

**INSTITUTE OF GEOLOGY, UNIVERSITY OF THE PUNJAB
LAHORE**

**REVISED COURSES AND SYLLABI
FOR
M.Phil APPLIED GEOLOGY
(PETROLEUM AND STRUCTURAL GEOLOGY)**

DURATION: 2 YEARS
COURSE WORK: 24 CREDIT HRS
THESIS WORK: 06 CREDIT HRS

Course Code:	Course Title	Credit hrs
FIRST SEMESTER		
GEOL-501	Regional Geology (Core-Course)	03
GEOL-520	Applied Sedimentology	03
GEOL-521	Global Tectonics	03
GEOL-522	Petroleum Structural Geology	03
SECOND SEMESTER		
GEOL-505	Research Methodology and Technical Writing (Core-Course)	03
GEOL-523	Applied Remote Sensing and GIS in Petroleum Geology	03
GEOL-524	Applied Reservoir Geology	03
GEOL-525	Seismic Interpretation	03
GEOL-526	Petroleum Geochemistry	03
GEOL-527	Logging and Log Interpretation	03
GEOL-528	Applied Stratigraphy and Sedimentation	03
GEOL-529	Siliciclastic Sedimentology	03
GEOL-530	Carbonate Sedimentology	03

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COURSE OUTLINE

M.PHIL PETROLEUM AND STRUCTURAL GEOLOGY

Duration: 2 years

Course Work: 24 Credit hours

Thesis Work: 06 Credit hours

FIRST SEMESTER

GEOL-501: REGIONAL GEOLOGY (CORE-SUBJECT, 03 Credit Hours)

The geology of Himalayas, Karakoram and Hindukush ranges. The geology and stratigraphy of the Salt Range, Sulaiman Range and Kirthar Range. The Katawaz Basin. The Makran and adjacent regions. The Chagai and adjacent regions. Ophiolites of the region. The Deccan traps and hot spots. The Geology of Indian Plate.

Books Recommended

1. Geology and tectonics of Pakistan by Kazmi, A.H., Jan, M.Q. (1997), Graphic Publishers, Karachi
2. Geodynamics of Pakistan, by A.Farah and K.DeJong, 1979, Elite Publishers, Karachi, Proceedings of the International Committee on Geodynamics.
3. Geology of Pakistan by Bender and Raza, 1995, Gebruder Borntraeger, Berlin.
4. Reconnaissance Geology of Part of West Pakistan, HSC, 1960.
5. Stratigraphy of Pakistan, S.M. Ibrahim Shah, 1997, GSP Memoir.
6. Stratigraphy of Pakistan, S.M. Ibrahim Shah, 2008, GSP Memoir (2nd Edition).
7. Stratigraphy of Pakistan, by Kazmi and Abbassi, 2008.

GEOL-520 APPLIED SEDIMENTOLOGY (03 CREDIT HOURS)

Sequence Stratigraphy: Concepts, principles and terminology, controls on sedimentary successions, sequences and system tracts, parasequences, facies architecture in shallow marine systems, fluvial systems, deep marine systems, climatic cyclicity, carbonate systems, stratigraphy of divergent motion basins, stratigraphy of convergent motion basins, orbital forcing.

Lab.

Seismic facies and chronostratigraphic diagrams, Changes in sea-level and rates of subsidence, sequences and parasequences, outcrop study-the book cliffs, climatic cyclicity, stratigraphy in tectonically active basins, burial history, the petroleum play and risk assessment, integrated exercises.

Books Recommended

1. Allen, P.A. and Allen, J.R. (1990). Basin Analysis – Principles and Applications, Blackwell Science, Oxford, pages 451.
2. Emery, D. and Myers, K.J., (1996). Sequence Stratigraphy. Blackwell Science, Oxford, pages 297, QE 651, E5.
3. Van Wagoner, J.C., et. al. (1988). An overview of the Fundamentals of Sequence Stratigraphy and key definitions. In. Villgus, C.K., et. al (eds), Sea-Level Changes – An Integrated Approach, S.E.P.M. Special Publication, 42, 39-45.

4. Van Wagoner, J.C., et al., (1990). Siliciclastic sequence stratigraphy in well logs, core and outcrops: Concepts for high resolution correlation of time and facies. A.A.P.G. Methods in Exploration Series, 7, pages 55, QE 539.2.S5V2.
5. Walker, R.G., (1990). Facies modeling and sequence stratigraphy. J. Sedimentary Petrology, 60, 777-786. XER 6997.
6. Jervy, M.T., (1988). quantitative geologic modelling of siliciclastic rock sequences and their seismic expression. In, Wilgus, C.K. et al. (eds.), Sea-Level Changes – An integrated Approach, S.E.P.M. Special Publication, 42, 47-69.
7. Mitchum, R.J. Jr., Van Wagoner, J.c. (1991). High frequency sequences and their stacking patters: sequence stratigraphic evidence for high frequence eustatic cycles. Sedimentary Geology, 70, 131-160.
8. Posamentier, H.W., et al., (1988a). Eustatic controls on clastic deposition I – conceptual framework. In, Wilgus, C.K., et al. (eds.), Sea-Level changes – an integrated approach, S.E.P.M. Special Publication 42, 109-124.
9. Posamentier, H.W., et al. (1988b). Eustatic controls on clastic deposition II – Sequences and systems tract models. In, Wilgus, C.K., et al. (eds.), Sea-Level Changes – An Integrated approach, S.E.P.M. Special Publication, 42, 125-154.
10. Posamentier, H.W., and Allen, G.P. (1993). Variability of the sequence stratigraphic model: effects of local basin factors. Sedimentary geology, 86, 91-109.
11. Posamentier, H.W. and Allen, G.P., (1993). Siliciclastic sequence stratigraphic patterns in foreland ramp-type basins. Geology, 21, 455-488.
12. Reading, H.G. (1996). Sedimentary environments: Processes, facies and stratigraphy. Blackwell Science, pages 688.
13. Vail, P.R., et al., (1977). Seismic Stratigraphy and Global Changes of Sea-Level, Part 3 Relative changes of Sea – Level from coastal onlap. In Payton, C.E. (ed.), Seismic Stratigraphy, Applications to hydrocarbon exploration. A.A.P.G. Memoir, 26, 63-81.
14. Walker, R.G., (1992). Facies Models: Response to sea leve change, Geological Association of Canada, 409 pages. QE 651.W2.
15. Sedimentology and sequence stratigraphy of reefs and carbonates: A short course, 1992. QE 471.15.C352.

GEOL-521 GLOBAL TECTONICS (03 CREDIT HOURS)

PART A:

Plate Tectonics: Introduction; Historical perspective; Continental drift and seafloor spreading; Internal structure of the Earth; Geometry of plate tectonics; Mechanisms and driving forces of plate tectonics, Neotectonics.

Divergent Margins: Structure and petrology of mid oceanic ridges; Petrology and petrogenesis of rift rocks; Mid-Atlantic Ridge; Red Sea Rift; Baikal Rift Zone; East African Rift; East Pacific Rise; Gakkel Ridge; Galapagos Rise; Explorer Ridge; Pacific-Antarctic Ridge and West Antarctic Rift.

Triple Junctions: Types, Afar Triple Junction; junction between the Arabian Plate, the African Plate and the Indo-Australian Plate; Galapagos Triple Junction; triple junction of Mt. Fuji; The North Seatriple junction

Convergent Margins: Structure and metamorphism along subduction zones; Oceanic trenches, volcanic and plutonic activity; Oceanic-continental, Oceanic-oceanic and Continental-continental boundaries. Subduction of the Juan de Fuca Plate beneath the North American Plate; Himalayas; Aleutian Islands; Andes; New Zealand to New Guinea subduction / transform boundaries; the Pontic Mountains; Mariana Trench

Collisions and Orogenic Belts: North American orogenies; European orogenies; Asian orogenies; South American orogenies; African orogenies; Australian orogenies; Antarctic orogenies; New Zealand orogenies

Transform faults: Middle East's Dead Sea Transform fault; New Zealand's Alpine Fault; Pakistan's Chaman Fault; Turkey's North Anatolian Fault; North America's Queen Charlotte Fault; San Andreas Fault; etc.

Continental margins and sedimentary basins: Basin evolution; Implication of plate tectonics; Continental extension and formation of sedimentary basins Ancient continental margins and comparative analysis of their oil-and-gas bearing.

PART B:

Geological framework and Principal geological divisions of Pakistan: Palaeogeographic and geodynamic evolution of Pakistan; Precambrian to Quaternary sedimentary sequence of Pakistan; Igneous and metamorphic rocks of Pakistan; The Chagai and Ras Koh area, The Dalbandin Trough, The Ras Koh Geanticline and Ras Koh-Mirjawa Flysch Belts, The Mashkhel depression, The Makran-Khojak-Pishin Flysch zone, The Makran, Khojak, and Pishin Flysch segment, The Fold and Thrust belts of Pakistan, Indus basin, Tethyan belt, The Sub, Lesser and Higher Himalayas, The KIA complex, The Karakorum block, The Hindu Kush elements.

Books Recommended:

1. Bender, Friedrich and Raza, Hilal A. (2006). Geology of Pakistan, Gebr. Borntraeger Verlagsbuchhandlung, Science Publishers, Stuttgart.
2. Moores, E.M. & Twiss, R.J., (1995). Tectonics, W.H. Freeman and Co.
3. Keary, P. & Vine, F.J., (1996). Global Tectonics, Blackwell.
4. Cox, A. & Hort, R.B., (1986). Plate Tectonics: How It works, Blackwell
5. Windley, B.F., (1984). The Evolving continents, John Wiley & Sons.

GEOL-522 PETROLEUM STRUCTURAL GEOLOGY (03 CREDIT HOURS)

Stress and Strain: Relationship between stress type and orientation of bedding. Deformation mechanisms. Recognition of faults in the field. Thrust fault geometry. Sequence of thrust emplacement. Interaction between successive thrusts. Emergent thrusts and blind thrusts. The basic step thrust. Step thrust geometry. Thin-skinned and thick-skinned thrust structures. Step thrusts in petroleum exploration. Superimposed step faults. Ratio of strike length of a thrust to the amount of its slip. Folded thrust faults and bedding plane faults. Folding and thrusting – which comes first. Major thrust and minor normal faults: The steep limb problem. Duplex structures. Foreland margins of fold and thrust belts. Normal faults: listric normal faults, growth faults. Strike slip faults: Wrench zones, Flower structures and triangle zones. Folds: Introduction. Description and classification (Layer thickness variation and morphological). Mechanics of folding (single and multilayer) Kink bend folds. Folds in foreland fold and thrust belts. Fault bend folds. Fault propagation folds.

Lab.

Understanding contours and topographic maps. Interpretation of geological maps. Interpretation of seismic sections. Use of stereographic projections to solve structural problems.

Books Recommended

1. Davis, G.H. & Reynolds, S.J., (1996). Structural Geology of Rocks and Regions, John Wiley & Sons.
2. Twiss, R.J. & Moores, E.M. (2007). Structural Geology, Freeman.
3. Suppe, J. (1985). Principals of Structural Geology, Prentice Hall.
4. Ramsay J.G. & Huber, M.I., (1983). The Techniques of Modern Structural Geology. V.I. Stress and Strain, Academic Press.

5. Ramsay J.G. & Huber, M.I., (1987). The Techniques of Modern Structural Geology. V.II Folds & Fractures, Academic Press.
6. Applied Concepts of Structural Geology in Hydrocarbon Exploration. OGTI Manual GL-303.
7. Exploration in Fold and Thrust Belts: Principles and Practices. OGTI Manual.

SECOND SEMESTER

GEOL-505: RESEARCH METHODOLOGY AND TECHNICAL WRITING (CORE-SUBJECT 03 Credit Hours)

Background and philosophy of research: concept of research, types of research, elements of research. Types of data for research. Various stages of research, research methods and methodology. Research proposal, selection of a research topic and problems, literature survey, reference collection, hypothesis, mode of approach, actual investigation, results and conclusion, presenting an oral scientific seminar, writing a report, research paper and thesis. Layout of a research report PhD thesis/ M.Phil dissertation. Plagiarism and its professional consequences.

GEOL-523 APPLIED REMOTE SENSING AND GIS IN PETROLEUM GEOLOGY (03 CREDIT HOURS)

Fundamentals of remote sensing, digital image data formats, image rectification and restoration techniques - geometric correction, radiometric correction and noise suppression, image histograms, density slicing, image enhancement techniques contrast manipulation, spatial filtering and edge enhancement, multi-image manipulations spectral ratioing, vegetation indices, principal components analysis, multi-spectral image classification involving supervised and unsupervised algorithms, Recent developments and applications.

Fundamentals of GIS, vector, raster and attribute data models, vector and raster data structure, spatial data input and editing, visualization and query of spatial data, spatial data transformations, spatial analysis, case studies of geological applications, current issues and trends in GIS. Principles of global positioning systems (GPS) and its applications. Some Case Studies in Petroleum exploration.

Lab.

Practical application of remote sensing, GIS in Petroleum Geology, Hands on practice on Arc GIS, IDRISI Software for Petroleum Exploration.

Books Recommended

1. Jensen, J.R. (1996). Introductory Digital Image Processing: a Remote Sensing Perspective, Prentice Hall, New Jersey.
2. Gupta, R.P. (2002). Remote Sensing Geology, 2nd edition, Springer-Verlag, Heidelberg,.
3. Lillesand, T.M. and Kiefer, R.W. (2000). Remote Sensing and Image Interpretation, John Wiley, & Sons, New York,
4. Benhardsen, T. (2002). Geographic Information Systems: an Introduction, John Wiley & Sons, New York,.
5. Bonham-Carter, G.F. (1994). Geographic Information System for Geoscientists Modelling with GIS, Pergamon Press, Oxford,
6. Coburn C. Timothy and Yarus M. Jeffrey (2000). Geographic Information Systems in Petroleum Exploration and Development (AAPG Computer Applications in Geology, No. 4), American Association of Petroleum Geologists.

GEOL-524 APPLIED RESERVOIR GEOLOGY (03 CREDIT HOURS)

Mechanical and chemical compaction, cap rocks (Shales and Salt) – Overpressure, fluid flow in porous media, petrophysics of reservoir rocks (well logs and cores), Stress conditions in reservoirs, fractured reservoirs, reservoir models, production geology, sandstone reservoirs, carbonate reservoirs and several case studies. Gas and Gals condensate.

Lab.

Specified Assignments / Projects

Books Recommended

1. Koederitz, I.F. Heavey., A.H., and Honarpour (1989). Introduction to Petroleum Reservoir Analysis, Contribution in Petroleum / Geology and Engineering-6, Gulf Publishing Co.
2. Muravyor, R. Et. al., (1985) Development and Exploration of Oil and Gas Field, Latest Ed. Peace Publishers, Mosco.
3. North F.D., (1985). Petroleum Geology. Allen & Unwin London.
4. Tearpock. D.J. & Bischke. R.E. (1991). Applied Subsurface Mapping , Prentice Hall.
5. Coss, R., (1993), Basics of Reservoir Engineering Editions Technip.
6. Lake L.W., & Carrol, Jr. H.B., (1986). Reservoir Characterization, Academic Press.
7. Roland., H.N., (1995). Modern Well Test Analysis (A Computer Aided Approach), Petroway.
8. Clayton V., Deutsch, (2002). Geo-Statistical Reservoir Modeling , Oxford University Press.
9. Richard H. Merkel, (1986). Well Log Formation Evaluation, AAPG Course Notes No. 14.

GEOL-525 SEISMIC INTERPRETATION (03 CREDIT HOURS)

Basic Principles of the seismic method and seismic interpretation 2D and 3D seismic reflection data: Introduction, structural and stratigraphic interpretation, reservoir identification and evaluation, horizon and formation attributes visualization. Exercises in structural and stratigraphic interpretation of 2D and 3D seismic data. Vertical seismic profiling. Interactive interpretation of 2D and 3D seismic on work station.

Lab.

Interpretation of various seismic sections, use of software to solve these problems.

Books Recommended

1. C.L. Liner, (2004). Elements of 3D Seismology, Pennwell Corporation, U.S.A.
2. R.E. Sheriff, and L.P. (1995). Geldart, Exploration Seismology, Cambridge University Press.
3. W.M. Telford, L.P. Geldart, and R.E. Sheriff (1990). Applied Geophysics, Cambridge University. Press.
4. M.B. Dobrin, and C.H. Savit, (1988). Introduction to Geophysical Prospecting, McGraw Hill.
5. E.S. Robinson and C. Coruh, (1988). Basic Exploration Geophysics, John Wiley and Sons, New York,
6. G. Nichols, (1999). Sedimentology and Stratigraphy, Bloackwell Science Publisher.

GEOL-526 PETROLEUM GEOCHEMISTRY (03 CREDIT HOURS)

Composition of biogenic matters. Geochemical conditions for the accumulation and formation of hydrocarbons. Generation and composition of petroleum hydrocarbons. Geochemical Assessment of source rocks. Geochemical Assessment of primary and secondary migration. Application of different geochemical prospecting and exploration methods. Geochemistry of oil well water. Biomarker study.

Lab. Specified Assignments/ Projects

Books Recommended

1. Beaumont, E.A. and Foster, N.H., (1988). Geochemistry, AAPG Special Publication No. 08.
2. Bernad B. et al. (1977). Geochemical Model for Characterization of Hydrocarbon Gas Sources in Marine Sediments Latest Ed. Proceeding Nine Offsh Technical Conference, John Wiley and Sons.
3. Chester, R. (1990). Marine Geochemistry, Unwin Hyman, London.
4. Demaison, G.J., (1984). Predictive Source Bed Stratigraphy, Proceedings of Eleven World Petroleum Congress, John Wiley and Sons.
5. Demaison, G.J. and Moonne. G.T. (1984). Petroleum Geochemistry and Source Rock Potential of Carbonate Rocks, AAPG Special Publication.
6. Kantsler, A.J. et. al., (1983). Geochemistry and Basin Evolution, AAPG Memorial No. 35.
7. Levinson, A.A., (1974). Introduction to Exploration Geochemistry (Organic), Latest Ed. Applied Publishing Ltd.
8. B.J. Roy et al. (1981). Advances in Organic Geochemistry by John Wiley and sons.
9. Jim Brooks & Dietrich Welte, (1987). Advances in Petroleum Geochemistry, Vol. 2, Academic Press.
10. Brook, Jim (1981). Organic Maturation Studies and Fossil Fuel Exploration, Academic Press.
11. Philip, R.P., (1985). Fossil Fuel Biomarkers, Applications and Spectra, Elsevier Science Publishers.
12. Miles, J. (1991). Illustrated Glossary of Petroleum Geochemistry, Oxford Science London.
13. Waples, D.W., (1985). Geochemistry in Petroleum Exploration, International Human Resource Development Corporation, Boston, USA.

GEOL-527 LOGGING AND LOG INTERPRETATION (03 CREDIT HOURS)

Introduction, logging environment (pressure / temperature), lithology interpretation form different types of log e.g. gamma ray and spectral gamma ray logs, resistivity logs, sonic or acoustic logs, density and photoelectric log, the neutron log, sequences and depositional environments from logs, determination of value of shale & movable hydrocarbons. C.B.L, F.M.I. caliber log.

Lab.

Quantitative uses of logs. e.g. porosity/ permeability calculation, hydrocarbon/water saturation, shale volume calculation.

Recommended Books

1. M.H. Rider (1999). Geological Interpretation of Well Logs, 2nd Edition, whittles publishing services,
2. Charles Gibbson, and George Asquith (1982). Basic Well Log analysis for Geologist (Methods), American Association of Petroleum Geologists.

GEOL-528 APPLIED STRATIGRAPHY AND SEDIMENTATION (03 CREDIT HOURS)

Stratigraphy, major areas of stratigraphy. Analysis of stratigraphic sequences in the different basins of Pakistan in terms of sequence stratigraphic concepts and higher-resolution interpretation of depositional sequences, significance of unconformities in Neo-proterozoic-phenerozoic sedimentary sequences, And sea level history through time.

Lab.

Two dimensional stratigraphic sections, Recognition of Various stratigraphic surfaces, Stacking patterns of Eustatic / relative sea level changes.

Books Recommended

1. Sam Boggs (2005). Principles of Sedimentology and Stratigraphy, 4th Edition, Prentice Hall.
2. S.M. Ibrahim Shah (2009). Stratigraphy of Pakistan, Memoir 22, Geological Survey of Pakistan (GSP), Quetta, Pakistan.
3. Catuneanu, O. (2006). Principles of Sequence Stratigraphy, Elsevier.
4. Wilgus, B.S. and Other, (1988). Sea-Level Changes an Integrated Approach, Society of Economic Paleontologists and Mineralogists (SEPM).

GEOL-529 SILICICLASTIC SEDIMENTOLOGY (03 CREDIT HOURS)

Sedimentary Structures-I, Sedimentary Structure-II, Techniques in Sedimentary Facies Analysis, The Nature of the Stratigraphic Record, Alluvial Environments-I, Alluvial Environments-II, Aeolian Environments, Lacustrine Environments, Facies Analysis in Non-Marine Environments, Tidal and Estuarine Environments, Clastic Coastal and Shallow Marine Environments, Deltaic Environments, Deep Marine Environments, Glacial and Volcanic Environments, Carbonate Petrology, Diagenesis, Carbonate environments, Plaeocurrent Analysis, Control-I Sea Level and climate, Controls-II Tectonics and Sediment Supply, Linked Depositional Systems.

Lab.

Sedimentary structures, Techniques in Sedimentary facies analysis, Alluvial Facies and facies models, Aeolian and lacustrine facies and facies models, Fieldtrip, Shallow marine environments, Deltas and deep marine environments, carbonate petrology, diagenesis, Palaeocurrents.

Books Recommended

1. Reading, H.G. (1996), Sedimentary Environments: Processes, Facies and Stratigraphy, Blackwell Science, Oxford pages 688.
2. Walker, R.G. and James, N.P. (1992). Facies Models: Responses to Sea-Level Changes. Geological Association of Canada, Ontario, pages 409.
3. Allen, P.A. (1997). Earth Surface Processes. Blackwell Science, Oxford, pages 404.
4. Collinson, J.D. and Thomposon, D.B., (1989). Sedimentary Structures, Chapmanand Hall, London, pages 207.
5. Leeder, M.R. (1999). Sedimentology and Stratigraphy Basins, Blackwell Science, Oxford, pages 592.
6. Nichols, Gary. (1999). Sedimentology and Stratigraphy, Blackwell Science, Oxford, pages 355.
7. Tucker, M.E. and Wright, V.P., (1990). Carbonate Sedimentology. Blackwell Science, Oxford, pages 482.
8. Tucker, M.E. (1996), Sedimentary Rocks in the Field, The Geological Society, London, pages 153.
9. Tucker, M.E. (2001). Sedimentary Petrology, Blackwell Science, Oxford, pages 262.

GEOL-530 CARBONATE SEDIMENTOLOGY (03 CREDIT HOURS)

Introduction: Carbonate Systems; Carbonate sediment and limestone components; The carbonate system; Limestone Classification; Biomineralization--sediment production; Algae; Lime mud and peloids; Constituents of carbonate rocks, skeletal grains: important texture, Cenozoic, Paleozoic, Mesozoic. Corals, sponges, bryozoans, algae, echinoderms (mainly, crinoids, echinoids) stromatoporoids, stromatolites, molluscs (bivalves, gastropods, cephalopods), trilobites, brachiopods, graptolites, foraminifera, coccoliths, ostracods; Constituents of carbonate rocks, non-skeletal grains: ooids, pisoids, oncoliths, peloids and intraclasts; Carbonate platforms; Carbonate shelves; Carbonate Ramps; Carbonate, Evaporite & siliclastic sediment partitioning; Platform Interior Carbonates;

Modern peritidal settings; Peritidal cycles; Modern reefs; Ancient reefs ; Sand shoals; Cool water settings; Deep water settings; Platforms and ramps; Stratigraphy of carbonates; Carbonate geochemistry; Diagenesis: seafloor; Meteoric diagenesis: mineralogical stabilization, Mixing zone diagenesis; Burial diagenesis; Dolomite; modals of dolomitization; Basin analysis; Hydrology of carbonate systems; Porosity development during burial diagenesis; Carbonates and Tectonics; Carbonates as petroleum reservoirs; Sea-level change and sequence stratigraphy Quaternary sea-level

Books Recommended

1. Wilson, J.L., (1975), Carbonate facies in geologic history, Springer, New York, USA.
2. Scoffin, T.P., (1987). Carbonate Sediments and Rocks, Blackwell Publications.
3. Walker, R.G. and James, N.P. (1992). Facies Models: response to sea level change: Geological Association of Canada, Department of Earth Sciences, Memorial University of Newfoundland, Canada.
4. James, N.P. and Choquette, P.W. (1990). Limestones: an introduction: Blackwell Science Publications.
5. Scholle, P.A., (1983). Carbonate Depositional Environments, John Willey & Sons.
6. McIlreath, I.G., and Morrow, D., (1990). Diagenesis, Black Well Science Publications.
7. Scholle, P.A., (1978). A color illustrated guide to carbonate rock constituents, AAPG Memoir 27.
8. Moore, C.H., (1989). Carbonate diagenesis and porosity, Elsevier.
9. Doyle, P., (1998). Understanding fossils: An Introduction to Invertebrate Paleontology, John Willey & Sons, New York, USA.
10. Boardman, R.S., Cheetham, A.H., and Rowell, A.J. (1987). Fossil invertebrates, Blackwell Science.