

# Savitribai Phule Pune University

(Formerly University of Pune)

## Syllabus for M.Phil./Ph.D. (PET) Entrance Exam : Geology Research Methodology : (Ph.D.)

1. **Foundation of Research:** Meaning, Objectives, Motivation, Utility. Concept of theory, Empiricism, Deductive and Inductive theory. Characteristics of scientific method - understanding the language of research - Concept, Construct, Definition, Variable. Research process
2. **Problem Identification & Formulation:** Definition and formulating the research problem, Necessity of defining the problem, Importance of literature review in defining a problem, Research question – Investigation question - Measurement issues - Hypothesis - Qualities of a good hypothesis - Null hypothesis and Alternative hypothesis. Hypothesis testing - Logic and importance
3. **Research Design:** Concept and importance in research - Features of a good research design - Exploratory research design - Concept, types and uses, Descriptive research design - Concept, types and uses. Experimental design - Concept of independent and dependent variables.
4. **Qualitative and Quantitative Research:** Qualitative - Quantitative research - Concept of measurement, causality, generalization, replication. Merging the two approaches.
5. **Data Collection and analysis:** Execution of the research - observation and collection of data - Methods of data collection, hypothesis-testing - Generalization and interpretation.
6. **Measurement:** Concept of measurement - what is measured? Problem in measurement in research - Validity and Reliability. Levels of measurement - Nominal, Ordinal, Interval, Ratio.
7. **Sampling:** Concept of Statistical population, Sample, Sampling frame, Sampling error, Sample size, Non response. Characteristics of a good sample. Probability sample - simple Random sample, Systematic sample, Stratified random sample and Multi-stage sampling. Determining size of the sample - Practical considerations in sampling and sample size.
8. **Data Analysis:** data Preparation - Univariate analysis (frequency tables, bar charts, pie charts, percentages), Bivariate analysis - Cross tabulations and Chi-square test including testing hypothesis of association, Correlation- Time series analysis, multivariate techniques, regression.
9. **Interpretation of Data and Paper Writing:** Layout of a Research paper, Journals in Geology and allied subjects, Impact factor of journals, When and where to publish? Ethical issues related to publishing, Plagiarism and self-plagiarism.
10. Use of Encyclopedias, Research guides, Handbook etc., Academic databases for concerned discipline.
11. **Use of Tools / Techniques for Research:** methods to search required information effectively, Reference management software like Zotero/mendeley, Software for paper formatting like LaTeX/MSOffice, Software for detection of plagiarism.
12. **Reporting and Thesis writing:** Structure and components of scientific reports - Types of report - Technical reports and thesis - Significance - Different steps in the preparation - Layout, Structure and Language of typical reports - Illustrations and tables - bibliography, referencing and footnotes - oral presentation - planning - preparation - practice - Making presentation - Use of visual aids - Importance of effective communication

13. **Application of Results and Ethics:** Environmental impacts - Ethical issues - ethical committees - Commercialization - Copyright - royalty - Intellectual property rights and patent law - Trade related aspects of intellectual property rights - Reproduction of published material - Plagiarism - citation and acknowledgement - Reproducibility and accountability.
14. **Reasoning and Mental Ability:** Analogy, Classification, Series, Coding-Decoding, Direction sense, Representation through Venn diagrams, Mathematical operations, Arithmetical reasoning, Inserting the missing Character, Number, Ranking and Time sequence test, Eligibility test, Number and symbols ordering, Comprehension questions, Statement and assumptions, Statement and conclusions, Statement and actions

### **Books Recommended**

1. Research Methodology - C. R. Kothari
2. Research Methodology : An Introduction - Stuart Melville and Wayne
3. Practical Research Methods - Catherine Dawson
4. Select references from the Internet

### **REFERENCES**

1. Garg, B. L., Karadia, R., Agarwal, F. and Agarwal, U. K., 2002. An introduction to Research Methodology, RBSA Publishers.
2. Kothati , C.R., 1990. Research Methodology: Methods and Techniques. New Age International. 418p.
3. Sinha, S. C. and Dhiman, A. K., 2002. Research Methodology, EssEss Publications. 2 volumes.
4. Trochim, W. M. K., 2005. Research Methods: the concise knowledge base, Atomic Dog Publishing. 270p
5. Wadehra, B. L. 2000. Law relating to patents, trade marks, copyright designs and geographical indications. Universal Law Publishing.

### **Additional reading**

1. Anthony, M., Graziano, A. M. and Raulin, M. L., 2009. Research Methods: A Process of Inquiry, Allyn and Bacon.
2. Carlos, C. M., 2000. Intellectual property rights, the WTO and developing countries: the TRIPS agreement and policy options. Zed Books, New York.
3. Coley, S. M. and Scheinberg, C. A., 1990, "Proposal Writing", Sage Publications.
4. Day, R. A., 1992. How to Write and Publish a Scientific Paper, Cambridge University Press.
5. Fink, A., 2009. Conducting Research Literature Reviews: From the Internet to Paper. Sage Publications
6. Leedy, P. D. and Ormrod, J. E., 2004 Practical Research: Planning and Design, Prentice Hall.
7. Satarkar, S. V., 2000. Intellectual property rights and Copy right. EssEss Publications.

## **Subject Concerned Syllabus Geology (Ph.D.)**

1. **About the Earth :** The earth and the solar system; important physical parameters and properties of the planet earth; abundance of elements in the earth; primary differentiation of the earth and composition of its various zones; composition of meteorites and the solar photosphere; shape and internal structure of the earth. Uniformitarianism; geological time scale; use of fossils and nuclear clocks in the subdivision of geological time.

2. **Materials of the Earth:** Gross composition and physical properties of important rocks and minerals; properties and process responsible for mineral concentrations; nature and distribution of rocks and minerals in different units of the earth; deformations of rocks; folds and faults and their surface expressions.
3. **Surface Features and Processes:** Physiography of the earth; landscape and seafloor; weathering, erosion, transportation and deposition of earth's material; formation of soil, sediments and sedimentary rocks; energy balance of the earth's surface processes.
4. **Internal Features and Processes :** Elastic waves and fine structure of the earth; crust, mantle and core; thermal, gravitational and magnetic fields of the earth; origin of the main geomagnetic field; mantle convection and plate tectonics; earthquakes and volcanoes; Isostasy.
5. **The Hydrosphere :** The hydrological cycle; inter-relationship of surface and ground water; seafloor spreading and hydrothermal vents; marine sediments, their composition and uses; distribution of temperature and salinity in the ocean; surface circulation, causes of ocean currents and important current systems; deep circulation. Water masses-their formation and characteristics; convergence and upwelling of ocean waters; sea level changes; waves and tides; chemistry of sea water, biological controls on the composition of the oceans; oceanic modulation of climatic changes estuary, bay and marine pollution.
6. **Geology of India:** Land, biotic and mineral resources and their role in development; salient aspects of plant zoogeography; geologic setting; location and approximate reserves of minerals, fuel and water resources of the Indian Territory. Important geological features of the Precambrian shield, the Gondwanas, the Deccan Trap.
7. **Man and Environment :** Ecology, ecosystem and biotic communities; carbon and nutrient cycling and food-chain; human impact on air, land, soil, water, climate and forest resources; conservation of resources; coping with natural hazards; problems of pollution and waste; application of engineering geology to development without destruction; optimum use of energy alternatives.
8. **Geomorphology:** Landforms-their types and development; weathering, transport and erosion; landforms in relation to rock type, structure and tectonics. Soils-their development and types. Geomorphic processes and their impact on various landforms and associated dynamics-slope, channel, coastline, glacial and aeolian; evolution of major geomorphological features of the Indian sub-continent; geomorphometric analysis and modelling.
9. **Sedimentology:** Classification of sedimentary rocks; petrography of rocks of clastic, chemical and biochemical origin. Sedimentary textures and structures. Diagenesis; marine, non-marine and mixed depositional environments. Facies association, sedimentation and tectonics; basin analysis; Reconstruction of palaeoenvironments using radioactive and stable isotopes.
10. **Paleontology:** Origin and evolution of life; fossils and their uses; species concept; functional morphology, classification and evolution of important invertebrate, vertebrate and plant fossils; biomineralisation and trace fossils; types of microfossils and their applications; palaeobiogeography and palaeoecology; evolution of man. Oxygen and carbon isotopic studies on fossils; analysis of palaeontological record for tracing plate tectonics processes.
11. **Stratigraphy:** Recent developments in stratigraphic classification: Litho bio and chrono stratigraphic units and their interrelationships; modern methods of stratigraphic correlation; steps in stratigraphic studies; approaches to palaeogeography; Earth's climatic history. Rocks of Phanerozoic Eon in India-their intercontinental correlation with special reference to type localities; boundary problems in stratigraphy; geodynamic evolution of the Indian subcontinent through the Phanerozoic.

12. **Structural Geology and Geotectonics:** Concepts of stress and strain; strain analysis using deformed objects; geometric classification of folds; mechanics of folding; folding in shear zones; geometry of superposed folding; structural analysis in terrains with multiple deformation; foliation and lineation; geometry and mechanics of shear zones; brittle ductile and ductile structures in shear zones; geometry of thrust sheets. Classification of unconformities; map patterns and their uses in the determination of large-scale structures. Isostasy; seismicity; sea-floor spreading and plate tectonics; orogenesis; orogenic belts of India; evolution of the Himalaya and Himalayan tectonics.
13. **Mineralogy:** Concept of symmetry, point group lattice and space group; principles of crystal chemistry; principles of optical and X-ray mineralogy. Structural classification of minerals; structure and its interrelation with physical and chemical properties of minerals important phase diagrams of major rock forming minerals and ore minerals; principles of geothermo-barometry.
14. **Geochemistry :** Abundances of elements; structure and atomic properties of elements; the Periodic Table; geochemical classification and distribution of elements in the earth; principles of geochemical cycling; principles of ionic substitution in minerals; laws of thermodynamics; concepts of free energy, activity, fugacity and equilibrium constant; thermodynamics of ideal, nonideal and dilute solutions; element partitioning in mineral/rocks formation and concept of distribution coefficients; concept of P-T-X. Eh-pH diagrams and mineral stabilities; radioactive decay schemes, growth of daughter isotopes and radiometric dating; stable isotopes and their fractionation. Mineral/Mineral assemblages as 'sensors' of ambient environments.
15. **Petrology :** Phase equilibria studies of single, binary, ternary and quaternary silicate systems with reference to petrogenesis; magmas, their generation in the crust and mantle, their emplacement and their relation to plate tectonics; magmatic crystallization, differentiation and assimilation; classification of igneous rocks; major and trace elements and isotopic composition of igneous rocks in the context of petrogenesis; petrogenesis of important types of igneous rocks; volatile components in petrogenesis. Physical and rheological properties of silicate melts-Bingham liquid; partial melting and fractional crystallization in closed and open system models. Role of T.P. and fluids in metamorphism; metamorphic facies; mineral assemblages and important reactions in different facies; types of metamorphism and metamorphic-belts; relationship among metamorphism, anatexis and granulization. Petrogenetic aspects of important rocks of India such as the Deccan Trap. The Layered intrusions, charnockites, khondalites and 'gondites'.
16. **Ore Geology:** Physico-chemical controls of deposition and of post-depositional changes in ores; geological processes of formation of economic mineral deposits; global metallogeny as related to crustal evolution; metallogenesis in space and time. Elements of ore petrology; mineral assemblages and fluid inclusions as 'sensors' of ore-forming environments; Live ore-forming systems. Geological setting, characteristic features and genesis of ferrous and non-ferrous ore deposits of India. Metallogenic history of India.
17. **Marine Geology:** Morphological and tectonic domains of the ocean floor; midocean ridge systems; seawater-basalt interaction and hydrothermal vents; models and rates of ocean circulation and of sedimentation in the oceans; diagenetic changes in oxic and anoxic environments; mobility of redox metals; major components of marine sediments and processes regulating sediment composition; geochronology of marine sediments from radioactivity measurements; sedimentary markers of palaeoenvironmental conditions; mineral resources of the oceans and factors controlling their distribution. Ocean margins; nature of deep sea sediments, their chronology and correlation; tectonic history of the oceans.

18. **Petroleum and Coal Geology:** Origin, migration and entrapment of petroleum; properties of source and reservoir rocks; structural, stratigraphic and combinations traps. Techniques of exploration. Petroliferous basins of India. Origin of peat, lignite, bitumen and anthracite. Classification, rank and grading of coal; coal petrography, coal measures of India.
19. **Precambrian Geology and Crustal Evolution:** Evolution of the early crust, early Precambrian life, lithological, geochemical and stratigraphic characteristics of granite greenstone and granulite belts. Stratigraphy and geochronology of the Precambrian terrains of India.
20. **Applied Geology:**
- Photo Geology and Remote Sensing:** Elements of photogrammetry; elements of photo interpretation; electromagnetic spectrum emission range, film and imagery; multispectral sensors; geological interpretation of air-photos and imagery.
  - Engineering Geology:** Mechanical properties of rocks; geological investigations for the construction of dams, bridges, highways and tunnels.
  - Mineral Exploration:** Geological and geophysical methods of surface and subsurface exploration on different scales, sampling, assaying and evaluation of mineral deposits; geochemical and Geobotanical surveys in exploration.
  - Hydrogeology:** Ground water, Darcy's law; hydrological characteristics of aquifers; hydrological cycle; precipitation, evapotranspiration and infiltration processes; hydrological classification of water-bearing formations; fresh and salt water relationship in coastal and inland areas; ground water exploration and management, water pollution, ground water regimes in India.

## **Research Methodology (M.Phil.)**

An overview of Research Methodology, Procedure of Scientific research: Defining Research Problem, Formulating Hypothesis, Research Design, Observation, Research Questions.

Methods of Data Collection, Sampling and Measurements and the concept of inference, Sources of Data in Different Branches of geology, Need for Sampling Methods, Size of Sampling, measurement in research, measurement Scales

Sources of Error in Measurement, Processing and Analysis of Data, Data Editing and formatting, Data Classification, Tabulation, Measurement of Central Tendency, Dispersion and deviation, Hypothesis Testing, Correlation and Regression.

Preparation of Research Reports, Stages of report writing, Layout, Types of Reports, Survey of literature, Research methods applied, Analysis, Conclusions, References and Bibliography

### **Reference Books**

Kothari, C. R.: Research Methodology : Methods and Techniques, WishwaPrakashan, 1994

Misra H.N. and V.P. Singh: Research Methodology in Geography: Social, Spatial and Policy Dimensions, Rawat Publications New Delhi, 1998.

The Scientific Approach: Basic Principles of the Scientific Method By Carlo L. Lastrucci Schenkman Publishing, 1963

Research Methodology by Panneerselvam R

Statistical Methods by S. P. Gupta

Statistics and Data Analysis in Geology, John C. Davis

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**12. Remote Sensing, GIS and Geoinformatics:**

Concept of Electromagnetic Radiation, Fundamentals & Physics of Remote Sensing, Concept and Scope of Remote Sensing, Definitions, Process and Characteristics of Remote Sensing System, Advantages and limitations.

Energy Interaction in the atmosphere: Scattering, absorption, transmission, atmospheric windows, Remote Sensing Scenario in Indian Context

Fundamentals of Geographic Information System: Basic Concepts, definition of GIS, Components of GIS, Lines, polygon, Functionality of GIS, Areas of GIS application, Advantage and Limitation of GIS, GIS Data: Spatial and Attribute Data, Information Organization and Data Structures, Raster and Vector data structures, Data file and database, Primary and Secondary digitization and scanning method, Techniques and procedure for digitizing, Errors of Digitization, Attribute data capture.

**13. Ore Geology:** Physico-chemical controls of deposition and of post-depositional changes in ores; geological processes of formation of economic mineral deposits; global metallogeny as related to crustal evolution; metallogenesis in space and time. Elements of ore petrology; mineral assemblages and fluid inclusions as 'sensors' of ore-forming environments; Live ore-forming systems. Geological setting, characteristics features and genesis of ferrous and non-ferrous ore deposits of India. Metallogenic history of India.

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