



Syllabus for Ist Semester Courses in M.Sc. Geology (June 2019 onwards)

Courses:

- SGEO0701 – Stratigraphy and Geology of India
- SGEO0702 - Geochemistry
- SGEO0703 – Structural Geology
- SGEO0704 – Advanced Gemmology
- Practical Course:
- SGEO0701PR, SGEO0702PR, SGEO0703PR and SGEO0704PR. (Pertinent to the above-mentioned theory courses)

M.Sc-I Geology

Course: SGEO701

Title: Stratigraphy and geology of India

Learning Objective: To understand the tectonics and geological formations in different basins through geological ages from studying the rock strata which will in turn, help in building the geological history of Indian subcontinent.

Number of lectures: 60

Unit 1: (15 lectures)

Precambrian Stratigraphy

Precambrian geochronology, Precambrian Stratigraphy of:

Dharwar Supergroup

Aravalli and Delhi fold belts

Singhbhum shear zone

Sausar Belt

Vindhyan Supergroup

Cuddapah Supergroup

Precambrian-Cambrian boundary

Unit 2: (15 lectures)

Palaeozoic and Gondwana Stratigraphy

Palaeozoic of Kashmir

Palaeozoic of Spiti

Gondwana Supergroup

Permian-Triassic Boundary

Unit 3: (15 lectures)

Mesozoic Stratigraphy

Triassic of Spiti

Jurassic of Kutch

Cretaceous of Trichinopalli

Deccan Volcanics

Cretaceous- Tertiary Boundary

Unit 4: (15 lectures)

Cenozoic Stratigraphy

Palaeogene Systems of India

Neogene Systems of India

Evolution of Himalaya

-Pleistocene-Holocene Boundary

Practical Courses

Stratigraphy and geology of India

Study of Geological Maps to establish the geological sequence of the area in the Chronological order

List of Recommended Reference Books

- 1) Valdiya, K. S (2010), The Making of India-Geodynamic Evolution; Macmillan Publishers India Ltd.
- 2) Ramakrishnan, M. and Vaidyanadhan, R. (2008), Vol. I and II, Geology of India; Geological Society of India, Bangalore.
- 3) Roy, R. L. (1990), Principles of Stratigraphy; Merrill Publishing Company, Ohio
- 4) Lewis, H.L (1987), Earth through Time; 3rd Edition. Saunders College Publishing, New York
- 5) Wadia, D.N (1984), Geology of India; 4th edition. Tata McGraw-Hill Publishing Co. Ltd., New Delhi.
- 6) Krishnan, M.S (1982), Geology of India and Burma; 6th Ed. CBS Publishers and Distributors (India).

M.Sc-I Geology
Title: Geochemistry

Course: SGEO702

Course Objectives: To learn basic concepts, applications, and scope of geochemistry. Studying Importance of geochemistry in Precambrian stratigraphy, and current status of numerous chemical analysis techniques. Studying importance in Climate Change, petrological and Paleooceanographic problems.

Number of lectures: 60

Unit 1: (15 lectures)

Introduction

Basic principles of geochemistry.

Elements: Atomic Structure, Formation, Abundance, Distribution in Earth and Solar System.

Periodic Table with special reference to transitional and trace elements.

Geochemical classification of the elements.

Trace element Geochemistry.

Thermodynamics

Basic concepts and terms, Fugacity and Activity.

Oxidation and Reduction reactions

Kinematics.

Unit 2: (15 lectures)

Isotope Geochemistry

Stable Isotopes of Carbon and Oxygen and its application in Geological Studies.

Radioactive Isotopes: Radioactivity, Decay scheme.

Introduction to Isotopic Systems of Carbon-14, Rb/Sr, Sm/Nd, Lu/Hf, U-Th-Pb, K/Ar, $^{40}\text{Ar}/^{39}\text{Ar}$ and their significance in geological studies

Introduction to Techniques used in geochemical analysis (ICP-AES, ICPMS, AMS, EPMA)

Unit 3: (15 lectures)

Applications of Geochemistry

Sedimentary Rocks (weathering, Diagenesis)

Igneous Rocks (Partial Melting and Fractional Crystallization)

Metamorphic Rocks (P-T-t Path)

Unit 4: (15 lectures)

Ocean Geochemistry

Ocean CaCO_3 Cycles

Geochronometry of Marine Deposits

Deposits Geochemical evidence of quaternary sea-level changes.

Elemental and isotopic proxies for past ocean temperature estimations

Tracers of past ocean circulation

Geochemical Indicators of Ice sheet dynamics during Glacial and Interglacial

Past Global Climate Change and tectonics indicated by marine microfossil geochemical analysis.

Geochemistry Practical Course:

Mineral Calculations

Normalization and End Member Calculations

Feldspar Group

Pyroxene Group

Olivine Group

Amphibole Group

Radiometric Dating problems (Isochron method & Concordia- Discordia method)

Classification of Rocks, Geochemical plots for tectonic discrimination of various Rocks.

Geochemical analysis of Marine Core data and interpreting past Ocean Circulation patterns, Past Global Climate change, Regional Climate Change.

List of Recommended Reference Books

1. Brownlow A. (1996), Geochemistry, 2nd edition, Prentice Hall.
2. Faure G. (1998), Principles and Application of Geochemistry, Prentice Hall.
3. Allegre C.J. (2008) Isotope Geology, Cambridge University Press.
4. Faure G. (1977) Principles of Isotope Geology, 1977, by, John Wiley & Sons Inc.
5. Mason B. and Moore C.B. (1985), Principles of Geochemistry, 4th edition, Wiley Eastern Limited.
6. Elderfield H. (2006), The Oceans and the Marine Geochemistry, 1st Edition, Elsevier.

M.Sc-I Geology
Title: Structural Geology

Course: SGEO703

Learning Objectives: To understand the concept of stress and strain and how rock behaves under different stress regimes. To learn the methods of structural analysis in complicated terrains and relationship between tectonics and crustal deformation. Detailed study of tectonites, rock fabric and its relation with deformation.

Recommendation- Personal laptop computer with stereo-plotting software

Number of lectures: 60

Unit 1:

(15 lectures)

Tectonites and microfabric

Concept of scale and homogeneity of geological body

Types of tectonites

Tectonite fabric and fabric domains

Fabric symmetry

Penetrative and non-penetrative discontinuities

Basic concepts of geometrical analysis

Interpretation of structure and fabric

Microfabric

Introduction

Deformation mechanisms

Crystal defects

Principles and types of microstructure development

Recovery, meta-dynamic recrystallisation & static grain growth

Grain shape & crystallographic fabric development

Deformation by transfer of dissolved material and structures in veins

Crystallographic preferred orientations in deformed rocks

Unit 2:

(15 lectures)

Foliation and lineation

Foliation

Axial plane foliation- fracture cleavage, crenulation cleavage, slaty cleavage, schistosity and metamorphic layering

Origin of axial plane foliations

Transposed foliation

Cleavage bedding relationship

Structural association of gently dipping schistosity

Field study of high grade gneissic terrain

Recognition of shear zones

Kinematic classification of shear zones

Fabric distribution in shear zones

Mylonites

Lineation

Description- Slickensides, fold axes, intersection lineation, mineral lineation, deformed pebbles, rods, mullions and boudinage

Origin of lineation

Lineation and kinematics

Problem of lineations indicating extension parallel to fold axes

Determining shear sense with lineation and in absence of lineation

Unit 3:

(15 lectures)

Structural associations and analysis

Strain measurement, stress-strain relationship

Mathematical expression of deformation

Cross section and data projection

Structure contouring

Slate belts and flat lying sediments

Fold geometry and outcrop patterns

Complex folds, Dome and basins

Analysis of area with complex structure

Extensional deformation regime- Study of Indian examples

Fold and thrust belts- Study of Indian examples

Recognition of faults on geological maps, seismic profiles and structure contour maps

Tectonic melanges

Wrench faults and associated structures

Multiply deformed belts of low and medium metamorphic grade- Indian examples

Restoration and balancing of geological section

Unit 4:

(15 lectures)

Tectonics and crustal deformation

Plate tectonics- Ridges, trenches, transform faults, geometry of plate motion, stress and strain within plates

Extensional, compressional and strike slip tectonic regimes

Tectonic settings- Ophiolites, cratons, active and passive margins, arc systems, orogens

Evolution of the crust-mantle system

Seismic structure of the crust

Plate tectonics and mountain belts

Changes in tectonic settings with time

Crustal deformation

Practical Course:

Structural geology

Profiles and cross sections of geological maps with showing various structural features: folds, faults, dykes, two series of dipping beds.

Geometrical construction of folds

Completion of outcrop and construction of geological map

Structure contour maps

Interpretation and cross sections of geological maps of complex structural areas

Equal-area net

a. Locating fold axis- β and π diagram

b. Point diagrams and contouring for various fabric elements

List of Recommended Reference Books

1. Hobbs D.W., Means W.D. And Williams P.F. (1976), An Outline of Structural Geology, John Wiley.
2. Groshong, R.H (2006), 3-D Structural Geology, Springer-Berlin-Hydelberg-New York
3. Fossen, H. (2010), Structural Geology, Cambridge University Press
4. Passicher C.W, Myers J.S and Kroner A. (1990), Field geology of high grade gneiss terraines; Narosa Publishing house, Springer Verlag and IUGS
5. Hatcher Jr. R.D. (1990), Structural Geology, Merrill Publishing Company.
6. Leyshon, P. R. And Lisle, R.J (2004), Stereographic projection techniques for geologists and civil engineers, Cambridge University Press
7. Condie, K (1976), Plate tectonics and crustal evolution, Butterworth Heinemann Publication
8. Ragan D.M. (1968), Structural Geology- An Introduction to Geometrical Techniques, 2nd ed., John Wiley and Sons.
9. Badgley P.C. (1959), Structural Methods for the Exploration Geologist, Oxford Book Company.
10. Ramsay J.G. and Huber M.I. (2002), The Techniques of modern structural geology, 2nd ed., Vol. 2, Elsevier Science Ltd.
11. Ghosh S.K. (1993), Structural Geology, Pergamon Press.

M.Sc. Geology
Title: Advanced Gemmology

Course: SGEO0704

Learning Objectives:

To develop means and ways to study and detect gem minerals and identify gemstones from the new synthetics and enhancement treatments as they are introduced.

Number of lectures: 60

Unit 1

(15 hours)

Introduction

The geological sources of gems

Laboratory equipment and methods

Polariscope, Dichroscope, Refractometer, Spectroscope, Chelsea Filter, UV & X-ray equipment

Gem Microscope

Electron microprobe, scanning electron microscope, spectrophotometers, Raman spectroscopy,

Quantitative cathodoluminescence.

Fashioning of gemstones

Cutting styles, critical angle, composite stones, gemstone polishing, lapidary techniques and gemstone carving.

Diamonds: Diamond cutting and polishing methods, diamond grading including cut, colour, clarity and carat weight.

Unit 2

(15 hours)

Internal features

Growth lines and colour zoning, twinning, types of inclusions. Identification features of natural gemstones, synthetic gemstones and simulants based on localities and process

Gemstone enhancements

Methods of staining, heat treatment, diffusion treatment, fracture filling, cavity filling, coatings, dyeing, laser drilling, atomic irradiation and their detection

Synthesis of gemstones

Methods of manufacture: flame-fusion (Vernueil), flux-melt, hydrothermal, crystal-pulling (Czochralski), skull-crucible method, zone melting, diamond synthesis, thin diamond films, chemical vapour deposition (CVD), ceramic techniques.

Gemstone simulants: Glass, plastics, diamond simulants, assembled or composite stones (includes doublets and triplets)

Unit 3

(15 hours)

Descriptive gemology of important gem minerals/gemstones excluding organic gemstones

(Gems)

Includes crystallography, chemical composition, physical and optical properties, inclusions, enhancements and diagnostic features.

Important gemstones including beryl group, chrysoberyl, corundum group, diamond, felspar group, garnet group, jadeite, marble, opal, peridot, spinel, topaz, tourmaline, zircon, zoisite.

Unit 4

(15 hours)

Descriptive gemology of less common species of gem minerals/gemstones including organic gemstones

Includes crystallography, chemical composition, physical and optical properties, inclusions, enhancements and diagnostic features.

andalusite, apatite, calcite, diopside, epidote, fluorite, gypsum, hematite, idocrase, iolite, kyanite, lapis lazuli, malachite, nephrite, peridot, quartz, rhodochrosite, rhodonite, scapolite, serpentine, sodalite, spodumene, talc, turquoise.

Biological Gem Materials

Animal origin:

Terrestrial; Ivory & teeth, bone & antler, horn, hoofs, claws, hair, skin & leather exoskeletons

Avian; Hornbill casque, claws and beaks, feathers

Marine; Pearl, shells, mother of pearl, operculum, calcific coral:- precious & reef building, tortoise shell, ivory and teeth, chitinous claws, skin

Plant origin:

Terrestrial; Amber, copal, resin & other solid plant resins, vegetable ivory, seeds, nuts, fruit skin, gourds, wood, jet/coal

Marine; Vegetable coral:- black & golden.

List of recommended Reference Books:

1. Renne, N. (2016) Gemstone buying guide, 3rd edition, International Jewelry Publications
2. Matlins, AL and Boananno, A. C. (2016) Gem identification made easy, 6th edition, Gemstone Press.
3. Cunningham DeeDee (2011) Practical Gemmology, NAG Press, London.
4. Schneider, S. (2011) Collecting fluorescent minerals Schiffer Publishing Ltd.
5. Campbell Pedersen, Maggie. (2010) *Gem and Ornamental Materials of Organic Origin*. NAG Press, London.
6. Schumann, W. (2009) Gemstones of the world, 5th edition, Sterling New York
7. O'Donoghue, M. (2006) Gems, Elsevier, Butterworth Heinemann.
8. Watermeyer, Basil. (2006) *Diamond Cutting: a Complete Guide to Diamond Processing*. 6th ed. Johannesburg.
9. Read, P.G (2005) Gemmology 3rd edition, Elsevier, Butterworth Heinemann.
10. Gübelin, Eduard J. and Koivula John I. (2005) Photoatlas of Inclusions in Gemstones, (Volume 3). Opinio Publishers, Basel.
11. Gübelin, Eduard J. and Koivula John I. (2005) Photoatlas of Inclusions in Gemstones, (Volume 2). Opinio Publishers, Basel.
12. Gübelin, Eduard J. and Koivula John I. (2004) Photoatlas of Inclusions in Gemstones, (Volume 1). 4th ed., Opinio Publishers, Basel.
13. Pagel-Theisen, Verena. (2003) *Diamond Grading ABC: the Manual*. 9th ed. Rubin & Son, Antwerp, Belgium.

14. O'Donoghue, M. and Louise, J. (2003), Identification of gemstones, Elsevier, Butterworth Heinemann.
 15. Korbel, P. and Novák, M. (2002) The complete encyclopedia of minerals, Chartwell books.
 16. Harlow, George.E., ed. (1998) *The Nature of Diamonds*. Press Syndicate of the Cambridge University Press, Cambridge, New York.
 17. Nassau, Kurt. (1994) Gemstone Enhancement: History, Science and State of the Art. 2nd ed. Butterworth-Heinemann, London
 18. Robbins, M. (1994) Fluorescence: Gems and minerals under ultraviolet light, Geoscience Press
 19. Anderson, B. W. (1990) Gem testing, 10th edition, Butterworth, London.
 20. Liddicoat, R. (1989) Handbook of gem identification, 12th edition, GIA, Santa Monica, CA.
 21. Arem. J. E. (1987) Color encyclopedia of gemstones 2nd edition, Van Nostrand Reinhold Company, New York.
 22. Bruton, Eric. (1978). Diamonds. 2nd ed. Chilton Book Co., Radnor, PA
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Practical Course:

Gem Properties and Characteristics

1. Hand specimen identification of gem minerals
2. Procedures of distinguishing, different gemstones using a dichroscope, polariscope and a loupe, on the basis of their various physical and optical characters.
3. Study of growth features and inclusions of the gemstones.
4. Drawings of various types of composite gemstones
5. Identification of natural, cultured, and imitation pearls on the basis of structural data.
6. Appraising gemstones

Evaluation and Assessment: SGEO0701, 702, 703 and 704 courses

Evaluation (Theory): Total marks per course - 100.

Continuous Internal Assessment (CIA) - 40 marks

CIA 1: Written test -20 marks

CIA 2: Assignment /MCQ/ One day Geological Field work around Mumbai with field report and viva on the fieldwork. -20 marks

End Semester Examination – 60 marks

One question from each unit for 20 marks, with internal choice. Total marks per question with choice -28 to 30.

Evaluation of SGEO07PR (Practicals) Total marks for Practical course - 100.

Template for SGEO courses End Semester examination in Semester 1

UNITS	KNOWLEDGE	UNDERSTANDING	APPLICATION and ANALYSES	TOTAL MARKS- Per unit
1	08	04	03	15
2	08	04	03	15
3	08	04	03	15
4	08	04	03	15
-TOTAL - Per objective	32	16	12	60
% WEIGHTAGE	53	27	20	100%

St. Xavier's College, Mumbai

Course: SGEO0701/702/703/704

Department of Geology

Roll Number: _____

UID Number: _____

MARKS: ___/20

Date: _____

Assessment Grid for Course: SGEO courses CIA 2 (Field Work)

Parameters Category	Details of Assessment	80 – 100 %	60 – 80 %	40 – 60 %	20 –40 %	0 - 20 %
		Excellent	Good	Satisfactory	Poor	Very Poor
Field Work (30 %)	1. Equipment – field diary, hammer, chisel, hand lens, map, Field discipline.(02)					
	2. Sample Collection and Instrument handling (01)					
	3. Prior Preparation (03)					
Field Report (60 %)	1. Field Diary (04)					
	2. Content, Presentation and Technical correctness (08)					
Viva Voce (10 %)	1. Ability to answer questions. (02)					
Total Marks/20						

Name, Signature of Course Instructor

Date: