



St. Xavier's College Mumbai

Syllabus For B.Sc Vth Semester Courses in Geology (June 2016 onwards)

- Contents:
- Theory Syllabus for Courses:
 - S.Geo.5.01 – Precambrian Geology of India
 - S.Geo.5.02 – Igneous Petrology
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 - S.Geo.5.04 – Metamorphic Petrology
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- Practical Course Syllabus for: S.Geo.5. PR and S.Geo.5.AC.PR
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T.Y. B.Sc. Geology
Title: Precambrian Geology of India

Course: S.Geo.5.01

Learning Objectives:

1. To bring about an understanding of the principals of Stratigraphy.
2. Understand the Precambrian Stratigraphy of India.

Number of lectures: 60

Unit 1

Introduction

(15 lectures)

Earth's Crustal Structure and Tectonic framework of India- Cratons.

Tectonic Elements of Continents & Oceans.

Tectonic Divisions of India.

Indian Cratons:

Dharwar Craton,
Bastar Craton,
Singhbhum Craton
Aravalli Craton

Unit 2

Proterozoic History

(15 lectures)

Proterozoic Sedimentary Basins:

Vindhyan Basin,
Delhi Basin
Cuddapah & Kurnool Basins.
Kaladgi Basin.

Unit 3

Mobile Belts

(15 lectures)

Proterozoic Eastern Ghat Mobile Belt

Marginal & Transition Zone

Western Charnockite Zone

Western & Eastern Khondalite Zone.

Satpura Mobile Belt

Central Indian Tectonic Zone

Sausar, Mahakoshal & Betul Supracrustal Belts.

Unit 4

Precambrians of Extra – Peninsula

(15 lectures)

Precambrian of Himalaya (Lesser & Higher Himalayas)

Precambrian of the Tethyan Basement

Salkhala Group

Vaikrita Group

Jutogh Group

Daling Group

Precambrians of the Lesser Himalaya

Western Sector

Central Sector

Eastern Himalaya

List Of Recommended Reference Books

1. Dasgupta, A. (2010) Phanerozoic Stratigraphy of India; World Press, Kolkata.
 2. Ramakrishnan, M. and Vaidhyanadhan, R. (2010) Geology of India - Vol. 1, Geological Society of India, Bangalore.
 3. Vaidhyanadhan, R. and Ramakrishnan, M. (2008) Geology of India - Vol. 2, Geological Society of India, Bangalore.
 4. Prasad, C.V.R.K. (2005) Elementary Exercises in Geology; Universities Press (India) Pvt. Ltd, Hyderabad.
 5. Directorate of Geology and Mining, Nagpur. (2000) Geology and Mineral Resources of Maharashtra.
 6. Deshpande, G.G. (1998) Geology of Maharashtra; Geological Society of India, Bangalore.
 7. Kumar, R. (1996) Fundamentals of Historical Geology and Stratigraphy of India, 4th ed., New Age International (P) Limited, Publishers.
 8. Lemon, R.R. (1990) Principles of Stratigraphy; Merrill Publishing Company, Ohio.
 9. Wadia, D.N. (1984) Geology of India, 4th ed., Tata McGraw-Hill Publishing, New York.
 10. Krishnan, M.S. (1982) Geology of India and Burma; 6th Ed. CBS Publishers & Distributors (India).
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Practical:

Stratigraphy and Geology of India

- I) Study of common sedimentary, igneous and metamorphic rocks in Hand specimen from different stratigraphic horizons.
- II) Diagrammatic examples of Lithostratigraphic boundaries and classification.
- III) Study of Geological maps with geological history of the area in chronological order.
- IV) Problems:
 - a) Stratigraphic sequence from geological section.
 - b) Characteristics of a Fold & Fault from a geological map.
 - c) Stratigraphic Boundary Problem.
 - d) Understanding Precambrian Geological Time Scale.

T.Y. B.Sc. Geology

Course: S.Geo.5.02

Title: Igneous Petrology

Learning objective:

To provide students a systematic approach in understanding the origin of igneous rocks, nomenclature, classification and their association with particular tectonic settings.

Number of lectures: 60

Unit-1

(15 lectures)

The Interior of the Earth:

Evidence of the Earth's Composition and Mineralogy: Seismic data, The Geothermal Gradient, Meteorites, Xenoliths.

Mantle Petrology; Low Velocity Zone, Pressure and Temperature variations with Depth and high pressure experimentation.

Classification and Description of Igneous Rocks:

The IUGS Classification System, Other aspects of classification; Chemical Classification;

Textures of Igneous rocks,

Crystallinity, Granularity, Shape of Crystals and Mutual Relations.

Equigranular, Inequigranular, Directive and Intergrowth Textures.

Terms related to some specific Textures and Microstructures : Perlitic Cracks, Spherulites, Orbicular Structure, Rapakivi Structure, Zoned Crystals, Xenocrysts, Quench Texture, Crystal Pseudomorph, and Cumulus Crystals.

Characters of the Common Igneous Rocks: Plutonic and Volcanic types; Examples of Common Igneous Rock Types and their Indian Occurrences.

Unit 2

(15 lectures)

The Phase Rule and crystallization and melting relations in one, two and three component Systems:

Melting Behavior of Natural Magmas, Phase Equilibrium and The Phase Rule, One Component Systems, Two Component (Binary Systems) and Its Petrogenetic Significance.

Binary Systems with Complete Solid Solution, Binary Eutectic Systems, Binary Peritectic Systems, the Alkali Feldspar System,

Ternary Systems:- Ternary Eutectic Systems, Ternary Systems with Solid Solution

Reaction Series, The Effect of Pressure and Fluid on Melting Behavior. The effects of Pressure on the Melting and Crystallization of Magma; Time and Crystallization; Rock Types and Mode of Occurrence.

Unit 3

(15 lectures)

The Evolution of Magmas:

Differentiation: Fractional Crystallization; Other Differentiation Mechanisms.

Magmatic Mixing and Assimilation.

Melting of the Mantle, Partial Melting, Magma Generation and Differentiation.

Generation of Basaltic magma from a Chemically Uniform Mantle.

Unit 4

(15 lectures)

Brief study of Plate tectonic settings and associated igneous rocks.

Subduction –Related Activity: Island Arc Volcanism, Rocks and Magma Series, The Ophiolite Suite; Calcalkaline and Tholeiite Groups; Petrogenesis of Island Arc Magmas, Plutonic Rocks – Batholiths related to subduction zones.

Gabbroic Layered Intrusions; Anorthosites; Alkali Basalts and Nephelinites; Carbonatites, Kimberlites and related Rocks.

List Of Recommended Reference Books

1. Bose M.K. (1997), Igneous Petrology. The World Press Pvt. Ltd. 568 p.
2. Bowen N.L. (1928), The evolution of Igneous Rocks. Princeton Univ. Press. N.J 332 p.
3. Hall A. (1987), Igneous Petrology. Longman. 573p.
4. Hatch F.H., Wells A.K and Wells M.K. (1984), Petrology of the igneous rocks. CBS Publishers, 551 p.
5. Philpotts A.R. (1994), Principles of igneous and metamorphic Petrology, Prentice Hall of India. 498p.
6. Turner F.J & Verhoogen J. (1951), Igneous and Metamorphic Rocks, McGraw Hill.
7. Williams H, Turner F.J & Gilbert C.M. (1955), Petrography. San Francisco: W.H. Freeman and company. 406p
8. Winter J. D. (2001), an Introduction to Igneous and Metamorphic Petrology, Prentice Hall, 697p.
9. Ehlers, E.G. and H. Blatt (1982), Petrology, Igneous, Sedimentary and Metamorphic, W.H Freeman, San Francisco.
10. Philpotts A. R. (2009), Petrography of Igneous and Metamorphic Rocks, Cambridge University Press, 686p.

Practical Course:

Megascopic identification and Petrography of Igneous Rocks

Igneous Textures.

Equigranular:

- a. Coarse –grained, Holocrystalline, Panidomorphic.
- b. Coarse –grained, Holocrystalline, Hypidiomorphic
- c. Medium –grained, Holocrystalline, Hypidiomorphic
- d. Fine –grained, Holocrystalline, Panidomorphic. (Orthophyric)
- e. Fine –grained, Holo/ Hemicrystalline, Hypidiomorphic
- f. Fine-grained, Holocrystalline, Allotriomorphic (Aplitic)
- g. Fine- grained, Hemicrystalline, Aphanitic, (Felsitic)
- h. Fine –grained, Holohyaline, Aphanitic

Inequigranular:

- a. Coarse/Medium/Fine, Holo/Hemicrystalline, Porphyritic
- b. Coarse/Medium/Fine, Holo/Hemicrystalline, Glomeroporphyritic
- c. Coarse/Medium, Holo/Hemicrystalline, Ophitic/ Subophitic
- d. Medium/ Fine, Holo/Hemicrystalline, Poikilitic
- e. Medium/Fine, Holocrystalline, Intergranular
- f. Medium/Fine, Hemicrystalline, Intersertal

g. Medium/Fine, Intergranular-cum-ophitic (Ophimottling)

Directive:

a. Fine, Hemicrystalline/Holohyaline, Banded (Fluidal)

b. Fine, Hemicrystalline, Trachytic

Intergrowth:

a. Graphic/Micrographic

b. Perthitic

c. Granophyric

Igneous Mega-Structures

1. Vesicular/ Amygdaloidal Lava

2. Blockery/ Clinkery Lava

3. Ropy Lava Surface

4. Columnar Joint Block

5. Flow Banding

6. Glomeroporphyritic Clusters

7. Intrusive Contacts and Xenoliths

Igneous Micro-Structures

1. Reaction: (a. Corona, b. Myrmekite)

2. Xenolithic

3. Spherulitic/ Variolitic

4. Perlitic Fracture

Study of the Texture, Mineral composition, Mode of occurrence, and Association of the following Rock Types.

1. Granite

2. Rhyolite

3. Pegmatite

4. Aplite

5. Quartz porphyry

6. Pitchstone

7. Obsidian

8. Syenite (Hornblende / Biotite)

9. Trachyte

10. Feldspar porphyry

11. Nepheline Syenite

12. Diorite

13. Gabbro

14. Norite

15. Dolerite

16. Basalt (Vesicular/ Non- Vesicular/ Porphyritic, Amygdaloidal)

17. Picrite

18. Peridotite

19. Dunite

20. Anorthosite

21. Carbonatite

T.Y.B.Sc Geology

Course: S.Geo.5.03

Title: Structural Geology

Learning Objectives:

To understand the concept of stress and strain and how rock behaves under different stress regimes. A detailed study of various geological structures i.e. Joints, Folds and Faults

Number of lectures: 60

Unit 1

(15 lectures)

Introduction, Types of Structures, Stress, Strain, Measurements of Stress and Strain, Mechanical Behaviour of Rocks

Introduction and Review

Structures and Structural Geology

Fundamental Concepts

Stress

Definitions

Stress on a Plane

Stress at a Point

Mohr Construction

Mohr's Hypothesis

Stress Ellipsoid

Strain

Definitions

Kinds of Strain

Strain Ellipsoid

Mohr Circles for Strain

Simple and Pure Shear

Measurement of Strain in Rocks

Kinds of Strain

Strain Markers

Flinn Diagram

Mechanical Behavior of Rock Materials

Elastic (Hooken) Behavior

Permanent Deformation – Ductility

Controlling Factors

Unit 2

(15 lectures)

Study of Structures I: Joints and Faults

Joints and Shear Fractures

Griffith and Coulomb theory of fractures

Joints and Fracture Mechanics

Classification of joints

Fault Classification and Terminology

Anatomy of Faults

Criteria for Faulting

Fault Mechanics

- Anderson's Fault Types
- Brittle versus Ductile Faults
- Shear Zones
- Shear – Sense Indicators

Thrust Faults

- Nature of Thrust Faults
- Detachment within a Sedimentary Sequence
- Small – Scale Features of Thrust Sheets

Strike – Slip Faults

- Properties and Geometry
- Environments of Strike – Slip Faulting
- Fault Geometry and Other Fault Types
- Termination of Strike – Slip Faults
- Transforms

Normal Faults

- Properties and Geometry

Unit 3

(15 lectures)

Study of Structures II: Folds-I

Fold Geometry and Classifications

- Descriptive Anatomy of Simple Folds
- Map – Scale Parallel Folds and Similar Folds
- Recognition of Folds

Fold Classifications

- Based on interlimb angle
- Ramsay standard classification
- Noncylindrical and Sheath Folds
- Fundamentals of Parallel Folds and Similar Folds

Complex Folds

Identification of overturned folds

- Occurrence and Recognition
- Fold Interference Patterns
- Recognition of Multiple Fold Phases

Unit 4.

(15 lectures)

Study of Structures II: Folds-II

Fold Mechanics

- Fold Mechanisms and Accompanying Phenomena
- Deformation Mechanisms and Strain
- Theory of progressive evolution of fold shapes in single competent layers.
- Layer parallel shortening
 - Dependence of fold shape on viscosity contrast in a single layer buckles
 - High competence contrast, Low Competence contrast
 - Zone of contact strain and its interrelationship with buckle folds
 - Change of fold shape with packing distance of competent layers
 - Fold styles in multilayers

List Of Recommended Reference Books

1. Fossen, H. (2010), Structural Geology, Cambridge University Press
2. Hobbs D.W., Means W.D. And Williams P.F. (1976), An Outline of Structural Geology, John Wiley.
3. Benninson, G and Moseley, K. (2003), An introduction to geological structures and maps, 7th edition, Arnold Publications
4. Lisle, R (2003) Geological structures and maps: a practical guide, Butterworth-Heinemann Ltd.
5. Billings M.P. (1972), Structural Geology, 3rd ed., Prentice- Hall, Inc., Englewood cliffs, New Jersey.
6. Ragan D.M. (1968), Structural Geology- An Introduction to Geometrical Techniques, 2nd ed., John Wiley and Sons.
7. Ramsay J.G. and Huber M.I. (2002), The Techniques of modern structural geology, 2nd ed., Vol. 2, Elsevier Science Ltd.

Practical Course:

- Profiles and cross sections of geological maps with showing various structural features: folds, faults, dykes, two series of dipping beds. (8 maps atleast)
- Patterns of dipping strata; Three-Point problems.
- Trigonometric solution of fault problems
- Equal-area net part I
 - a. Plotting a line that lies in a plane
 - b. Determining the angle between two lines
 - c. True strike and Dip from apparent dips
 - d. Attitude of intersection of two planes
- Equal-area net part II
 - a. Determining the angle between two planes
 - b. Determining the orthographic projection of a line on a plane
 - c. Determining the angle between a line and a plane
 - d. Bisecting the angle between two lines
 - e. Bisecting the angle between two planes

T.Y. B.Sc. Geology
Title: Metamorphic Petrology.

Course: S.Geo.5.04

Learning Objectives:

As a branch of petrology, metamorphic petrology deals with the change in rock structure, composition and texture based on the varying pressure and temperature conditions. This course aims at preparing the learner for appreciating the processes that lead to such changes. The learner will be able to identify in hand specimen as well as through petrographic examination, the various rocks.

Number of lectures: 60

Unit 1: (15 lectures)

Introduction to Metamorphic Petrology

Definition of metamorphism.
Agents of metamorphism
Types of Metamorphism
Introduction to metamorphic fluids
Metasomatism and examples of metasomatism
Classification of Metamorphic rocks
Textures and structures of metamorphic rocks

Unit 2: (15 lectures)

Thermodynamics and metamorphism

Phase rule and phase diagrams
Introduction to chemographic projections
Types of metamorphic reactions
Concept of metamorphic facies

Unit 3: (15 lectures)

Metamorphism- types and products-I

Metamorphism of basic rocks and their facies
UHP and UHT metamorphism of basic rocks
Introduction to P-T-t paths
Metamorphism of pelitic rocks- Barrovian zones
Partial melting and migmatites

Unit 4: (15 lectures)

Metamorphism- types and products-II

Metamorphism of carbonate rocks- Contact and regional
Zones of metamorphism of calc-silicate rocks
Charnockites and Khondalites-Granulites with reference to Indian examples
Porphyroblasts and Tectonism: pre-, syn- and post- tectonic porphyroblasts
Introduction to paired metamorphic belts

List Of Recommended Books:

1. Winter J.D (2013) Principles of Igneous and Metamorphic Petrology (Second Edition), PHI Learning Private Limited, Delhi.
2. Williams H, Turner F.J & Gilbert C.M. (1955), Petrography, W.H. Freeman and company. San Francisco, 406p.
3. Greensmith J. (1989), Petrology of the Sedimentary rocks (7th Edition), C.B.C. Publishers, New Delhi.
4. Blatt H., Tracy R.J. and Owens B.E. (2006), Petrology – Igneous, sedimentary and Metamorphic (3rd Edition), W.H. Freeman and Company, New York.
5. Yardley Bruce W.D. (1989), An Introduction to Metamorphic Petrology, Longman Singapore Publishers (Pvt.) Ltd.
6. Harker Alfred (1974), Metamorphism, Chapman and Hall, London.
7. Turner F.J and Verhoogen J. (1960), Igneous and Metamorphic Petrology, Mc Graw-Hill.
8. Bayley B. (1996), Introduction to Petrology, Prentice Hall, New York.
9. Miyashiro A. (1998), Metamorphism and Metamorphic Belts, George Allen & Unwin, New York.
10. Mason Roger (1984), Petrology of the Metamorphic Rocks, CBS Publishers and Distributors, New Delhi.
11. Winkler Helmut G.F. (1987), Petrogenesis of Metamorphic Rocks (Fifth Edition), Narosa Publishing House, New Delhi.
12. Philpotts A and Ague J. (2009) Principles of Igneous and Metamorphic Petrology (Second Edition), Cambridge University Press, UK.

Practical Course:

Calculations of stable mineral composition at equilibrium

Megascopic and Microscopic Identification of Metamorphic Rocks.

Metamorphic Textures

1. Idioblastic
2. Porphyroblastic
3. Granuloblastic
4. Xenoblastic

Metamorphic Structures

1. Cataclastic
2. Slaty cleavage
3. Maculose
4. Granulose
5. Schistose
6. Gneissose

Metamorphic Rocks

1. Quartzite
2. Marble
3. Slate

4. Phyllite
5. Mica Schist (with Staurolite/ Garnet)
6. Actinolite/ Chlorite Schist
7. Mica- Gneiss
8. Hornblende Gneiss.
9. Granulite
10. Eclogite
11. Serpentine
12. Khondolite
13. Charnockite

T.Y. B.Sc. Geology

Course: S.Geo.5.AC

Title: Remote Sensing and Image Interpretation

PRE-REQUISITES: Courses S.Geo.3.0 and S.Geo.4.0

Additional Requirements (Recommended): Laptop Computer.

Learning Objectives:

Gathering data about various earth surface features through space and air borne sensors has been effectively used for understanding and analyzing various phenomenon ranging from vegetation , agriculture, natural resources mapping and exploitation to environment monitoring. Remote sensing is today an integral part of any study that needs inputs in the form of spatial and spectral reflectance of earth's surface characteristics. This course, aimed at all learners with a background in the earth sciences, will develop skills in understanding how the satellite image data is acquired and interpreted. The use of printed satellite imageries as well as data in digital form will result in the learner also developing the necessary competence in automated classification of satellite image data.

Number of lectures: 60

Unit 1

(15 lectures)

Concepts of Remote Sensing

Concepts and Foundations of Remote Sensing

Definition of Remote Sensing.

Energy Sources and Radiation Principles.

Energy interactions in the Atmosphere: Scattering, Absorption.

Energy interactions with earth surface features: Spectral Reflectance of Vegetation, Soil and Water, Spectral response patterns, Atmospheric Influences on Spectral Response Patterns.

Brief history of Remote Sensing from the advent of photography till today's aerial and space-based remote sensing systems.

The concept of resolution: Spatial, Spectral, Temporal and Radiometric.

Unit 2

(15 lectures)

Satellite Sensors and Data

Space Borne Imaging Systems- The Landsat, IRS, SPOT and High resolution Land Satellites
(the characteristics of these satellites- their orbits, their sensors, and their resolutions)

Multispectral, Thermal and Hyper spectral Sensing

Across track scanning.

Along track scanning.

Operating principles of Across track Multispectral Scanners.

Across track Thermal scanning.

Thermal Radiation principles.

Unit 3

(15 lectures)

Introduction to Digital Image Processing

Introduction.

Image Rectification and Restoration.
Image Enhancement.
Contrast Manipulation.
Spatial Feature Manipulation.
Multi-Image Manipulation.

Unit 4

(15 lectures)

Digital Imaging classification

Image Classification: Supervised Classification.
The Classification Stage: Minimum-Distance to Means Classifier, Parallelepiped Classifier, Gaussian Maximum Likelihood Classifier.
The Training Stage.
Unsupervised Classification.
Classification Accuracy Assessment.

List Of Recommended Reference Books

1. Drury S.A., (1993), Image Interpretation in Geology, 2nd ed., Chapman and Hall, London.
2. Jensen John R. (2000), Remote Sensing of the Environment – An Earth Resource perspective, Pearson Education Series, Low Price Edition.
3. Lillesand T. M., Ralph W. Kiefer and Jonathan W. Chapman (2004), Remote Sensing and Image Interpretation, 5th ed, Wiley.
4. Mather Paul M., (2004), Computer Processing of Remotely Sensed Images- An Introduction, 3rd ed., John Wiley.
5. Narayan L.R.A. (1999), Remote Sensing and its Applications., Universities Press.
6. Ramasamy S.M., (2005), Remote Sensing in Geomorphology, New India Publishing Agency.
7. Schowengerdt Robert A., (2006), Remote Sensing – Models and Methods for Image Processing, 2nd ed., Elsevier (Academic Press).
8. Wanless Harold R. (1969), Aerial Stereo Photographs, Hubbard Press, USA.

Practical Course:

Remote Sensing and Image Processing

- Interpretation of Satellite Imagery for – landforms, geological structures, rock and soil types, man made structures.
 - Data Products and Meta data
 - Digital Image Processing (using number matrix): enhancement, manipulation and classification.
 - Digital image processing on Computer
 - Display of various types of image formats
 - Pallets and Display elements
 - Georeferencing
 - Image enhancement
 - Image classification
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