NEP Curriculum of

M. Sc. - Geology Program

2025-2026

for

St. Xavier's College, Ranchi

(An Autonomous College of Ranchi University)

Department of Geology
St. Xavier's College
Dr. Camil Bulcke Path, Ranchi - 834001

Meeting of Board of Studies – Geology (B. Sc.; M. Sc.)
Venue: Department of Geology, St. Xavier's College, Ranchi

Date: 04.11.2025

Honourable Members Present:

Sl. No.	Members		Signature
1.	**Ms. Mable M. Toppo** Head, Department of Geology St. Xavier's College, Ranchi	Chairperson	04/11/25
2.	**Prof. (Dr.) Uday Kumar** Ex. Head, Univ. Dept. of Geology Ranchi University, Ranchi	University Representative	4.11.25
3.	**Prof. (Dr.) A.P. Krishna** Department of Remote Sensing, BIT, Mesra, Ranchi	External Member and Subject Expert	4/11/25
4.	**Prof. (Dr.) Sahendra Singh** Department of Applied Geology, IIT-I.S.M., Dhanbad	External Member and Subject Expert	04.11.25
5.	**Dr. M. K. Saini** Senior Principal Scientist CSIR – CIMFR, Ranchi	Expert from Industry	04/11/2025
6.	**Shri Atul Beck** Scientist – B, CGWB, SUO, Ranchi	Alumnus Member	Beck 4-11-25
7.	**Mr. Vinod Kumar Tirkey** Department of Geology St. Xavier's College, Ranchi	Internal Member	4.11.25
8.	**Dr. Somesh Sengupta** Department of Geology St. Xavier's College, Ranchi	Internal Member	4/11/25
9.	**Dr. Melvin A. Ekka** Department of Geology St. Xavier's College, Ranchi	Internal Member	4/11/2025

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HIGHLIGHTS OF NEP PG CURRICULUM

CREDIT OF COURSES

The term 'credit' refers to the weightage given to a course, usually in terms of the number of instructional hours per week assigned to it. The workload relating to a course is measured in terms of credit hours. It determines the number of hours of instruction required per week over a semester (minimum 15 weeks).

a) One hour of teaching/ Lectures or two hours of laboratory /practical work will be assigned per class/interaction.

One credit for Theory = 15 Hours of Teaching

One credit for Practicum = 30 Hours of Practical work

One credit for Internship = 02 Weeks of Practical experience

b) For credit determination, instruction is divided into three major components:

Hours (L) – Classroom Hours of one hour duration.

Tutorials (T) – Special, elaborate instructions on specific topics of one hour duration

Practical (P) – Laboratory or field exercises in which the student has to do experiments or other practical work of a two-hour duration.

Internship - For the Exit option after 1st year of the 2-year P.G. Programme for the award of P.G. Diploma, Level 6.5, Students can either complete two 4-week internships worth 2 credits each or one 8-week internship for all 4 credits. This practical experience connects academic learning with real-world applications, offering valuable exposure to professional environments in their fields of study.

PG CURRICULUM

1. The PG Curriculum will be either of 1-year duration for students who studied the four-year UG Programme (FYUGP) or a 2-year duration for students who studied a three-year UG programme from a CBCS/LOCF/FYUGP Curriculum.

2. There is a flexible mode in the PG programme offered to the students of Ranchi University, Ranchi. The total credit for any semester will be 20 credits.

3. **Two-year PG curriculum**: The First year of the PG curriculum offers coursework only. There will be 3 courses at level 400 and 2 courses at level 500 in the first and the second semesters of any 2-year PG programme.

4. **One-year PG curriculum**: The Courses in the 1-year PG programme and the second year of the 2-year PG programme are the same.

a. **Course work only**: There will be 5 courses at level 500 of 4 credits each in every semester for the coursework offered in the programme.

b. **Course work and Research**: There will be 5 courses at the level 500 bearing 4 credits each in the first semester of a 1-year PG or in the third semester of a 2-year PG. There will be Research work offered in the next semester for this mode offered in the programme. The eligibility for this mode is available in the NEP PG curriculum of Ranchi University, Ranchi.

c. **Research work only**: The eligible student will be offered this mode to conduct extensive research under the supervision of a guide. Each semester will be equivalent to 20 credits. The selection of a candidate for the research mode will depend upon the eligibility of the student, availability of the guide and seat in the department/institution of Ranchi University, Ranchi.

PROMOTION CRITERIA

Two Years Post-graduation programme having coursework only:

i. Each course shall be of 100 marks having two components: 30 marks for Sessional Internal Assessment (SIA), conducted by the Department/College and 70 marks shall be assigned to the End Semester University Examination (ESUE), conducted by the University.

ii. The marks of SIA shall further break into, 20 for Internal Written Examinations, 05 for Written Assignment/ Seminar presentation and 05 for overall performance of a student including regularity in the classroom lectures and other activities of the Department/College.

iii. The Requisite Marks obtained by a student in a particular subject will be the criteria for promotion to the next Semester.

iv. There shall be two written internal examinations, each of 1 hour duration and each of 20 marks, in a semester out of which the 'Better One out of Two' shall be taken for computation of marks under SIA.

v. If a student failed to secure pass marks in Mid Semester, he/she has to reappear in Mid C End Semester Examinations.

vi. In case a student is fail to secure pass marks in End Semester Examination, then he/she has to appear only in End Semester Examination of following Sessions within period of Upper Limit of Four Years and the Marks of Mid Semester will be carried for the preparation of result.

vii. Students' final marks and the result will be based on the marks obtained in Mid Semester and End Semester Examination organized taken together.

viii. The pass marks in the programme will be 45% of the total marks obtained in each Core/ Elective/ Other Courses offered.

ix. In absolute terms of marks obtained in a course, a minimum of 28 marks is essential in the ESUEand a minimum of 17 marks is to be secured in the SIA to clear the course. In other words, a student shall have to pass separately in the ESUE and in the SIA by securing the minimum marks prescribed here.

x. Every candidate seeking to appear in the ESUE shall be issued an Admit Card by the University. No candidate will be permitted to appear in the examination without a valid admit card.

xi. A candidate shall be permitted to proceed in next Semester (2nd, 3rd and 4th) provided he/she has passed at least in 3 courses out of 5 courses in the respective semester in theory and practical/ project courses taken together.

xii. A student will have to clear all his papers within maximum of Four Years of duration to qualify for the degree.

However, it will be necessary to procure pass marks in each of the papers before completion of the programme.

VALUE ADDED COURSES

1. The Value added course will be of 2 credits to be covered during the first semester.

2. There will be objective-type questions asked in the End Semester University Examination (ESUE).

3. There will be OMR-based examination and the correct answer is to be marked by a black ballpoint pen only on the OMR sheet provided by the University.

4. For 50 Marks Examination the student will be provided Two hours for marking their responses.

5. Students are not allowed to choose or repeat courses already undergone at the undergraduate level in the proposed major and minor streams.

6. The performance in this course will not influence the SGPA or CGPA of the PG Programme where the student is registered to obtain the Master's Degree. However, it will be mandatory to secure minimum pass marks in the course before exit from the PG Programme.

7. If the student fails to secure the minimum pass marks in the Value added course in the first semester, he may appear in the examination of the said course with the following batch of the next session.

8. The student may appear in the examination of the said course further if could not clear the course in the following attempt, subject to the date of validation of the Registration.

The Regulations related to any concern not mentioned above shall be guided by the existing Regulations of the PG Curriculum of Ranchi University, Ranchi.

COURSE STRUCTURE FOR PG **'PG DIPLOMA/ COURSEWORK ONLY/ COURSEWORK WITH RESEARCH/ RESEARCH ONLY '**

Table 1: Credit Framework for One Year Postgraduate Programme (PG) [Total Credits = 80]

Academic Level	Level of Courses	Semester	Coursework Level 400	Coursework Level 500	Research Preparedness	Research thesis/ Project/ Patent	Total Credits
YEAR 1							
Level 6.5	**Coursework**	**I**	**4+4+4**	**4+4**	**---**	**---**	**20**
		II	**4+4+4**	**4+4**	**---**	**---**	**20**
YEAR 2:	**Exit Point: Having Internship of 4 credits Exit allowed with PG Diploma Certificate**						
Level 6.5	**Coursework**	**III**	**---**	**4+4+4+4+4**	**---**	**---**	**20**
		IV	**---**	**4+4+4+4+4**	**---**	**---**	**20**
OR							
Level 6.5	**Coursework + Research**	**III**	**---**	**4+4+4+4+4**	**---**	**---**	**20**
		IV	**---**	**---**	**20**		**20**
OR							
Level 6.5	**Research**	**III**	**---**	**---**	**20**	**---**	**20**
		IV	**---**	**---**	**---**	**20**	**20**
						Total credits of P.G. Programme = **80**	

Note: **Having Internship of 4 credits 'Exit' is allowed with awarding the PG Diploma Certificate**.

Implemented from Academic Session 2025-26 & Onwards

The Courses in One Year P.G. Programme and in the Second year of Two years P.G. Programme are Common.

Table 2: Semester wise Examination Structure for Mid Sem G End Sem Examinations:

Sem	Core, AE/ GE/ DC/ EC & Compulsory FC Courses				Examination Structure		
	Paper	Paper Code	Credit	Name of Paper	Mid Semester Evaluation (F.M.)	End Semester Evaluation (F.M.)	End Semester Practical/ Viva (F.M.)
I	Foundation Course	FCGLG101	4	Geotectonics and Structural Geology	30	70	----
	Core Course	CCGLG102	4	Stratigraphy and Palaeobiology	30	70	----
	Core Course	CCGLG103	4	Crystallography and Descriptive Mineralogy	30	70	----
	Core Course	CCGLG104	4	Geology of Jharkhand	30	70	----
	Practical on Core	CPGLG105	4	Practical-I	----	----	100
II	Core Course	CCGLG201	4	Geomorphology and RS-GIS in Geology	30	70	
	Core Course	CCGLG202	4	Geochemistry and Igneous Petrology	30	70	----
	Core Course	CCGLG203	4	Sedimentary and Metamorphic Petrology	30	70	----
	IKS Course	CCGLG204	4	IKS			
	Practical on Core	CPGLG204	4	Practical-II	----	----	100

FORMAT OF QUESTION PAPER FOR MID/ END SEMESTER EXAMINATIONS

Question format for **20 Marks**:

Subject/ Code

F.M. =20 **Time**=1Hr. Exam Year

General Instructions:

i. **Group A** carries very short answer type compulsory questions.
ii. **Answer 1 out of 2** subjective/ descriptive questions given in **Group B**.
iii. Answer in your own words as far as practicable.
iv. Answer all sub parts of a question at one place.
v. Numbers in right indicate full marks of the question.

Group A

1. [5x1=5]
   i. .....
   ii. .....
   iii. .....
   iv. .....
   v. .....
2. ..... [5]

Group B

3. ..... [10]
4. ..... [10]

Note: There may be subdivisions in each question asked in Theory Examination.

Question format for **70 Marks**:

Subject/ Code

F.M. =70 **Time**=3HrS. Exam Year

General Instructions:

i. **Group A** carries very short answer type compulsory questions.
ii. **Answer 4 out of 6** subjective/ descriptive questions given in **Group B**.
iii. Answer in your own words as far as practicable.
iv. Answer all sub parts of a question at one place.
v. Numbers in right indicate full marks of the question.

Group A

1. [5x1=5]
   i. .....
   ii. .....
   iii. .....
   iv. .....
   v. .....
2. ..... [5]

Group B

3. ..... [15]
4. ..... [15]
5. ..... [15]
6. ..... [15]
7. ..... [15]
8. ..... [15]

Note: There may be subdivisions in each question asked in Theory Examination.

SEMESTER I 5 Papers

Total 100 x 5 = 500 Marks

I. FOUNDATION COURSE [FCGLG101]

Marks: 30 (MSE: 20Th. 1Hr + 5Attd. + 5Assign.) + 70 (ESE: 3Hrs)=100 **Pass Marks (MSE:17 + ESE:28)=45**

Instruction to Question Setter:

Mid Semester Examination (MSE):

*There will be **two** groups of questions in written examinations of 20 marks. **Group A is compulsory** and will contain five questions of **very short answer type** consisting of 1 mark each. **Group B will contain descriptive type five** questions of fivemarks each, out of which any three are to be answered.*

End Semester Examination (ESE):

*There will be **two** groups of questions. **Group A is compulsory** and will contain two questions. **Question No.1 will be veryshort answer type** consisting of five questions of 1 mark each. **Question No.2 will be short answer type** of 5 marks. **GroupB will contain descriptive type six** questions of fifteen marks each, out of which any four are to be answered.*

Note: *There may be subdivisions in each question asked in Theory Examinations*

*The Mid Semester Examination shall have three components. (a) Two Semester Internal Assessment Test (SIA) of20 Marks each, (b) Class Attendance Score (CAS) of 5 marks and (c) Class Performance Score (CPS) of 5 marks. **"Best of Two"** shall be applicable for computation of marks for SIA.*

(Attendance Upto75%, 1mark; 75<Attd.<80, 2 marks; 80<Attd.<85, 3 marks; 85<Attd.<S0, 4 marks; S0<Attd, 5 marks).

GEOTECTONICS AND STRUCTURAL GEOLOGY

(Credits: Theory-04, C0 Hours)

Course objectives

1. 1. To provide foundational knowledge of the Earth's interior through seismic wave behavior, radioactivity, and palaeomagnetism, linking these concepts to global tectonic landforms.

2. To foster an understanding of Plate Tectonics theory and its geological expressions, focusing on the tectonic evolution of India, particularly the Himalayas.

3. To train students in rock deformation principles and the identification and interpretation of structural elements like folds, faults, and unconformities.

4. To introduce advanced fabric analysis techniques, emphasizing field and laboratory methods for cleavage, lineation, petrofabrics, and tectonite classification.

5. To develop practical skills in geological mapping using toposheets, clinometers, GPS, and oriented sampling across various lithological terrains.

Course learning outcomes

On successful completion of the course, students will be able to:

1. Explain Earth's internal structure and composition using seismic waves, radioactivity, and palaeomagnetic data; identify major tectonic domains like shields and rifts.

2. Apply Plate Tectonics to interpret geological phenomena at plate boundaries, sea-floor spreading, and orogeny, focusing on India's tectonic framework and Quaternary evolution, especially the Himalayas.

3. Analyze stress-strain relationships and rock behavior under varying pressure-temperature conditions; classify folds, faults, joints, and unconformities based on mechanics and stratigraphy.

4. Describe planar and linear fabrics (cleavage, schistosity, lineation), analyze petrofabric diagrams, and classify tectonites and diapiric structures using field and lab data.

5. Demonstrate skills in reading geological maps, measure strike-dip with a clinometer, collect oriented samples, and prepare geological maps of various terrains using GPS.

Course Outline

Unit 1: Earth's Interior and Global Tectonic Framework

Study of seismic waves – structure and composition of the earth – Radioactivity – Basic concept of palaeomagnetism Major tectonic features of the earth-shield areas, mobile belts, rift valleys, mid oceanicridges, continental shelves and slopes, submarine canyons.

Unit 2: Plate Tectonics and Indian Tectonic Evolution

Plate Tectonics: concept, geological and tectonic environment of Plate boundaries, Sea Floor Spreading, Island arcs, Hydrothermal vents; Orogeny and orogenic cycles – Epeirogeny and evolution of plateaus.Structural and tectonic features of India. Tectonic framework of India; Structure and Origin of the Himalaya. Quaternary tectonics

Unit 3: Principles of Rock Deformation and Structures

Mechanical principles of rock deformation; Concept of stress, strain and the resulting ellipsoids; Factorscontrolling behavior of rock material. Folds, Recognition, mechanics and causes of folding – Recognition of top and bottom of beds; Faults, recognition criteria and mechanics of faulting; Joints- Quantitative and qualitative classification of joints; Unconformities – types, recognition, significant distinction from faultsand their use in dating structural events.

Unit 4: Planar, Linear Fabrics and Petrofabric Analysis

Cleavage, Schistosity and Lineation – their description, origin and relation to major structures. Petrofabricanalysis – Field and laboratory techniques – petrofabric diagrams land their interpretation. Classification andcharacteristics of Tectonites, Diapirs and related structural features.

Unit 5: Geological Mapping And Field Techniques

Toposheets: – Definition, scale, reading various components of a toposheet. Geological map - definition, various components of a geological map including scale, legend, structures etc. Geological Field workinstruments, Use of clinometer compass, Brunton compass, strike and dip measurements; Sampling and oriented sample and its significance; Geological mapping of igneous, sedimentary and metamorphic terrains. GPS and its applications in Geology.

Suggested Books:

- Condie, Kent. C. (1982): Plate Tectonics and Crustal Evolution, Pergamon Press Inc.
- Gass I.G. (1982): Understanding the Earth. Artemis Press (Pvt) Ltd. U.K.
- Ghosh, S.K. (1993): Structural Geology: Fundamental and Modern Development. Pergamon Press.
- Hobbs, B.E., Means, W.D. and Williams, P.F. (1976): An outline of Structural Geology, John Wiley and Sons, New York
- Naqvi, S.M.(2005)Geology and Evolution of the Indian Plate (From Hadean to Holocene - 4Ga to

4Ka) GSI, Bangalore

- Ramsay, J.G. (1967): Folding and fracturing of rocks, McGraw Hill.
- Windley B. (1973): The Evolving continents, John Wiley and Sons, New York.
- N.J. Price and J.W. Cosgrove (1990) Analysis of Geological Structures, Cambridge University Press
- Ragan, Donal M.: Structural Geology, Cambridge University Press
- Whitten, E. H. Timothy (1966) Structural geology of folded rocks. Chicago: Rand McNally,
- George H. Davis (2011) Structural Geology of Rocks and Regions, John Wiley and Sons
- Fossen H (2010) Structural Geology, Cambridge University Press

II. CORE COURSE [CCGLG102]

Marks: 30 (MSE: 20Th. 1Hr + 5Attd. + 5Assign.) + 70 (ESE: 3Hrs)=100	Pass Marks (MSE:17 + ESE:28)=45

Instruction to Question Setter:

Mid Semester Examination (MSE):

*There will be **two** groups of questions in written examinations of 20 marks. **Group A is compulsory** and will contain five questions of **very short answer type** consisting of 1 mark each. **Group B will contain descriptive type five** questions of fivemarks each, out of which any three are to be answered.*

End Semester Examination (ESE):

*There will be **two** groups of questions. **Group A is compulsory** and will contain two questions. **Question No.1 will be veryshort answer type** consisting of five questions of 1 mark each. **Question No.2 will be short answer type** of 5 marks. **GroupB will contain descriptive type six** questions of fifteen marks each, out of which any four are to be answered.*

Note: *There may be subdivisions in each question asked in Theory Examinations*

*The Mid Semester Examination shall have three components. (a) Two Semester Internal Assessment Test (SIA) of 20 marks each, (b) Class Attendance Score (CAS) of 5 marks and (c) Class Performance Score (CPS) of 5 marks. **"Best of Two"** shall be applicable for computation of marks for SIA.*

(Attendance Upto75%, 1mark; 75<Attd.<80, 2 marks; 80<Attd.<85, 3 marks; 85<Attd.<S0, 4 marks; S0<Attd, 5 marks).

STRATIGRAPHY AND PALAEOBIOLOGY

(Credits: Theory-04, C0 Hours)

Course objectives

1. To establish core principles of stratigraphy, including litho-biofacies, correlation techniques, magnetostratigraphy, and sequence stratigraphy, with application to Indian Precambrian and Phanerozoic successions.

2. To provide detailed knowledge of the geological evolution, depositional history, fossil assemblages, and boundary problems in Palaeozoic, Mesozoic, and Tertiary formations of India, with emphasis on type localities and Gondwana Supergroup.

3. To train students in the morphology, classification, biostratigraphic utility, and evolutionary patterns of key invertebrate fossil groups and ichnofossils.

5. To introduce vertebrate palaeontology, focusing on classification, evolutionary lineages (Equidae, Proboscidae, Hominidae), and causes of extinction in Siwalik mammalian fauna.

5. To impart practical understanding of micropalaeontology (especially Foraminifera), Gondwana palynology, and the role of microfossils in biostratigraphy and hydrocarbon exploration.

Course learning outcomes

On completion of the course, students will be able to:

1. Explain stratigraphy principles, facies concepts, and correlation methods (litho-, bio-, magneto-, sequence) to reconstruct the tectonic-sedimentary evolution of the Dharwar, Singhbhum, Vindhyan, and Cuddapah basins.

2. Describe the lithology, fossils, depositional environments, and boundary issues (P/C, P/Tr, K/T) of Palaeozoic, Gondwana, Mesozoic, and Tertiary (Siwalik, NE India) successions in Indian localities.

3. Analyze, classify, and interpret the morphology and evolutionary significance of Trilobites, Brachiopods, Bivalves, Cephalopods, Gastropods, Echinoids, and ichnofossils, noting taphonomic biases.

4. Classify vertebrates and trace evolutionary trends in Equidae, Proboscidae, and Hominidae; evaluate causes of Siwalik mammalian extinction using palaeoecological data.

5. Apply micropalaeontological techniques to identify Foraminifera and Gondwana palynomorphs, demonstrating their relevance in biostratigraphic correlation and petroleum exploration.

Course Outline

Unit 1: Principles of Stratigraphy and Precambrian Successions

Principles of Statigraphy; Concept of Lithofacies and Biofacies; Stratigraphic Correlation; Concepts of Magnetostratigraphy and Sequence stratigraphy. Precambrian Stratigraphy of Dharwar and Singhbhum- Chotanagpur craton; Proterozoic stratigraphy -tectonic framework, geological history and evolution of Vindhyan Super Group, Cuddapahs and their equivalents.

Unit 2: Phanerozoic Stratigraphy of India

Palaeozoic stratigraphy: Palaeozoic formations of India with special reference to type localities, history of sedimentation, fossil content; Concept, classification, lithology, life and age of Gondwana supergroup ; Mesozoic formations of India with special reference to type localities, history of sedimentation, fossil content; Tertiary formations of North-eastern India, Siwalik Group; Stratigraphic boundary problems –Pre Cambrian-Cambrian (P/C),Permian-Triassic(P/Tr) and Cretaceous –Tertiary (K/T) boundaries.

Unit 3: Invertebrate Paleontology and Ichnofossils

Study of Ichnofossils; Taphonomy and preservation. Morphology, classification, biostratigraphy and evolutionary trends of Trilobites, Brachiopods, Bivalves, Cephalopoda, Gastropods and Echinoids.

Unit 4: Vertebrate Paleontology and Siwalik Fauna

Vertebrate and its classification. Evolutionary trends in Equidae, Proboscidae and Man; Siwalik mammals and their causes of extinction.

Unit 5: Micropaleontology and Gondwana Palynology

Micropalaeontology; Foraminifera, diamorphism, morphology and biostratigraphy; Gondwana flora and their significance, Palynology, types of Gondwana palynomorphs and its importance; Microfossilsand their significance in oil exploration.

Suggested Books:

- A.Sahni, (1996),Cretaceous Stratigraphy and Palaeoenvironments. GSI, Bangalore
- Boggs, S. (2001): Principles of Sedimentology and Stratigraphy, Prentice Hall.
- Danbar, C.O. and Rodgers, J. (1957): Principles of Stratigraphy, John Viley and Sons.
- Doyle, P. and Bennett. M.R. (1996): Unlocking the Stratigraphic Record, John Viley and Sons.
- Krishnan,M.S. (1982): Geology of India and Burma, C.B.S. Publ. and Distributors, Delhi.
- M. Ramakrishnan C R. Vaidyanadhan (2008)Geology of India – (Vol. 1C 2) GSI, Bangalore
- T.M.Mahadevan (2002),Gology of Bihar and Jharkhand. GSI, Bangalore

- Naqvi, S.M. and Rogers, J.J.W. (1987): Precambrian Geology of India, Oxford University Press.
- Naqvi, S.M.(2005)Geology andEvolutionof the Indian Plate (From Hadean to Holocene - 4Ga to 4 Ka)GSI, Bangalore
- Pascoe, E.H. (1968): A Manual of the Geology of India and Burma (Vols.I-IV), Govt. of India Press, Delhi.
- Schoch, Robert, M. (1989): Stratigraphy: Principles and Methods, Van Nostrand Reinhold, New York.
- Boardman, R.S., Cheethan, A.M. and Rowell, A.J. (1988): Fossil Invertebrates, Blackwell.
- Clarksons, E.N.K. (1998): Invertebrate Paleontology and Evolution, Allen and Unwin, London.
- Horowitz, A.S. and Potter, E.D. (1971): Introductory Petrography of Fossils, Springer Verlag.
- Raup, D.M. and Stanley, S.M. (1985): Principles of Paleontology, CBS Publ.
- Shrock R.R.(1953)Principles of Invertebrate Paleontology, Mc Graw Hill Book Co.

III. CORE COURSE [CCGLG103]

Marks: 30 (MSE: 20Th. 1Hr + 5Attd. + 5Assign.) + 70 (ESE: 3Hrs)=100	Pass Marks (MSE:17 + ESE:28)=45

Instruction to Question Setter:

Mid Semester Examination (MSE):

*There will be **two** groups of questions in written examinations of 20 marks. **Group A is compulsory** and will contain five questions of **very short answer type** consisting of 1 mark each. **Group B will contain descriptive type five** questions of fivemarks each, out of which any three are to be answered.*

End Semester Examination (ESE):

*There will be **two** groups of questions. **Group A is compulsory** and will contain two questions. **Question No.1 will be veryshort answer type** consisting of five questions of 1 mark each. **Question No.2 will be short answer type** of 5 marks. **GroupB will contain descriptive type six** questions of fifteen marks each, out of which any four are to be answered.*

***Note:** There may be subdivisions in each question asked in Theory Examinations*

*The Mid Semester Examination shall have three components. (a) Two Semester Internal Assessment Test (SIA) of20 Marks each, (b) Class Attendance Score (CAS) of 5 marks and (c) Class Performance Score (CPS) of 5 marks. **"Best of Two"** shall be applicable for computation of marks for SIA.*

(Attendance Upto75%, 1mark; 75<Attd.<80, 2 marks; 80<Attd.<85, 3 marks; 85<Attd.<S0, 4 marks; S0<Attd, 5 marks).

CRYSTALLOGRAPHY AND DESCRIPTIVE MINERALOGY

(Credits: Theory-04, C0 Hours)

Course objectives

1. 1. Build foundational concepts in crystal symmetry, space group derivation, and X-ray diffraction for mineral identification.

2. Develop skills in optical mineralogy using polarized light microscopy, interference phenomena, and determination of optic sign.

3. Introduce crystal chemistry principles, bonding, ionic substitution, phase transformations, and related analytical techniques.

4. Familiarize students with advanced instruments like petrological microscopes, SEM-EDS, LA-ICPMS, FTIR, and Raman, along with rock-forming silicate classification.

5. Enable systematic study of major mineral groups focusing on chemistry, properties, stability, occurrence, alteration, and paragenesis.

Course learning outcomes

On completing the course, students will be able to:

1. Derive 32 crystal classes and 230 space groups using symmetry elements; apply Hermann-Mauguin notation and solve X-ray diffraction problems.

2. Determine optical properties of uniaxial and biaxial minerals using various methods.

3. Explain crystal-chemical principles and interpret mineral composition using analytical data.

4. Interpret results from various spectroscopic and microscopic techniques; classify silicates and describe non-silicate minerals.

5. Identify and characterize major rock-forming mineral groups based on their chemistry and stability.

Course Outline

Unit 1 Crystal Symmetry and X-Ray Crystallography

External symmetry of crystals: Symmetry Elements, methods of projection, Hermaun Mauguin notation.Internal symmetry of crystals: Derivation of 230 space groups, diffraction of crystals by X-rays, Braggs' law.

Unit 2 Optical mineralogy under Polarized Light

Behaviour of light in minerals, Double refraction, Optic axis, Uniaxial and biaxial minerals, Retardation, Birefringence, Interference of light, Interference colour, Order of Interference colour, Michael Levy's Chart, determine birefringence, Optical Indicatirx: uniaxial and biaxial indicatrix, Scheme of pleochroism, Optical accessory plates (mica, gypsum and quartz), Sign of elongation, Conoscopic and orthoscopic light view, Interference figure: Isogyre, isochromes, melatope; Determination of Optic sign.

Unit 3 Principal of Crystal Chemistry

Principles of crystal chemistry; Chemical bonds, ionic radii, Coordination principle, Radius ratio; Principles of ionic substitution in minerals; Isomorphism, Exsolution, Polymorphism, Pseudomorphism; Introduction to XRF, XRD and Electron Probe Microanalysis

Unit 4 Instrumentation and Mineral Classification

A comprehensive study on Petrological Microscope, SEM-EDS, LA-ICPMS, FTIR, and Raman Spectroscopy: its principles, mechanism, limitations, and applications. Introduction of Oxides, Carbonates, Phosphates and Sulphide minerals; Structural classification of silicate minerals.

Unit 5 Systematic study of Rock-Forming minerals

Description of chemistry, optical, physical properties, classification, P-T stability, mode of occurrences, alteration and paragenesis of the following mineral groups: Olivine group, Garnet Group, Aluminosilicate, Zircon; Epidote group, Beryl, Tourmaline; Pyroxene & Pyroxenoids group, Amphibole group; Clay minerals, Mica groups, Chlorite, Serpentine; Quartz, Feldspar, Feldspathoid, Zeolite minerals.

Suggested Books

- Dexter Perkins, 2003 – Mineralogy, Pearson Education Private ltd.
- Carmelo Giacovazzo, 2002 – Fundamentals of crystallography, Oxford University Press
- Boris Konstantinovich Vaĭnshteĭn, 1994 – Modern Crystallography: Fundamentals of crystals,symmetry and methods of structural crystallography, Springer
- William D. Nesse, 2009 – Introduction to Mineralogy, Oxford University Press
- Dana, E.S. – 1955 – Text Book of mineralogy, Wiley
- Wade, F.A. and Mattox, R.E – 1960 – Elements of crystallography and Mineralogy, Harmer and brods.
- Philips, P.C. – 1971 – An introduction to Crystallography, John Wiley
- Winchell, A.N. – 1968 – Elements of optical Mineralogy, parts, I C II Wiley Eastern
- Berry, L.G. and Mason B, Dietrich. 1983 – Mineralogy- Concept, Descriptions Determinations,Freeman
- Burerger, M.J. – 1956 – Elementary Crystallography, Wiley
- Heinrich, E.W. – 1965 – Microscopic identification of Minerals McGraw Hill

- Naidu, P.R.J. C.S. – 1971 – Johansen's optical mineralogy, Allied
- Haribury, C.S. – 1971 – Dana's Manual of Mineralogy, Wiley.
- Deer, W.A. Howie, R.A. C Zussman, J – 1992 – Rock forming Mineralogy Vols. 1 to 5, Longmans.
- Hammond, C. 1990. Introduction to Crystallography. Oxford: Oxford University Press.
- Klein, C. 2002. Manual of Mineral Science. 22nd edition. New York: John Wiley and Sons.

IV. CORE COURSE [CCGLG104]

Marks: 30 (MSE: 20Th. 1Hr + 5Attd. + 5Assign.) + 70 (ESE: 3Hrs)=100	Pass Marks (MSE:17 + ESE:28)=45

Instruction to Question Setter:

Mid Semester Examination (MSE):

*There will be **two** groups of questions in written examinations of 20 marks. **Group A is compulsory** and will contain five questions of **very short answer type** consisting of 1 mark each. **Group B will contain descriptive type five** questions of fivemarks each, out of which any three are to be answered.*

End Semester Examination (ESE):

*There will be **two** groups of questions. **Group A is compulsory** and will contain two questions. **Question No.1 will be veryshort answer type** consisting of five questions of 1 mark each. **Question No.2 will be short answer type** of 5 marks. **GroupB will contain descriptive type six** questions of fifteen marks each, out of which any four are to be answered.*

Note: *There may be subdivisions in each question asked in Theory Examinations*

*The Mid Semester Examination shall have three components. (a) Two Semester Internal Assessment Test (SIA) of20 Marks each, (b) Class Attendance Score (CAS) of 5 marks and (c) Class Performance Score (CPS) of 5 marks. **"Best of Two"** shall be applicable for computation of marks for SIA.*

(Attendance Upto75%, 1mark; 75<Attd.<80, 2 marks; 80<Attd.<85, 3 marks; 85<Attd.<S0, 4 marks; S0<Attd, 5 marks).

GEOLOGY OF JHARKHAND

(Credits: Theory-04, C0 Hours)

Course objectives

1. To understand the physiography, geological history, tectonic framework, and rock types of Jharkhand, focusing on plateaus, river systems, and cratonic evolution.

2. To learn about the stratigraphic succession from Archean to Recent, including key formations (Singhbhum Craton, Gondwana, Rajmahal Traps) and geotourism potential.

3. To develop expertise in the distribution, genesis, exploration, and economic significance of Jharkhand's mineral resources.

4. To analyze the impact of mineral-based industries and mining methods, emphasizing sustainable development.

5. To equip students with knowledge of hydrogeology, groundwater management, natural hazards, and environmental assessments in Jharkhand's hard-rock terrain.

Course learning outcomes

Upon completing the course, students will be able to:

1. Describe the physiography, drainage patterns, tectonics, and rock types of Jharkhand, and reconstruct the geological history of the Chotanagpur and Singhbhum cratons using key sections.

2. Classify and correlate stratigraphic units from Archean to Cenozoic, interpret landforms, and promote geotourism for geoheritage conservation.

3. Map and explain the genesis, distribution, and exploration techniques for major and minor minerals in Jharkhand.

4. Evaluate the economic impact of mineral resources on local industries, assess mining methods and environmental challenges, and propose sustainable practices.

5. Analyze groundwater occurrence in fractured rocks, assess water quality issues and natural hazards, and prepare environmental impact statements using case studies from Jharkhand.

Course Outline

Unit 1 – Physiography and Geological Setting
Geographical location and physiographic divisions of Jharkhand; Major river basins and drainage systems: Damodar, Koels, Subarnrekha; Geological history and tectonic framework of the Chotanagpur, Physiographic regions of Jharkhand: Western Highlands, Central plateau, Dalma, Dhanjori highlands; Types of rocks: igneous, sedimentary, metamorphic occurrence in Jharkhand.

Unit 2 – Stratigraphy of Jharkhand
Archean to Recent rock formations of Jharkhand: Archean -Proterozoic: Older Metamorphic Tonalite Gneiss (OMTG), Singhbhum Craton, Chakradharpur Granite Gniess and Chotanagpur Gneissic Complex; Proterozoic formations: Iron Ore Series, Dalma volcanic rocks; Koderma Mica Belt, Kolhan Group, Vindhyan Supergroup, Hazaribagh Granite and Pegmatite; Palaeozoic-Mesozoic: Gondwana formations: Coal-bearing sequences (Damodar valley); Jurassic – Cretaceous : Rajmahal Trap; Cenozoic Tertiary : Dhalbhum/Jhargram, Lateritic and alluvial deposits.

Unit 3 – Mineral Resources, Industries and sustatinable development in Jharkhand

Iron ore: distribution and genesis (Noamundi, Gua, Chiria); Coal: Gondwana coalfields (Jharia, Bokaro, North Karanpura); Bauxite, mica, kyanite, uranium, gold, copper and other important minerals; Minor minerals: limestone, china clay, graphite; Asbestos, Barytes, Beryl, Chromite, Garnet, Lead, Building material.

Contribution of mineral resources to the economy of Jharkhand; Metallurgical and industrial centers: Jamshedpur, Bokaro, Sindri, etc.; Sustainable development in mineral-rich regions.

Unit 4 – Hydrogeology and Environmental Geology

Groundwater occurrence in hard rock terrains; Water quality issues: arsenic, fluoride contamination in Jharkhand; Natural hazards: landslides, subsidence, coal mine fires; Recent case studies of environmental impact assessment in Jharkhand.

Unit 5 - Geomorphology and Geotourism

Geomorphic Processes: erosion and weathering eg, lateritic soils and rounded hilltops, Soils and surface features: red and yellow soils, Lateritic soils, alluvial soils, Rock outcrops.

Denudation such as peneplains and residual hills eg, Parasnath, Netarhat; Tectonic activities : faulting and Uplifting influenced river courses, producing waterfalls and rapids, Volcanism: traps of Rajmahal, Dalma etc.

Geotourism: Dudhi Nala section; Plant fossils of Jurassic period: fossil occurrences of Mandro; Parasnath, Netarhat; Geotourism as a tool for Sustainanble rural development and Geoheritage conservation.

Recommended References:

- GSI publications on Jharkhand stratigraphy and mineral resources
- Krishnan, M.S. – Geology of India and Burma
- Mahadeva, T. M. (2002): Geology of Bihar and Jharkhand, Geological Society of India.
- Ramakrishnan & Vaidyanadhan – Geology of India, Vol. 1 & 2
- Reports of Jharkhand Department of Mines and Geology.
- Singh, Savindra (2018): Geomorphology, Pravalika Publication.

V. CORE COURSE PRACTICAL [CPGLG105]

Marks: 100 (ESE Pr: 6Hrs)= 100	Pass Marks =45

Instruction to Question Setter:

End Semester Practical Examination (ESE Pr):

The questions in practical examination will be of equal to 70 marks and will be so framed that the students are able to answer them within the stipulated time. 20 marks will be awarded on the performance in viva voce whereas 10 marks willbe awarded on cumulative assessment which is further subdivided as 5 marks for Practical record and 5 marks for Attendance.

Note:

(Attendance Upto75%, 1mark; 75<Attd.<80, 2 marks; 80<Attd.<85, 3 marks; 85<Attd.<S0, 4 marks; S0<Attd, 5 marks).

Practical – 1

(Credits: Practical-04, 120 Hours)

Course objectives

1. Develop skills in geological outcrops, cross-sections, and structural problem-solving using stereographic projection.
2. Training in mineral chemistry calculations, thin-section identification of minerals, and optical properties determination.
3. Gain proficiency in megascopic and microscopic rock identification from Indian stratigraphic horizons.
4. Recognize invertebrate and vertebrate fossils, plant fossils, microfossils, and palynomorphs through morphological study.
5. Integrate field, laboratory, and analytical techniques for comprehensive geological interpretation and reporting.

Course learning outcomes

Upon completing the course, students will be able to:

1. Complete outcrop maps, construct geological cross-sections, and solve dip-strike, fold, and fault problems accurately using stereographic nets.

2. Calculate structural formulae of rock-forming minerals from chemical data and balance cations/anions.

3. Identify rock-forming minerals in thin sections, determine optic sign, pleochroic scheme, and An% in plagioclase.

4. Recognize and describe igneous, sedimentary, and metamorphic rocks from Indian localities, noting stratigraphic age and mineral assemblage.

5. Examine and illustrate key features of microfossils and palynomorphs under a microscope and assign biostratigraphic zones.

Course Outline

- Completion of outcrops in given maps;
- Structural problems by Stereographic Net;
- Plotting of Geological Sections;
- Mineral formulae, calculation of important rock forming mineral groups;
- Microscopic identification of important rock forming minerals;
- Determination of Optic Sign of Uniaxial and Biaxial Minerals;
- Determination of pleochroic scheme;
- Determination of An content in Plagioclase felspars;
- Study of rocks in hand specimens from known Indian stratigraphic horizons and typelocalities;
- Megascopic study of Invertebrate fossils;
- Study of Molar tooth of important vertebrate fossils;
- Study of morphological characters of selected microfossils;
- Megascopic study of Plant Fossils;
- Study of morphological characters of selected palynomorphs.

SEMESTER II 5 Papers

Total 100 x 5 = 500 Marks

I. CORE COURSE [CCGLG201]

Marks: 30 (MSE: 20Th. 1Hr + 5Attd. + 5Assign.) + 70 (ESE: 3Hrs)=100	**Pass Marks (MSE:17 + ESE:28)=45**

Instruction to Question Setter:

Mid Semester Examination (MSE):

*There will be **two** groups of questions in written examinations of 20 marks. **Group A is compulsory** and will contain five questions of **very short answer type** consisting of 1 mark each. **Group B will contain descriptive type five** questions of fivemarks each, out of which any three are to be answered.*

End Semester Examination (ESE):

*There will be **two** groups of questions. **Group A is compulsory** and will contain two questions. **Question No.1 will be veryshort answer type** consisting of five questions of 1 mark each. **Question No.2 will be short answer type** of 5 marks. **GroupB will contain descriptive type six** questions of fifteen marks each, out of which any four are to be answered.*

***Note:** There may be subdivisions in each question asked in Theory Examinations*

*The Mid Semester Examination shall have three components. (a) Two Semester Internal Assessment Test (SIA) of20 Marks each, (b) Class Attendance Score (CAS) of 5 marks and (c) Class Performance Score (CPS) of 5 marks. **"Best of Two"** shall be applicable for computation of marks for SIA.*

(Attendance Upto75%, 1mark; 75<Attd.<80, 2 marks; 80<Attd.<85, 3 marks; 85<Attd.<S0, 4 marks; S0<Attd, 5 marks).

GEOMORPHOLOGY AND RS-GIS IN GEOLOGY

(Credits: Theory-04, C0 Hours)

Course objectives

1. Establish a foundation in geomorphic processes and landform evolution across various environments.

2. Integrate structural and lithological influences on landform development and resource exploration.

3. Introduce basics of electromagnetic radiation, spectral signatures, and satellite systems.

4. Develop skills in image interpretation, GIS principles, and identifying rock types from remote sensing.

5. Facilitate quantitative terrain analysis, morphometric studies, and geomorphological mapping using RS-GIS tools.

Course learning outcomes

On completing the course, students will be able to:

1. Explain landform evolution through the structure-process-time framework; classify fluvial, aeolian, glacial, karst, volcanic, and coastal landforms using cyclic models and rejuvenation effects.

2. Analyze the influence of geologic structures (folds, faults, domes) on drainage patterns; apply geomorphology in groundwater, mineral, oil exploration, and engineering site selection with Indian case studies.

3. Describe the electromagnetic spectrum, atmospheric windows, spectral reflectance, and characteristics of thermal/microwave remote sensing; list major satellite programs (Landsat, Sentinel, RISAT, Cartosat) with sensors and resolutions.

4. Perform visual interpretation of satellite images using tone-texture-pattern; identify rock types (igneous, sedimentary, metamorphic) and tectonic features; apply digital image processing and GIS for geological mapping.

5. Conduct morphometric analysis (stream order, bifurcation ratio); prepare geomorphological maps based on genesis; evaluate terrain for strategic purposes using RS-GIS integration.

Course Outline

Geomorphology

Unit 1 Fundamental Concepts and Landform Evolution

Fundamental concepts – significance of structure, process and time; A brief account of concepts of evolution of landforms; Characteristic features of landforms, Characteristics and

types of fluvial landforms, Fluvial cycle, concept of peneplains, stream rejuvenation, causes and effects; Aeolian landforms, Arid Cycle of erosion; Glacial landforms, periodicity of glaciation and its causes; Karst topography, Relationship of geologic structures to topography; Volcanic landforms

Unit 2 Coastal, Structural, and Applied Geomorphology

Geomorphology of the coasts, classification of shorelines and their evolution. Evidence of eustatic changes and their causes. Influence of lithology on relief. Development of landforms of flat lying, tilted, folded, dome and faulted structures, Development of drainage systems, Drainage Patterns, Drainage analysis in Geological interpretation. Geomorphic features of India; Application of Geomorphology in groundwater, mineral and oil exploration and Engineering projects.

RS-GIS in Geology

Unit 3 Principles of Remote Sensing and Satellite Systems

Electromagnetic spectrum and its properties, Atmospheric Windows; Interaction of electromagneticradiation with matter, Spectral signatures; Basic ideas of Thermal Infra-red and Microwave Remote Sensing; Photogrammetry- recent advancements and applications; Remote Sensing Satellite programmes and their characteristics.

Unit 4 Image Interpretation, Digital Techniques, and Geological Applications

Basic principles of Image interpretation and Digital image techniques; Principles and applications ofGIS; Image characters and their relations with ground objects based on tone, texture and pattern; Interpretation of topographic and tectonic features; Identification of Igneous, Sedimentary andMetamorphic rock types in images.

Unit 5 Terrain Analysis, Morphometry, and Geomorphological Mapping

Principles of terrain analysis; Morphometric analysis; Geomorphological mapping based on genesisof landforms; Terrain evaluation for strategic purposes.

Suggested Books:

- Richard J. Huggett – 2007 – Fundamentals of Geomorphology, Routledge
- Keith A. Sverdrup, Alison Duxbury, Alyn C. Duxbury, 2006 – Fundamentals of Oceanography,McGraw-Hill Higher Education
- Thornbury, W.D., 1969 – Principles of Geomorphology, Wiley.
- Worcester, P.G., 1948 – A text book of Geomorphology
- B.W. Sparles, 1981 – Geomorphology, Longman Group Ltd.
- Bloom, A.L. 1979 – Geomorphology, Prentice Hall.
- Arthur L. Bloom, 2004 – Geomorphology: a systematic analysis of late Cenozoic landforms, WavelandPr Inc,
- Lillesand, T.M. and Keifer,R.W.1987;Remote Sensing and Image Interpretation; John Wiley
- S.N.Pandey,1987:Principles and Applications of Photogeology; Wiley Eastern, New Delhi
- Gupta R.P.1990:Remote Sensing Geology; Springer Verlag

II. CORE COURSE [CCGLG202]

Marks: 30 (MSE: 20Th. 1Hr + 5Attd. + 5Assign.) + 70 (ESE: 3Hrs)=100	Pass Marks (MSE:17 + ESE:28)=45

Instruction to Question Setter:

Mid Semester Examination (MSE):

*There will be **two** groups of questions in written examinations of 20 marks. **Group A is compulsory** and will contain five questions of **very short answer type** consisting of 1 mark each. **Group B will contain descriptive type five** questions of fivemarks each, out of which any three are to be answered.*

End Semester Examination (ESE):

*There will be **two** groups of questions. **Group A is compulsory** and will contain two questions. **Question No.1 will be veryshort answer type** consisting of five questions of 1 mark each. **Question No.2 will be short answer type** of 5 marks. **GroupB will contain descriptive type six** questions of fifteen marks each, out of which any four are to be answered.*

Note: *There may be subdivisions in each question asked in Theory Examinations*

*The Mid Semester Examination shall have three components. (a) Two Semester Internal Assessment Test (SIA) of20 Marks each, (b) Class Attendance Score (CAS) of 5 marks and (c) Class Performance Score (CPS) of 5 marks. **"Best of Two"** shall be applicable for computation of marks for SIA.*

(Attendance Upto75%, 1mark; 75<Attd.<80, 2 marks; 80<Attd.<85, 3 marks; 85<Attd.<S0, 4 marks; S0<Attd, 5 marks).

GEOCHEMISTRY AND IGNEOUS PETROLOGY

(Credits: Theory-04, C0 Hours)

Course objectives

1. To understand trace element geochemistry, partition behavior, diffusion, fractionation models, and REE-Eh-pH applications in igneous petrogenesis.

2. To understand thermodynamic laws, elemental distribution in Earth reservoirs, geochemical cycles, and cosmic/meteroite compositions.

3. To classify igneous rocks (IUGS), interpret textures, and model magmatic evolution through differentiation, assimilation, and mantle melting processes.

4. To apply phase equilibria in binary/ternary systems, link plate tectonics and plume magmatism to magma generation, and compute CIPW norms.

5. To reconstruct petrogenetic histories of major igneous rock suites (granites, basalts, ophiolites, komatiites, alkaline rocks, layered intrusions).

Course learning outcomes

On completing the course, students will be able to:

1. Apply Goldschmidt classification, Nernst/Bulk D, Fick's laws, Rayleigh fractionation, and REE patterns to interpret trace element behavior and construct Eh-pH stability diagrams for mineral assemblages.

2. Explain thermodynamic laws, calculate Gibbs free energy/enthalpy, and trace geochemical cycles; compare cosmic, meteorite, and Earth reservoir compositions.

3. Classify plutonic/volcanic rocks (IUGS), interpret igneous textures, model magmatic differentiation and mantle melting types.

4. Solve phase diagrams in binary (Ab-An, Di-An) and ternary systems (Fo-Di-An, Ne-Ks-Si); correlate magma types with tectonic settings (MORB, OIB, arc, LIP), compute CIPW norms, and explain mantle metasomatism.

5. Deduce petrogenetic models for granites (I-, S-, A-type), basalts (MORB, OIB), ophiolites, komatiites, anorthosites, layered intrusions, and alkaline/carbonatite suites using geochemical and field data.

Course Outline

Unit I Trace Element & Geochemical Fractionation

Goldschmidt's classification of elements; fractionation of elements in minerals/rocks; Nernst's partition coefficient (compatible and incompatible elements), Nernst-Berthelot partition coefficient and bulk partition coefficient; Fick's laws of diffusion and activity composition relation (Roult's and Henry's laws); application of trace elements in petrogenesis; principles of equilibrium and Rayleigh fractionation; REE patterns; Eh and pH diagrams and mineral stability.

Unit 2 Thermodynamics And Cosmogeochemistry

Thermodynamics - Basic terminology, its laws, applications, and related calculations; Chemical composition and characteristics of atmosphere, lithosphere, hydrosphere; geochemical cycles; Origin and abundance of elements in the Solar System and in the Earth, cosmic abundance of elements; meteorites - types and composition.

Unit 3 Magmatic Processes

Viscosity, temperature and pressure relationships in magmas; IUGS classification of plutonic and volcanic rocks; nucleation and growth of minerals in magmatic rocks, development of igneous textures-its classification and petrogenetic significances; magmatic evolution (differentiation, assimilation, mixing and mingling); types of mantle melting (batch, fractional and dynamic)

Unit 4 Phase equilibrium and Tectonic Magmatism

Phase equilibrium - binary systems (albite-anorthite, albite-orthoclase, diopside-anorthite, forsterite-silica) and Ternary systems (diopside-albite-anorthite, diopside-forsterite-silica, diopside-forsterite-anorthite, forsterite-anorthite-silica, nepheline kalsilite silica) and relevance to magmatic crystallization; Plate tectonics and generation of magmas; Plume magmatism and hot spots; Large igneous provinces and mafic dyke swarms; mantle metasomatism and CIPW norm

Unit 5 Petrogenesis of Major Igneous Suites

Petrogenesis of granites, basalts, ophiolite suite, komatiites, syenites, boninites, anorthosites and layered complexes, and alkaline rocks (carbonatite, kimberlite, lamproite, lamprophyre)

Suggested Books:

- Krauskopf, K.B. (1967): Introduction to Geochemistry, McGraw Hill.
- Mason, B. and Moore, C.B. (1991): Introduction to Geochemistry, Wiley Eastern.
- Rollinson, H.R. (1993): Using geochemical data: Evaluation, Presentation, Interpretation. Longman U.K.
- Bose, M.K. (1997): Igneous Petrology, World Press, Kolkata.
- Best, Myron G. (2002): Igneous and Metamorphic Petrology, Blackwell Science.
- Cox, K.G., Bell, J.D. and Pankhurst, R.J. (1993): The Interpretation of Igneous Rocks, Champman andHall, London.

- Faure, G. (2001): Origin of Igneous Rocks, Springer.
- Hall, A. (1997): Igneous Petrology, Longman.
- LeMaitre R.W. (2002): Igneous Rocks: A Classification and Glossary of Terms, Cambridge UniversityPress.
- McBirney (1994): Igneous Petrology, CBS Publ., Delhi
- Phillpotts, A.R. (1994): Principles of Igneous and Metamorphic Petrology, Prentice Hall of India.
- Sood, M.K. (1982): Modern Igneous Petrology, Wiley-Interscience Publ., New York.
- Wilson, M. (1993): Igneous Petrogenesis, Chapman and Hall, London.
- Winter, J.D. (2001): An Introduction to Igneous and Metamorphic Petrology, Prentice Hall, New Jersey.
- Hoefs, J. (1980): Stable Isotope Geochemistry, Springer-Verlag.
- Krauskopf, K.B. (1967): Introduction to Geochemistry, McGraw Hill.
- Mason, B. and Moore, C.B. (1991): Introduction to Geochemistry, Wiley Eastern.
- Rollinson, H.R. (1993): Using geochemical data: Evaluation, Presentation, Interpretation. Longman U.K.

III. CORE COURSE [CCGLG203]

Marks: 30 (MSE: 20Th. 1Hr + 5Attd. + 5Assign.) + 70 (ESE: 3Hrs)=100	Pass Marks (MSE:17 + ESE:28)=45

Instruction to Question Setter:

Mid Semester Examination (MSE):

*There will be **two** groups of questions in written examinations of 20 marks. **Group A is compulsory** and will contain five questions of **very short answer type** consisting of 1 mark each. **Group B will contain descriptive type five** questions of fivemarks each, out of which any three are to be answered.*

End Semester Examination (ESE):

*There will be **two** groups of questions. **Group A is compulsory** and will contain two questions. **Question No.1 will be veryshort answer type** consisting of five questions of 1 mark each. **Question No.2 will be short answer type** of 5 marks. **Group B will contain descriptive type six** questions of fifteen marks each, out of which any four are to be answered.*

Note: *There may be subdivisions in each question asked in Theory Examinations*

*The Mid Semester Examination shall have three components. (a) Two Semester Internal Assessment Test (SIA) of20 Marks each, (b) Class Attendance Score (CAS) of 5 marks and (c) Class Performance Score (CPS) of 5 marks. **"Best of Two"** shall be applicable for computation of marks for SIA.*

(Attendance Upto75%, 1mark; 75<Attd.<80, 2 marks; 80<Attd.<85, 3 marks; 85<Attd.<S0, 4 marks; S0<Attd, 5 marks).

SEDIMENTARY AND METAMORPHIC PETROLOGY

(Credits: Theory-04, C0 Hours)

Course objectives

1. To understand sedimentary processes, textures, structures, provenance analysis, and facies modeling for basin evolution.

2. To integrate tectonics with sedimentation, classify basins, and apply seismic/sequence stratigraphy using Indian examples.

3. To establish principles of metamorphic grades, facies, phase rule, and graphical tools (ACF, AKF, AFM) for mineral assemblages.

4. To interpret regional and contact metamorphism across pelites, mafic-ultramafic, carbonates, and granitoids (including charnockites, migmatites).

5. To link metamorphism with plate tectonics, paired belts, and polymetamorphism in Archaean–Proterozoic terrains.

Course learning outcomes

On completing the course, students will be able to:

1. Analyze weathering, transport, depositional structures, textural maturity, and heavy mineral suites to reconstruct provenance and sedimentary environments.

2. Construct facies models, classify sedimentary basins, draw isopach/stratum maps, and interpret seismic/sequence stratigraphy for Indian basins.

3. Define metamorphic zones/grades, facies series, apply phase rule, and plot ACF/AKF/AFM diagrams to predict mineral assemblages in low-P, high-P, and ultra-high-P metamorphism.

4. Describe prograde mineral reactions in pelites, mafic rocks , carbonates, and interpret migmatites/charnockites.

5. Correlate metamorphic belts with plate boundaries,explain paired belts, and distinguish Archaean (high-T, low-P) vs. Proterozoic polymetamorphism.

Course Outline

Unit 1 Sedimentary Processes and Provenance

Surface processes and rock weathering; Processes of transport and generation of sedimentary rocks; Sedimentary Texture: Textural elements of clastic and non-clastic rocks, Sructures: important erosional, depositional and post depositional sedimentary structures and their significance; Provenance: Source of sediments, compositional maturity; Significance of light and heavy minerals in provenance study.

Unit 2 Sedimentary Environments and Basin Analysis

Sedimentary environment and facies. Facies modeling for marine, non-marine and mixed sediments. Tectonics and sedimentation. Classification and definition of sedimentary basins. Sedimentary basins of India. Cyclic sediments. Seismic and sequence stratigraphy. Purpose and scope of basin analysis. Stratum contours and isopach maps.

Unit 3 Metamorphic Principles and Graphical Tools

Concept of Zones and Grades; Metamorphic facies and facies series; Fabric in metamorphism; Classification of Metamorphic Rocks; Mineralogical Phase Rule; A detailed description of each of low pressure, medium to high pressure and very high pressure with special reference to mineralogical assemblages Metamorphic Differentiation; ACF, AKF and AFM diagrams in metamorphic petrology.

Unit 4 Regional and Contact Metamorphism

Regional metamorphism and Ocean Floor Metamorphism; Regional and thermal metamorphism of pelitic rocks. Regional and thermal metamorphism of basic and ultrabasic rocks; Regional and thermal metamorphism of impure, silicious carbonate rocks; Metamorphism of Granitoids, Charnockites and Migmatites.

Unit 5 Metamorphism and Plate Tectonics

Metamorphism in space and time: Plate tectonics and metamorphic processes; Paired metamorphic belts, Archaean and Proterozoic terrains; polymetamorphism.

Suggested Books

- Blatt, H., Middleton, G.V. and Murray, R.C. (1980): Origin of Sedimentary Rocks, Prentice-Hall Inc.
- Collins, J.D., and Thompson, D.B. (1982): Sedimentary Structures, George Allen and Unwin, London.
- Lindholm, R.C. (1987) A Practical Approach to Sedimentology, Allen and Unwin, London.
- Miall, A.D. (2000): Principles of Basin Analysis, Springer-Verlag.
- Pettijohn;, F.J. (1975): Sedimentary Rocks (3rd Ed.), Harper and Row Publ., New Delhi.
- Reading, H.G. (1997): Sedimentary Environments and facies, Blackwell Scientific Publication.
- Reineck, H.E. and Singh, I.B. (1973): Depositional Sedimentary Environments, Springer-Verlag.
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IV. CORE COURSE [CCGLG204]

Marks: 30 (MSE: 20Th. 1Hr + 5Attd. + 5Assign.) + 70 (ESE: 3Hrs)=100	Pass Marks (MSE:17 + ESE:28)=45

Instruction to Question Setter:

Mid Semester Examination (MSE):

*There will be **two** groups of questions in written examinations of 20 marks. **Group A is compulsory** and will contain five questions of **very short answer type** consisting of 1 mark each. **Group B will contain descriptive type five** questions of fivemarks each, out of which any three are to be answered.*

End Semester Examination (ESE):

*There will be **two** groups of questions. **Group A is compulsory** and will contain two questions. **Question No.1 will be veryshort answer type** consisting of five questions of 1 mark each. **Question No.2 will be short answer type** of 5 marks. **Group B will contain descriptive type six** questions of fifteen marks each, out of which any four are to be answered.*

***Note:** There may be subdivisions in each question asked in Theory Examinations*

*The Mid Semester Examination shall have three components. (a) Two Semester Internal Assessment Test (SIA) of20 Marks each, (b) Class Attendance Score (CAS) of 5 marks and (c) Class Performance Score (CPS) of 5 marks. **"Best of Two"** shall be applicable for computation of marks for SIA.*

(Attendance Upto75%, 1mark; 75<Attd.<80, 2 marks; 80<Attd.<85, 3 marks; 85<Attd.<S0, 4 marks; S0<Attd, 5 marks).

INDIAN KNOWLEDGE SYSTEM AND GEOTOURISM & GEOHERITAGE STUDIES (IKS)

(Credits: Theory-04, C0 Hours)

Course objectives

1. To understand the ancient Indian Knowledge System, including geomythology and Vedic perspectives on the Earth and its relevance to modern geology.
2. To study the historical evolution of geological knowledge in India and the contributions of Indian and British geologists and institutions.
3. To explain the concepts of geoheritage, geodiversity, geotourism, and geoconservation,

emphasizing their scientific, educational, and sustainable importance.

4. To evaluate the management, conservation, and promotion of geoheritage sites in India and Jharkhand for sustainable geotourism and public awareness.

Course learning outcomes

On completing the course, students will be able to:

1. Demonstrate an understanding of traditional and modern geological knowledge systems in the Indian context.

2. Identify and describe major geoheritage sites of India and Jharkhand, explaining their geological and cultural significance.

3. Analyze the roles of national institutions and policies in the development and conservation of Earth science heritage.

4. Apply principles of geoconservation and sustainable geotourism in managing and promoting geological sites responsibly.

Course Outline

Unit I Introduction to IKS and Historical Geology

Introduction to Indian Knowledge system; Geomythology of India; Vedic view of Earth; Various knowledge related to earth/ geology in ancient India vital for human civilization; Documented geological knowledge in India pre and post-Independence; contribution of British and Indian geologist

Unit II Role of Institutions and Agencies in Earth Science System

The role and contribution of various institutes (GSI, AMD, CGWB, NGRI, PRL, etc) agencies (CII, CMPDI, ONGC, MECL, etc) government ministries (MoES, MoJS, MoM, DAE, DST,

etc) related to geology and earth science in nation building; Major awards and societies of earth sciences.

Unit III Geoheritage and Geodiversity

Introduction to Geoheritage and Geodiversity: Definition, scope, and significance; Geotourism and Geoconservation: Concepts, objectives, and sustainable approaches; Geological Heritage, Importance and Distribution: Meaning, educational and conservation value, distribution in Jharkhand; Geoheritage and Geoarchaeological Sites of Jharkhand: Location, geology, conservation status; rock carvings, rock paintings, and notable geotourism destinations.

Unit IV Geoheritage Sites of India

Geoheritage Sites of India: Major sites, geological importance, and conservation practices; Important Geological and Geoheritage Sites in India: Jhamarkotra Fossil Park, Akal Fossil Wood Park (Jaisalmer), Lonar Lake (Maharashtra), Peninsular Gneiss (Lalbagh), Columnar Basalt (St. Mary's Island), Pillow Lavas (Chitradurga), Pyroclastic Rocks (Kolar), Varkala Cliff Section, Volcanogenic Bedded Barytes (Cuddapah), Eparchean Unconformity (Chittoor).

Unit V Conservation and Management

Conservation of Geological and Geomorphological Heritage in India: Strategies, policies, and institutional roles; Geoheritage Conservation in Jharkhand: Recognition, protection measures, and challenges; Role of Geology and Geography in Tourism: Interlinkages with natural and climatic regions of India.

Suggested Books

- Geological world heritage: A global framework – Paul Dingwall, Tony Weighill and Tim Badman (2005)
- A monograph on National Geoheritage monuments of India (2016) – INTACH, Natural Heritage division, New Delhi. Tourism Geography (1998)
- Geotourism hotspots of Indian subcontinent: 36th International Geological Congress,New Delhi, 2016.
- KS Valdiya 2012. Geography, Peoples and Geodynamics of India in Puranas and Epics: A Geologist Interpretation. ARYAN BOOKS INTERNATIONAL.
- Vedic View of the Earth: A Geological Insight into the Vedas, S.R.N.Murthy
- Official website of various organisations such as https://www.moes.gov.in/, https://www.ngri.res.in/, etc.

CORE COURSE PRACTICAL [CPGLG205]

Marks: 100(ESE Pr: 6Hrs)=100	Pass Marks =45

Instruction to Question Setter:

End Semester Practical Examination (ESE Pr):

The questions in practical examination will be of equal to 70 marks and will be so framed that the students are able to answer them within the stipulated time. 20 marks will be awarded on the performance in viva voce whereas 10 marks willbe awarded on cumulative assessment which is further subdivided as 5 marks for Practical record and 5 marks for Attendance.

Note:

(Attendance Upto75%, 1mark; 75<Attd.<80, 2 marks; 80<Attd.<85, 3 marks; 85<Attd.<S0, 4 marks; S0<Attd, 5 marks).

PRACTICAL-II *(Credits: Practical-04, 120 Hours)*

Course Objectives

1. To develop proficiency in megascopic and microscopic identification of igneous, sedimentary, and metamorphic rocks, including sedimentary structures.

2. To train students in graphical representation of modal and chemical analyses using standard petrological diagrams (QAP, APF, ACF, AKF, AFM).

3. To impart computational skills in geochemical calculations, including CIPW norms, Niggli values, partial melting models, distribution coefficients, and trace/REE diagrams for igneous interpretation.

4. To enable quantitative analysis of drainage morphometry and interpretation of satellite imagery/aerial photos for geological applications.

5. To provide hands-on field experience in geological mapping of complex terrains, report preparation, and integration of lab-field data for holistic geological synthesis.

Course learning outcomes

On completing the course, students will be able to:

1. Identify and describe igneous, sedimentary, and metamorphic rocks megascopically (hand specimen) and microscopically (thin section), including primary/secondary sedimentary structures, with accurate mineral assemblages and textures.

2. Plot modal compositions on QAP/APF diagrams for igneous classification and chemical data on ACF/AKF/AFM diagrams for metamorphic facies interpretation, achieving >90% accuracy in rock categorization.

3. Compute CIPW norms, Niggli values, partial melting fractions, distribution coefficients, and construct trace element/REE diagrams to infer igneous petrogenesis and tectonic settings.

4. Perform morphometric analysis of drainage basins (stream order, bifurcation ratio, density) and interpret satellite imagery/aerial photos for lithology, structures, and landforms.

5. Geological mapping in complex areas, prepare detailed field reports with maps/sections, and integrate lab data for geological synthesis and problem-solving.

Course Outline

(A) *Full Marks : 60*

(i) Megascopic and Microscopic studies of Igneous, Sedimentary and Metamorphic rocks.

(ii) Megascopic studies of Sedimentary structures.

(iii) Graphic representation of Modal analyses in QAP and APF diagrams

(iv) Graphic representation of chemical analyses in ACF, AKF and AFM diagrams.

(v) Calculation of C.I.P.W. Norm and Niggli Values

(vi) Morphometric analysis of drainage system.

(vii) Exercises on satellite imagery/photo interpretation

(viii) Partial melting, co-efficient distribution value calculations

(ix) Trace elements, REEs diagram to interpret the igneous rock types

(B) *Full Marks: 40*

(i) Geological Mapping of two weeks duration in a geologically complex area and Field WorkReport based on it.

Ms. Mable M. Toppo

Prof. (Dr.) Uday Kumar

Prof. (Dr.) A. P. Krishna

Prof. (Dr.) Sahendra Singh

Dr. M. K. Saini

Shri Atul Beck

Mr. Vinod Kumar Tirkey

Dr. Somesh Sengupta

Dr. Melvin A. Ekka