

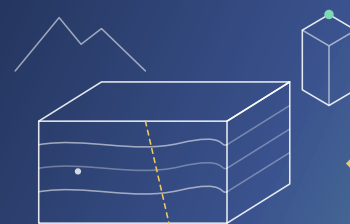
Module code

SPG-3414

Type of module

Undergraduate: Geosciences – Elective

Instrumental Analysis in Geosciences



Modular credits

4

Total student
engagement

56 hours

Prerequisite

SPG-1203 Introduction
to Geology

Anti-requisite

None

Aims

To equip students with expertise in modern analytical techniques, covering principles, applications, limitations, and QC/QA in geological investigations. It introduces key instrumental methods, develops practical skills in operating instruments and interpreting data for mineral exploration, environmental monitoring, and resource management.

Module learning outcomes (MLO):

On successful completion of this module, a student will be expected to be able to:

MLO 1

Analyse and evaluate the fundamental principles and operational mechanisms of key analytical methods used in geosciences.

MLO 2

Operate key instruments (e.g. SEM, XRF) under supervision to analyse samples and generate geological data.

MLO 3

Process raw data and interpret analytical outputs (e.g. XRD spectra, CHNS results).

MLO 4

Apply QA protocols (blanks, standards, duplicates) during data collection.

MLO 5

Evaluate method suitability for specific geological materials and research questions.

MLO 6

Troubleshoot analytical limitations.

MLO 7

Design integrated analytical workflows combining multiple techniques.

MLO 8

Critically assess data quality and uncertainty in published geochemical studies.

MLO 9

Synthesise multi-method datasets into coherent geological interpretations.

Module contents

Introduction to analytical science, overview of analytical techniques and their geological applications	Concept of "fitness for purpose" in method selection	Scanning Electron Microscopy (SEM), Energy Dispersive and Wavelength Dispersive Spectroscopies (EDS and WDS), detection limits, vacuum requirements and conducting coatings
Principles of electron-matter interactions, qualitative versus quantitative EDS analysis	X-Ray diffraction (XRD), crystallography fundamentals and phase identification, Rietveld refinement for quantitative analysis, detection limits, and amorphous phases	X-ray fluorescence (XRF), inductively coupled plasma (ICP), optic emission and mass spectroscopy (OES and MS) techniques; laser ablation ICP-MS
WDXRF versus EDXRF performance characteristics	Detection limits, matrix effects in XRF, ionisation interference in ICP-MS	Instrumental Neutron Activation Analysis (INAA), nuclear reaction principles and gamma spectroscopy
Raman Spectroscopy and FTIR, molecular vibration theory and spectral interpretation, applications in mineralogy and organic geochemistry, limitations from fluorescence interference in Raman	Spectroscopic methods, spectral data analysis, visible-NIR-SWIR spectroscopy, Mössbauer spectroscopy, Laser-Induced Breakdown Spectroscopy (LIBS) for mineral identification	Hyperspectral data processing techniques
Laser particle size analysis, light scattering principles and size distribution curves, sample dispersion requirements	CHNS and proximate analyses, combustion methods for organic/inorganic carbon quantification	Method limitations and error propagation
QA/QC in Geochemical analysis	Standards certification and laboratory accreditation, data validation workflows	Effective graphical representation of analytical data
Forensic mineralogy combining SEM, XRD, and XRF		

Assessment

50%

Examination

50%

Coursework



■ Examination — 50%
 ■ Weekly practical reports — 5%
 ■ Class tests — 15%
 ■ Project presentation — 20%
 ■ Assignments and activities — 10%

Formative assessment

Weekly quizzes,
discussion and
feedback

Summative assessment

COMPONENT	WEIGHTING
Examination	50%
Coursework	50%
Individual	20%
Weekly practical reports	5%
Class tests	15%
Group	30%
Project presentation	20%
Assignments and activities	10%

Graduate attributes and skills

Programme learning objectives (PLO) addressed

2

PLO 2 (Application of Scientific Methods and Data Analysis)

4

PLO 4 (Critical Thinking and Problem-Solving Skills)

7

PLO 7 (Independent Learning and Professional Development)

3

PLO 3 (Integrated Laboratory, Field, and Technical Skills)

6

PLO 6 (Communication and Collaboration Skills)

Sustainability concept addressed

9

SDG 9 Industry, Innovation and Infrastructure

11

SDG 11 Sustainable Cities and Communities

12

SDG 12 Responsible Consumption and Production

Digital skills/software used (not limited to)

- Application software (e.g. Microsoft Excel, analytical instruments' proprietary interfaces)
- Organisational tools (e.g. Notion, Canvas)

Micro-credentialling option

Yes, 4 MCs

Stackable towards GenBESTARI Undergraduate Degree Programme or other relevant Lifelong Learning Programmes

No

Document details

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