

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

**COURSES AND SYLLABI
FOR
M.PHIL. APPLIED GEOLOGY
(MINEROLOGY / PETROLOGY)**

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-SUBJECT)	03
GEOL-502	IGNEOUS PETROGENESIS	03
GEOL-503	APPLIED GEOCHEMISTRY	03
GEOL-504	GEOLOGY AND TECHNOLOGY OF INDUSTRIAL ROCKS & MINERALS	03
SECOND SEMESTER		
GEOL-505	RESEARCH METHODOLOGY AND TECHNICAL WRITING (CORE-SUBJECT).	03
GEOL-506	INDUSTRIAL MINERALOGY	03
GEOL-507	ORE GEOLOGY MINING AND PROCESSING	03
GEOL-508	METAMORPHIC PETROGENESIS	03
GEOL-509	METALLOGENY AND PLATE TECTONIC	03
GEOL-510	ADVANCE INSTRUMENTAL TECHNIQUES AND PHYSICAL PROPERTIES	03

INSTITUTE OF GEOLOGY UNIVERSITY OF THE PUNJAB, LAHORE**COURSE OUTLINE****M.PHIL APPLIED GEOLOGY
(MINERALOGY / PETROLOGY)****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 Abbasi, 2008.

GEOL: 502 IGNEOUS PETROGENESIS (03 CREDIT HOURS)

Magmatic evolution. Fractionation in magmas. Classification of Igneous Rocks Mode, shaval IUGS etc. Convection and mixing in magma chambers. Contamination. Mixing of magmas. Hybridization. Assimilation. Partial melting. Phase Rule. Binary, Ternary, Albite-anorthite and forsterite-fayalite. Variation diagrams. Ternary diagrams (One system) Trace element fractionation by Magma. Basalts. Basalt petrogenesis in relation to tectonic environments. Alpine peridotites. Serpentinization. Ophiolites. Semail ophiolite. Troodos ophiolite. Ophiolites of Pakistan. Kimberlites. Lamprophyres. Layered intrusions. Texture of Igneous rocks, Igneous rocks of various tectonic setting.

Books Recommended

1. Le Maitre, R.W., Streckeisen, A., Zanettin, B., Bas, M.J Le., Bonin, B. and Bateman, P., 2005. Igneous Rocks: A classification and glossary of terms, Recommendations of the International Union of Geological Sciences Sub-Commission on the Systematics of Igneous Rocks, 2nd Edition, Cambridge University Press, U.K.
2. Raymond, L.A., 2002. Petrology, McGraw Hill.
3. Myron, G., 2002. Igneous and Metamorphic Petrology, John Willey & Sons, U.K.
4. Geoffrey, F.D. 2000. Dynamic Earth: Plates, Plumes and Mantle Convection, Cambridge University Press, U.K.
5. Blatt, B., and Tracy, R., 1995. Petrology, 2nd Edition: Igneous, Sedimentary and Metamorphic, W.H. Freeman & Co., U.K.

6. Wilson, M., 1989. Igneous Petrogenesis, Unwin Hyman, London, U.K.
7. Morse, S.A., 1980. Basalts Y-Phase Diagram, Springer-Verlag, New York, USA.

GEOL-503: APPLIED GEOCHEMISTRY (03 CREDIT HOURS)

Variation diagrams. Geochemistry as petrogenetic indicator. Trace elements and rare earth elements geochemistry. General chemical properties and abundances of rare earth elements. Meteorites, their classification, mineralogy and composition. Use of rare earth elements in meteorites as reference standards. Use of geochemistry in mineral exploration. Presentation of chemical data of rock and mineral analyses. Eh-pH diagrams. Various types of chemical surveys. Primary and secondary dispersion of elements. Introduction of environmental geochemistry.

Books Recommended

1. Sharp, Z., 2006. Principles of Stable Isotope Geochemistry, 1st Edition, Pierson, Prentice Hall, New Jersey, USA.
2. Denis, M.S., 2006. Trace Elements in Magmas: A Theoretical Treatment, Cambridge University Press, U.K.
3. John, V.W., 2005. Essentials of Geochemistry, Jones & Bartlett; USA.
4. Albarede, F., 2003, Geochemistry an Introduction, Cambridge University Press, U.K.
5. Faure, G., 1998. Principles and Applications of Geochemistry, Prentice Hall, USA.
6. Krauskope, 1995. Introduction to Geochemistry, McGraw Hill & Co.
7. Holloway, J.R., 1988. Simulating the Earth: Experimental Geochemistry, Springer-Verlag, New York, USA.

GEOL-504: GEOLOGY AND TECHNOLOGY OF INDUSTRIAL MINERALS AND ROCKS (03 CREDIT HOURS)

Geological setting, mineralogy, important properties, beneficiation, search methods and uses of Sands and gravels, hard Rock aggregates, Dimension stone, Slate, Limestone, Magnesite, Common clay and shale, Kaolinite, Bentonite and Fuller, Earth, Silica sand, Heavy mineral sands, Dunite and serpentinite, Feldspars, Nepheline syenite, Natural abrasive materials, Cement raw materials, Gypsum, chromite, Fluorite, Barite and Gemstones, including diamond.

Books Recommended

1. Wenk, H.R. and Bulakh, 2004. Minerals: Their constitution and origin, Cambridge University Press, U.K.
2. Kazmi, A.H. & Abbas, S.G. 2001. Metallogeny and Mineral Deposits of Pakistan, Orient Petroleum, Pakistan.
3. Jan, M.Q. and Kazmi, A.H., 1997. Geology and Tectonics of Pakistan, Graphics Publishers, Karachi, Pakistan.
4. Bender and Raza, 1995. Geology of Pakistan, Gebruder Borntraeger, Berlin.
5. Ahmad, Z., and Siddiqui, R.A., 1992. Mineral and Rocks for Industries, Geological Survey of Pakistan (G.S.P).
6. Ahmad, Z., 1969. Directory of Mineral Deposits of Pakistan, Geological Survey of Pakistan (G.S.P).
7. Lefond, S.J. et al. (1983). Industrial Minerals and Rocks, Vol. 02, American Institute of Mining, Metallurgical and Petroleum Engineers, USA.
8. Collis, L. and Fox, R.A. 1985. Aggregates: Sand, Gravel and Crushed Rock aggregates for Construction Purposes. Engineering Geology, Special Publication, Geological Society of London, U.K.
9. Harben, P.W. and Bates, R.L. 1990. Industrial Minerals: Geology and World deposits. Industrial Minerals Division, Metal Bulletin Plc. London, U.K.
10. P.W. Scot (1988). Extractive Industry Geology 1985, Geological Society, Miscellaneous Paper No. 18.
11. Ryan, W. and Radford, C. 1987. Whitewares: Production, Testing and Quality Control. Pergamon Press, Oxford, UK.

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-506: INDUSTRIAL MINERALOGY (03 CREDIT HOURS)

Geology, occurrence, properties and uses of clays, ceramic materials, construction materials, sand, gravel and lightweight aggregates, gypsum, anhydrite, lime, limestone, magnesite, pigments and filters, fluorspar, graphite, refractories, asbestos, mica, talc, barite, glass sands, potash, sulphur and abrasives. Occurrence, distribution and utilization of industrial minerals deposits in Pakistan.

Books Recommended

1. Wenk, H.R. and Bulakh, 2004. Minerals: Their constitution and Origin, Cambridge University Press, U.K.
2. Kazmi, A.H. & Abbas, S.G. 2001. Metallogeny and Mineral Deposits of Pakistan, Orient Petroleum, Pakistan.
3. Jan, M.Q. and Kazmi, A.H., 1997. Geology and Tectonics of Pakistan, Graphics Publishers, Karachi, Pakistan
4. Bender and Raza, 1995. Geology of Pakistan, Published by Gebruder Borntraeger, Berlin, Germany.
5. Klein, C., 1993. Manual of Mineralogy 21st Edition, John Willey & Sons, Inc.
6. Blackburn, 1992. Principles of Mineralogy, William C. Brown.
7. Ahmad, Z., and Siddiqui, R.A., 1992, Mineral and Rocks for Industries, Geological Survey of Pakistan (G.S.P.).
8. Ahmad, Z., 1969. Directory of Mineral Deposits of Pakistan, Geological Survey of Pakistan (G.S.P.).

GEOL-507: ORE GEOLOGY, MINING AND PROCESSING (03 CREDIT HOURS)

Formation of minerals deposits and their classification. Distribution of ore deposits in relation to plate tectonics. Introduction geophysical exploration and survey technique. Ore reserve calculations. Mining methods and machinery. Ore dressing, physical and chemical beneficiation of ores. Environmental aspects of mining processing of ores. Important industrial minerals and their applications. Mineral potential of Pakistan.

Books Recommended

1. Robb, L., 2005, Introduction to Ore forming Processes, Blackwell Science Ltd. U.K.
2. Smirnov, V.I. and Creighton, H.C., 2001. Geology of Mineral Deposits, New Chand and Bros, India.
3. Evans, A.M., 1997. An Introduction to Economic Geology & its Environmental Impacts, John Willey & Sons Inc.
4. Evans, A.M., 1993. Ore Geology and Industrial Minerals, Blackwell Science, Oxford, U.K.
5. Barnes, J.W., 1988. Ore and Minerals, Open University Press, USA..
6. Sawkins, F.J., 1984. Metal Deposits in Relation to Plate Tectonics, Springer-Verlag, New York, USA.
7. Evans, A.M., 1987. An Introduction to Ore Geology, Blackwell Scientific.
8. Edward, R. and Atkinsons, K., 1986, Ore Deposit Geology, Chapman and Hall.

9. Mitchell, A.H.G. and Garson, M.S., 1981. Mineral Deposits and Global Tectonic Setting Academic Press.

GEOL- 508: METAMORPHIC PETROGENESIS (03 CREDIT HOURS)

Field relation of metamorphic rocks. Deformation, fabric, structures and textures of metamorphic rocks. Measurement of metamorphic structures. Metamorphic rocks of the ocean floor. ACF and AFM diagrams. The concept of metamorphic facies. Facies of regional metamorphism. Facies of contact metamorphism. Cataclastic metamorphism. Metasomatism. Metamorphic complexes of Pakistan. Paragenesis of Metamorphic Minerals. Geothermometry & Geobarometry.

Books Recommended

1. Fettes, D. and Desmons, J., 2007. Metamorphic Rocks: A classification and Glossary of Terms, Recommendations of the International Union of Geological Sciences Sub-Commission on the Systematics of Metamorphic Rocks, Published by Cambridge University Press, U.K
2. Myron, G., 2002. Igneous and Metamorphic Petrology published by John Willey & Sons, U.K.
3. Raymond, L.A., 2002. Petrology, McGraw Hill.
4. Bucher, K. and Frey, M. 2002. Petrogenesis of Metamorphic Rocks, Springer-Verlag, Berlin Heidelberg, New York, USA.
5. Blatt, H. and Tracy, R., 1995. Petrology, 2nd Edition: Igneous, Sedimentary and Metamorphic, W.H. Freeman & Co.
6. Bucher, K. and Frey, M., 1994. Petrogenesis of Metamorphic Rocks, Springer-Verlage, New York.
7. An Introduction to Metamorphic Petrology by Yardley, B., 1989, Longman Earth Science Series Longman Scientific & Technical, U.K.
8. Metamorphic Petrology by Francis, J. and Turner, 1981, Hemisphere Publishing Corporation.
9. Miyashiro, A. 1973. Metamorphism and Metamorphic Belts, George Allen & Unwin.

GEOL-509: METALLOGENY AND PLATE TECTONIC (03 CREDIT HOURS)

Genesis, occurrence and important features of deposits of chromite, platinum group elements, gold and uranium deposits. Important features of porphyry deposits, Cu-Ni-Fe deposits, volcanic hosted massive sulphide deposits, Mississippi valley type deposits, carbonatites, greisen deposits, skarn deposits and placer deposits. Occurrence, distribution and utilization of metallic mineral deposits in Pakistan.

Books Recommended

1. Smirnov, V.I. and Creighton, H.D., 2001, Geology of Mineral Deposits, New Chand and Bros., India.
2. Kazmi, A.H. and Abbas, S.G., 2001. Metallogeny and Mineral Deposits of Pakistan, Orient Petroleum, Pakistan.
3. Jan, M.Q. and Kazmi, A.H., 1997. Geology and Tectonics of Pakistan, Graphic Publishers, Karachi.
4. Necrosov, I., 1996. Geochemistry, Mineralogy and Genesis of Gold Deposits, Taylor & Francis, UK.
5. Bender and Raza, 1995. Geology of Pakistan, Gebruder Borntraeger, Berlin.
6. Park and Freeman, D., 1995. Geology of Ore deposits, W.H. Freeman & Co.
7. Evans, A.M., 1993. Ore Geology and Industrial Minerals, Blackwell Publishers.
8. Ahmad, Z., and Siddiqui, R.A., 1992. Mineral and Rocks for Industries, Geological Survey of Pakistan (G.S.P.).
9. Evans, A.M., 1988. An Introduction to Ore Geology, 2nd Edition, Blackwell Scientific Publication
10. Ahmad, Z., 1969. Directory of Mineral Deposits of Pakistan, Geological Survey of Pakistan.

GEOL-510: ADVANCE INSTRUMENTAL TECHNIQUES AND PHYSICAL PROPERTIES (03 CREDIT HOURS)

Introduction, instrumentation and production of X-rays. The interaction of X-rays with matter, X-ray dispersion and detection, X-ray diffraction, X-ray fluorescence, Emission spectroscopy, Atomic Absorption Spectrometry, Atomic Emission Spectrometry, Infra-red absorption. Scanning Electron Microscopy, Transmission Electron Microscopy Inductively coupled plasma spectrometry. MS Spectrometer. Electron Microprobe. Thermal analysis (DTA/TG).

Discussion and application of the theory to the following methods of determining the physical properties of geological material: Powder and particle size measurements (sieving and sedimentation), density / SG, and automated methods (Coulter counter), surface area measurement (gas absorption, permeability, and BET equation), colour measurements (colour specifications, spectrometric curves).

Books Recommended

1. Williams, K.L, 1987. Introduction to X-ray Spectrometry, Allen and Unwin, London, U.K.
2. Jenkins, R., 1986. Introduction to X-ray Spectrometry, John Wiley and Sons, New York, USA.
3. Nuffield, E.W., 1966. X-ray Diffraction Methods, John Wiley and Sons, New York, USA.
4. Gamna, R., John, S., Adams and Gasparini, P., 1970. Spectrometry of Rocks, Elsevier Publishing Company. Amsterdam, London, U.K.
5. Allman, M. and Lawrence, D.F., 1972, Geological Laboratory Techniques, Arco Publishing Company Inc. New York, USA.
6. Moore and Reynolds (1986). XRD and the identification and analysis of clays Minerals, Oxford University Press, UK.