor topography. Principles and applications of GIS in geomorphology.

Unit-IV : **I**mportance and scope of field geology, Study of outcrops, Field observations, Topographic forms, Reconnaissance survey, Topographic maps, Profile section, Interpretation of contour maps, Mapping and analysis of sedimentary, igneous & metamorphic terrains.

Unit-V : Geological surveying, Plane table survey, Use of Brunton compass, Clinometer, Prismatic compass, Abney level, Dumpy level and Thedolite. Air reconnaissance. Air photography & AIV mapping, Stereoscope and stereoscopic vision.

Practical : Exercise on morphometric analysis of river basins. Use of clinometer, Bruton compass. Prismatic compass, Abney level, Dumpy level, Theodolite & Plane table.

Books :

(1) Surveying Vol.-I & Vol.-II, Kanetkar Kulkarni
(2) Surveying, Punmia.
(3) Field Geology - Lahee 1987 CBS Pub New Delhi.

M.Sc. PART-II SEMESTER-III
PAPER-IX
STRATIGRAPHY

Unit-I : Nomenclature and modern stratigraphic code: lithostratigraphy, biostratigraphy, magnetostratigraphy, event stratigraphy, pedostratigraphy, sequence stratigraphy, geochronology and chronostratigraphy.

Unit-II : Stratigraphy, economic significance and correlation of Archaean and Precambrian sequences of Dharwad and Central India, Vindhyan, Cuddapah, Delhi and extra-peninsular part.

Unit-III : Stratigraphy, economic significance and correlation of Mesozoic sequences of India - Triassic of Spiti, Jurassic of Cutch and Rajasthan, Cretaceous of south India. Gondwana Super group including palaeoclimate and flora.

Unit-IV : Stratigraphy, economic significance and correlation of Tertiary group of rocks- Siwalik, Assam and Andaman-Nicobar.

Unit-V : Rise of Himalaya, Precambrian- Cambrian boundary, Permian-Triassic boundary, Age and stratigraphy of Deccan volcanics, Cretaceous-Tertiary boundary.

Practical : Preparation of palaeogeographic and stratigraphic maps of important periods of earth history.

Books :

(1) Boggs, Sam Jr., 1995 : Principles of Sedimentalogy and Stratigraphy, Prentice Hall.
(2) Doyle, P. and Bennett., M.R. 1996 : Unlocking the Stratigraphic Record, John Wiley.
(3) Brenner, R.E. and McHargue, T.R. 1988 : Integrative Stratigraphy : Concepts and Applications, Prentice Hall.
(4) Naqvi, S.M. and Rogers, J.J.W. 1987 : Precambrian Geology of India, Oxford Univ., Press.
(5) Pascoe, E.H.1968 : A Manual of Geology of India and Burma, Vol.I -IV Govt. of India Press.
(6) The Nature of Stratigraphical record. Ager D.V. (1973) London: Macmillan.
(7) Dynamic Stratigraphy, Mathews, R.K. (1974) Englewood eliffs, N.J. Prentice Hall.

PAPER - X
ORE GEOLOGY AND MINING GEOLOGY

Unit-I : Introduction to Ore Geology- Modern concepts of ore genesis; Mode of occurrence of ore bodies. Morphology and relationship of host rock, Wall-rock alteration. Classification of ore deposits. Ore deposits and plate tectonics.

Unit-II : Texture, paragenesis; Paragenitic sequence and zoning of ores. Ore bearing fluids, movement. Origin and migration. Structural, physiochemical and stratigraphic control of ore localization. Chemical composition of ores. Fluid inclusion in ores - principles, assumption, limitation and application.

Unit-III : Trace elements. Rare earth elements. Stable isotopes study of oxygen-hydrogen isotopes, Sulphur isotopes, Carbon isotopes, Radio isotopes; Study of rubidium - strontium, uranium-thorium - lead isotopes.

Unit-IV : Petrological ore association. Orthomagmatic ores of mafic felsic association - diamonds in Kimberlites; chromite; Cyprus type Cu-Zn; Kiruna type Fe-P; Pegmatites, Skarns. Porphyry association. Ores of sedimentary affiliation. Ores of metamorphic affiliation.

Unit-V : Application of rock mechanics in mining. Planning. Exploration and exploratory mining surface and underground mineral deposits. Diamond drilling, shaft sinking, drifting, cross cutting, winzing, stopping, room and pillaring, top-slicing, sub level, caving & block caving. Cycles of surface and underground mining operation. Exploration for placer deposits. Open pit mining. Ocean bottom mining. Types of drilling methods.

Practicals: Megascopic study of structures and fabrics of different ores with their association and uses. Mineralogical and textural studies of common ore minerals under ore-microscope. Exercise on mine sampling and determination of tenor, cut-off grades and ore reserves.

Books:

1. Craig J.M. Vaughan D.J. 1981 : Ok Petrography and Mineralogy. John Wiley
2. Evans AM 1993, Ok Geology and Industrial Mineral Blackwell.
3. Sawakins F.J. 1984 Metal deposits in relation to Plate tectonics, Springer Verlog
4. Stanton R.L. 1972 Ok Petrology. Mc Graw Hill.
5. Torling DH 1981. Economic Geology and Geotactonics, Blackwell Sci.publ.
6. Branes, H.L. (1979): Geochemistry of Hydrothermal Ore Deposits, John Willey.
7. Klamm D. Sch neider H J 1977 Time and Strata Bound ok deposits, Springer Verlog
8. Guel bert J M and Park Jr.C.F. 1986. Te Geology of ore deposits, Freeman Press
9. Mukherjee A. 2000 ok genesis - A Holstic Approach. Allied Publishers.
10. Mc Kinstry HE 1962 Mining Geology IIEd Asia Publishing House
11. Clark GB 1967 Elements of Minng III Ed John Wiley
12. Arogya Swami RPN 1996 Courses in Mining Geology IV Ed Oxford IBH

13. Cuilbert, J.M. and Park,Jr. C.F.(1986): The Geology of Ore Deposits, Freidman.

14. James R. Craig and David J. Vaughan (1994): Ore Microscopy and Petrography.

15. Ramdhor, P. (1969): The Ore Minerals and their Intergowths, Pergamon Press.

16. Wolf, K.H. (1976-1981): Hand Book of Stratabound and Stratiform Ore Deposits, Elsevier Publ..

PAPER - XI
HYDROGEOLOGY

Unit-I : Hydrologic cycle and processes : Groundwater origin, types, importance. Water bearing properties of rocks - porosity, permeability, specific yeild, specific retention, hydraulic conductivity, transmissivity and storage coefficient. Water table contour maps and their interpretation, Flactuation of water table

Unit-II : Groundwater flow - Darcyôs law and its applications, formation constant, flow through aquifers, storage equation, differential equation governing goundwater flow. Evaluation of aquifer properties- aquifer test, confined, semi confined and unconfined aquifers, bounded and leaky aquifers, partially penetrated aquifiers; Water well technology : well types, drilling methods, constrution, design and development of wells.

Unit-III : Quality of ground water - physical and chemical qualities. Presentation of the results of chemical analysis. Diagramatic representation of geochemical data.Quality standard of ground water in domestic, agriculture& industries. Sodium absorption ratio.permeability index, CPHEEO standards for drinking water

Unit-IV : Groundwater exploration - geomorphic and geologic control on groundwater. Groundwater provenances of India. Geologic and hydrologic methods, Surface geophysical methods, Geophysical well logging.

Unit-V : Groundwater development and management groundwater recharge, discharge and balance. Estimation of recharge components. Estimation of groundwater discharge. Groundwater resource evaluation.. Artificial recharge - spreading methods, induced recharge, recharge well method, sub-surface, dams etc. Conjunctive and consumptive use, water logging problems , Rainwater harvesting , Watershed managementt

Practical : Hydrogeology

Well Inventory Data Collection.

Preparation and interpretation of water table counter maps . Fence diagrams, groundwater budgeting. Estimation of Porosity and Permeability. Physical analysis of water. Pumping test, groundwater provinces of India.

Books :

(1) Todd D.K. 1980 : Groundwater Hydrology, John Wiley.
(2) Davies, S.N. & De Weist, R.J.M., 1966 : Hydrology, John Wiley.
(3) Freeze R.A. & Cherry J.A. 1979 : Ground Water, Prentice Hall.
(4) Fetter, C.W., 1990 : Applied Hydrogeology, Merill Publishing.
(5) Raghunath N.M. 1982 : Ground Water, Wiley Eastern.
(6) Karanth, K.R. 1987 : Groundwater Assessment - Development and Management. Tata Mc-Graw Hill.
(7) Alley, W.M. 1993 : Regional Ground Water Quality : VNR, New York.
(8) Subramaniyam, V., 2000 : Water, Kingston Publ., London.
(9) G Matthess, F.H. Frimel. Progress in Hydrogeochemistry Springer Publ
(10) Gunture Faure. Principals in Isotope Geology(1977) Willey
(11) Gautam Mahajan Ground water recharge 1993 Ashish Pub Hs. New Delhi.
(12) W.A. Petty John Introduction to the Artificial Ground water recharge 1988 Scientific Pub Jodhpur
(13) M.L. Sharma Ground water recharge 1987 AA Balkems Austeliya
(14) Chow, V.T., 1988 : Advanced in Hydroscience, McGraw Hill.
(15) Walton, W.C., 1988 : Ground Water Resource Evaluation, McGraw Hill.
(16) Black, W. & others (Ed.), 1989 : Hydrogeology, Geol. Soc. of America Publ.
(17) Mahajan G., 1990 : Evaluation and Development of Ground Water, D.K.Publisher.
(18) Singhal, B.B.S., 1986 : Engineering Geoscience : Savita Prakashan.

(19) Domenico, P.A. & Schwartz F.W. : Physical and Chemical Hydrogeology, John Wiley and Sons.
(20) S.P.Garg Groundwater & Tube wells Oxford & IBH
(21) S M Garg Hydrology & water resource Engn 1996 Khanna Pub. Delhi
(22) Patel A.S. Water Management
(23) Murti J.S. Water Shade Management
(24) Franklin. W.Schawartz 7Hubao Zhang2003 : Fundamental of ground Water Willey Publ.
(25) Sharma R.K., Sharma T.K.2000;Text book of hydrogeology and water resources Enng

Dhanpatraipublications

PAPER - XII

EXPLORATION METHODS

Unit-I : Geological exploration: Prospecting and exploration - Scope of prospecting and exploration. Surface and subsurface methods. Guides for mineral search-physiographic, stratigraphic, lithological, mineralogical and structural Control of ore localization. Pitting, trenching, and drilling for prospecting, diamond and churn drilling. Sampling methods, Calculation of grade and ore reserves.

Unit-II : Electrical methods: resistivity methods - Principles, instruments, field procedures, interpretation and applications. Electromagnetic methods: Principles, instruments, lateral exploration, electromagnetic depth soundings, interpretation and applications. Induced Polarization methods: Principles, Instruments, field procedures, interpretation and applications, self potential method.

Unit-III : Magnetic methods: Principles, instruments, field procedures, reduction of data, preparation of magnetic anomaly maps and profiles, airborne magnetometers, data interpretation and its applications.

Gravity methods: Principles, instruments, field procedures, reduction of gravity datum, gravity anomaly maps, data interpretation and applications.

Well Logging Methods: Classification of well logging methods. Electrical logging - Self potential logging, resistivity logging, induction logging; Radioactivity logging - Sonic logging Interpretations and applications of well logging methods.

Unit-IV : Seismic methods - Refraction methods - principle, instruments equipments; Operational Methods - Fan shooting, arc shooting, profile shooting, correlation method of refracted waves, reduction of data, interpretation of data and applications. Seismic surveys, velocity determination, elevation and weathering corrections, data processing, plotting of depth sections, interpretation and applications.

Unit-V : Geochemical exploration - Geochemical principles - Geochemical cycle, primary and secondary dispersion patterns, geochemical anomalies and background values, geochemical surveys. Biogeochemical prospecting. Geochemical Prospecting for minerals, oil and natural gas.

Practicals:

Problems in interpretation of geophysical logs for geological purpose.

Problems in geological interpretation of geophysical data (gravity, magnetic, electrical, seismic) in mineral exploration.

Problems in geological interpretation of geochemical data in mineral exploration.

Problems on computation of ore reserves and sampling calculations.

Books:

(1) Sharma P.V., 1986 : Geophysical Methods in Geology, Elsevier.
(2) Sharma, P.V. 1997 : Environmental and Engineering Geophysics, Cambridge University, Press.
(3) Vogelsang, D., 1995 : Environmental Geophysics - A Practical Guide, Springer Verlag.
(4) Dobring, M.B. 1976 : Introduction to Geophysical Prospecting, McGraw Hill.
(5) Parasins, D.S., 1975 : Principles of Applied Geophysics, Chapman and Hall.
(6) Stanisalve, M. 1984 : Introduction to Applied Geophysics, Reidel Publ.
(7) Krynine, D.H. and Jdd., W.R. 1998 : Principles of Engineering Geology, CBS Editon.
(8) Arogyaswami, R.P.N. (1996): Courses in Mining Geology, Oxford and IBH Publ.
(9) Bagchi, T.C., Sengupta, D.K., Rao, S.V.L.N. (1979): Elements of Prospecting and Exploration, Kalyani Publ.
(10) Banerjee , P.K. and Ghosh, S. (1997): Elements of Prospecting for Non-fuel Mineral deposits, Allied Publ.

(11) Chaussier, Jean ï Bernard and Morer, J. (1987): Mineral Prospecting Manual., North Oxford Academic.

(12) Dhanraju, R. (2005): Radioactive Minerals, Geol. Soc. India, Bangalore.

(13) Mineral Concession Rules 1960 (2005), IBM, Nagpur.

(14) Rajendran S. (2007): Mineral Exploration: Recent Strategies.

(15) Sinha, R.K. and Sharma, N.L. (1976): Mineral economics, Oxford and IBH Publ.

M.Sc. PART-II SEMESTER - IV
PAPER - XIII
REMOTE SENSING AND GIS

Unit-I : Principles of remote sensing. Electromagnetic spectrum ï characteristics, remote sensing regions and bands; Photogrammetry. Aerial photos ï types, scale, resolution, properties of aerial photos, stereoscopic parallax, relief displacement Remote sensing Satellite. Global and Indian space missions. Image characters and their relations with ground object based in tone, texture and pattern.

Unit-II : Multispectral Sensors : Multispectral remote sensing, multiband cameras, opto-mechanic scanners, modular multispectral scanners, landsat multispectral scanners, thematic mapper, linear imaging self-scanning sensors.

Microwave remote sensing : Microwave radiometer, sidelooking airborne radar, syntheti caperture radar, wind scatterometer, radar polarimetry, radar interferometry.

Unit-III : Digital image processing : Introduction, characteristics of digital images, pixel parameters. Image processing techniques applied to satellite imagery - image reduction, image magnification, image enhancement, contrast enhancement, ratioing, principal component analysis. Filtering techniques - discrete linear operations, spatial smoothing operators, spatial sharpening operators, edge detection. Classification / pattern recognition. Configuration of digital analysis system : Hardware and software - Image processing system. Characteristics of Arc view, Arc info, Map info.

Unit-IV : Geological applications : Image elements - tone, colour, texture, pattern, shape, size, shadows, sites, associations. Terrain elements - drainage patterns, drainage density, landforms, erosion. Remote sensing for lithological

discrimination and geological mapping. Application of thermal remote sensing

in geology - basic concepts, thermal properties of material, atmospheric windows for thermal infrared remote sensing.

Unit-V : Geographical information system : Definition and importance of GIS; Data input and output; GIS data - Types, representation and sources; Data acquisition, verification and editing, georeferencing, GIS data base and data base management system; Spatial data analysis : Terminology, measurement of length, perimeter and area, reclassification, buffering and neighborhood functions, data interpretation map overlay, spatial interpolation, surface analysis, network analysis, digital terrain visualization.

Practical :

Interpretation of aerial photographs and satellite imageries ï Geological structure, lithology, landforms, minerals, soils, groundwater; Application of GIS in geological studies.

Books :

(1) Millerm, V.C. 1961: Photogeology, McGraw Hill.

(2) Sabbins, F.F., 1985: Remote Sensing - Principles and Applications, Freeman.

(3) Ray, R.G. 1969: Aerial Photographs in Geology, Interpretations, USGS Prof. Paper 373.

(4) Drury, S.A. 1987: Image Interpretation in Geology, Allen and Unwin.

(5) Moffit, F.H. and Mikhail, E.M. 1980: Photogrammetry, Harper and Row.

(6) Lillesand, T.M. and Kieffer, R.W. 1987: Remote Sensing and Image Interpretation, John Wiley.

(7) Paine, D.P. 1981: Aerial Photography and Image Interpretation for Resource Management, John Wiley.

(8) Pandey, S.N. 1987: Principles and Applications of Photogeology, Wiley Eastern, New Delhi.

(9) Gupta, R.P. 1990: Remote Sensing Geology, Springer Verlag.

(10) Kang-tsung Chang 2006: Introduction to Geographic Information System, Tata McGraw Hill.

(11) Chandra A.M. and Ghosh S.K. (2006): Remote Sensing & GIS, Narosa Pub. House, New Delhi.

(12) Preben: Future Trends in Remote Sensing, T & F Publishers

(13) Verbyala: Satellite Remote Sensing of Natural Resource, T & F Publisher

(14) Chandra A. M. (2006): Remote Sensing & GIS, Narosa Publising House. Delhi.

PAPER - XIV
ENVIRONMENTAL GEOLOGY AND ENGINEERING GEOLOGY

Unit-I : Concept and principle of environmental geology. land capability classification; Landuse pattern. Assessment of impact of landuse & reclamation of land. Soil : Soil as a resource-nature, profile, origin and classification. Soil conservation, soil weathering; soil degradation and remedial measures. Desertification and degradation of land, causes of desertification, measures to combat desertification. Organic and inorganic cantaminations of ground water and its remedial measures.

Unit-II : Impact of man on environment. Open cast mining & quarring, , Disposal of industrial & radioactive waste, Fertilizer and pesticides. Impact of mining activities on the environment. Environmental impact assessment and management of mining areas, dumping of overburdens. Global warming. Green house effect.

Unit-III : Earthquake and seismic hazards; Origin and severity of earthquake, effects of earthquakes, seismic zones of India. Landslides : Destabilizing forces, Types,. Identification of landslide zones.Controlling landslides - methods for prevention or control of landslides. Floods and Floods Management : Causes of floods ï excess flows, reduced carrying capacity of rivers, runoff verses infilteration, Management of floods - reservoirs, water spreading, groundwater recharge, stream chanalization, flood embankments, hazard zoning and flood forecasting and warnings.

Unit-IV : Engineering Properties and Classification of Rock Masses: Strength characteristics - unconfined compressive strength, uniaxial tensile strength, shear strength, Deformational characters - modulus of elasticity, poisson ratio., Residual stress Engineering classification of rock masses ï Classification based on strength and modulus, rock quality designation, rock structure rating, rock mass rating system, rock quality index system. Susceptibility or rocks towards weathering, test for assessing weathering, Engineering classification of weathered rock masses.

Unit-V : Site Investigation and ground Improvement : Geological investigation, geophysical investigation, drilling and logging. Ground improvement - grouting, types, procedures, grouting applications.

Geology investigation for dams and reservoirs sites : types of dams, forces acting on a dam, geological consideration, geological investigation for site location, seepage problem, silting problem. Geology investigation for tunnel alignment : types of tunnels, geological consideration, geological investigation for tunnel alignment, excavation through blasting, stress distribution during excavation, ground failure in tunnels, tunnel supports. Methods of tunnelling in hard rocks and in Soft soils

Practicals :

Study of maps and models of importance engineering structure as dam sites & tunnels.

Interpretation of geological maps for land slide problems.

Study of properties of common rock with reference to their utility in engineering project.

Physical and chemical analysis of ground water. Piper Diagrams, SAR Problems

Classification of ground water for use in drinking, irrigation in Industrial.

Books :

(1) Valdiya, K.S., 1987 : Environmental Geology - Indian Context. Tata McGraw Hill.
(2) Keller, E.A., 1978 : Environmental Geology, Bell and Howell, USA
(3) Bryant, E., 1985 : Natural Hazards, Cambridge University Press.
(4) Patwardhan, A.M., 1999 : The Dynamic Earth System, Prentice Hall.
(5) Subramaniam, V., 2001 : Text Book in Environmental Science, Narosa International.
(6) Bell, F.G., 1999 : Geological Hazards, Routledge, London.
(7) Smith, K. 1992 : Environmental Hazards, Routledge, London
(8) Vogelsang, D., 1995 : Environmental Geophysics - A Practical Guide, Springer Verlag.
(9) Krynine, D.H. and Judd.W.R., 1998 : Principles of Engineering Geology, CBS Edition.
(10) Reddi MTM A Text Book of Applied Engineering Geology
(11) Goel P.K. Water Pollution - causes, effect & Control

PAPER - XV
INDIAN MINERAL DEPOSIT AND MINERAL ECONOMICS

Unit-I : Process of formation of mineral deposits : magnetic concentration, sublimation, contact metasomatism, hydrothermal, sedimentation, bacteriogenic, submarine exhalative and volcanogenic, evaporation, residual and mechanical concentration, oxidation and supergene enrichment.

Unit-II : Classification of mineral deposit, wall rock alteration; Mineralogy, mode of occurrence, origin, geological association, geographical distribution and use of gold, copper, lead, zinc, aluminum, magnesium, iron, manganese, chromium, nickel.

Unit-III : Mineralogy, mode of occurrence, origin, geological association, geographical distribution and use of atomic minerals, ceramic materials, metallurgical and refractory materials; Industrial and manufacturing materials; Abrasive and abrasion minerals.

Unit-IV : Mineral economics and its concept, Mineral Legislation in India, Economic consideration in mineral exploration, National mineral policy, Mineral processing, Economics of mineral production, Co-products-byproducts of mining and mineral processing, Mineral dressing.

Unit-V : International scenario of mineral wealth; Strategic, critical and essential minerals of India, War minerals, Internal and external mineral trade, consumption and substitution of minerals, economical mineral conservation.

Books:

(1) Sinha and Sharma: Economics Geology

(2) Umeshwar Prasad (1996) : Economic Geology, CBS Publication, New Delhi .

(3) Chatterjee, K. K. ((1993): An introduction to Mineral Economics, Wiley Eastern Limited.

(4) Jain, S. K. (2001): Mineral Processing, PB Publication.

(5) S.K. Babu, D.K. Sinha (1988) - Practical Manual of Exploration & prospecting, CBS New Delhi

(6) A.H.G. Mitchell & M.S. Garson (1981): Mineral Depositor & Global tectonics Setting, Academic press, London.

(7) Danniel Muller David Groves: Pottassic Igncous Rock & Associated Gold Copper Mineralization (3rd Edn Springer)

(8) James R. Graig & David J. Vaughan (1981): Ore Microscopy and Ore Petrology, Wiley Eastern Limited.

(9) G.D.Price N.L. Rose (1992): The Stability of Minerals, Chapman & Hall

(10) U. Aswathanarayana : Principles of Nuclear Geology, Oxonian Press, New Delhi.

PAPER - XVI
PETROLEUM AND COAL GEOLOGY

Unit-I : Petroleum: Origin, chemical composition, Occurrence. Reservoir rocks : general attributes and petrophysical properties. Classification of reservoir rocks-fragmental and chemical reservoir rocks. Reservoir rocks ï petrology, porosity and permeability; Reservoir traps ï structural, stratigraphic and combination traps. Migration of oil and gas: primary and secondary migration.

Unit-II : Hydrocarbon traps: Definition, anticlinal and trap theory, classification of hydrocarbon traps (Structural, stratigraphic and combination), time of trap formation and time of hydrocarbon accumulation, cap rock - definition and general properties. Oil reservoir fluids - water, oil and gas; Oil and source rock correlation.

Unit-III : Prospecting for oil and gas, well drilling methods and logging procedures. Coring and core analysis.

Application of logs in petrophysical and facies analyses. Estimation of oil and gas reserves.

Geology of the productive oilfields of India. Petroliferous basines of India. Onshore and offshore petroliferousbasins of India; future prospects and the economic scenario of Petrolium.

Unit-IV : Coal : Definition and origin of coal; Sedimentology of coal bearing strata. Rank, grade and type of coal. Indian and international classifications. Chemical analysis of coal (proximate and ultimate analysis). Macroscopic ingredient and microscopic constituents, Physical properties of coal.

Coal Petrology and its significance in industrial and geological problems. coal carbonization (coke manufacture), coal gasification and coal hydrogenation.

Unit-V : Coal bed methane : A new energy resource. Maturation of coal and generation of methane in coal beds. Fundamentals of coal bed methane exploration and production. Coal forming epochs in the geological past. Coal as a source

rock for oil and gas; Geological and geographical distribution of coal and lignite deposits in India; Gondwana coals - Classification, Conditions of deposition and petrography. Methods of coal prospecting and estimation of coal reserves. Reserves and production of coal in India.

Books :

(1) North F.K. 1985 : Petroleum Geology, Allen and Unwin.

(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., and Singh, M.P., 2000 : Textbook of Coal (Indian Context), Tara Book Agency, Varanasi.

(4) Singh, M.P. (Ed.), 1998 : Coal and Organic Petrology, Hindustan Publ. Corp., New Delhi.

(5) Stach., E., Mackowsky, M.T.H., Taylor G.H., Chandra, D., Teichmuller, M., and Teichmuller, R., 1982 : Stachôs Text Book of Coal Petrology, Gebruader Borntraeger, Stuttgart.

(6) Holson, G.D. and Tiratsoo, E.N., 1985 : Introduction to Petroleum Geology, Gulf Publ. Houston, Texas.

(7) Tissot, B.P. and Welte, D.H., 1984 : Petroleum Formation and Occurrence, Springer - Verlag.

(8) Selley, R.C., 1998 : Elements of Petroleum Geology, Academic Press.

(9) Durrance,, E.M., 1986 : Radioactivity in Geology. Principles and Application. Ellis Hoorwool.

(10) Boyle, R.W. 1982 : Geochemical Prospecting for Thorium and Uranium Deposits, Elsevier.

(11) Tissat B.P. and Welte D.N., 1984 : Petroleum Formation and Occurrence, Springer Verlag.

(12) Leuerson, 2006: Geology of Petrolium 2nd Ed

(13) Khilyuk Gas Migration : Events Precoding Earthquakes.

(14) Chilingan Geology and Geochemistry of oil and gas. 2005.

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