UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

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Fundamentals of **Geometallurgy**

Course **Requirements**

- National Senior Certificate or equivalent NQF Level 4 qualification
- **2+ years' experience**

Alternatively, National Senior Certificate (Matric) or an equivalent NQF Level 4 qualification + 2 years working experience. Records of any formal or informal training

Course **Dates**

Visit our website for the latest updated dates

Duration: 5 weeks

Lectures 7 hours per day x 3 days, 5 hours x 2 days (block release in Week 1)

Class presentation 2 hours

Independent reading time: 6 hours per week x 5 weeks

Exam at the end of Week 2

Assignment due at the end of Week 5

Course **Format**

Students can choose to attend the live classes on campus or via Zoom.

Course **Fees**

Visit our website for the latest updated fees

Course **Aims**

This course aims to:

- This course aims to equip students with a thorough understanding of the fundamental principles of geometallurgy in its two main domains of science and engineering.
- The course provides students with an overview of geometallurgy and ore characterisation techniques to enable them to identify and evaluate mineral processing and geostatistical methods.

Course **Content**

The course content addresses the following topics:

- Introduction to geometallurgy.
- Ore characterisation techniques.
- Geostatistical methods.
- Mineral processing basics.
- Case studies in geometallurgy.

Course **Outcomes**

By the end of the course, the student should be able to:

- Explain geometallurgical principles.
- Apply ore characterisation techniques.
- Use geostatistical methods in geometallurgy.
- Integrate geometallurgical data into mining operations.
- Communicate geometallurgical findings effectively.

Predictive Geometallurgy

Course **Requirements**

- NQF Level 7 undergraduate qualification

Prerequisite short course:

- Fundamentals of Geometallurgy

Course **Dates**

Visit our website for the latest updated dates

Duration: 5 weeks

Lectures 7 hours per day x 3 days, 5 hours x 2 days

Class presentation 2 hours

Independent reading time: 6 hours per week x 5 weeks

Preparation and completion of assessments: 6 hours per week x 5 weeks

Exam at the end of Week 2

Assignment due at the end of Week 5

Course **Format**

Students can choose to attend the live classes on campus or via Zoom.

Course **Fees**

Visit our website for the latest updated fees

Course **Aims**

This course aims to:

- This course aims to equip students with knowledge such that they will be able to demonstrate the uses of predictive geometallurgy and its applications in optimising mining operations.
- Students will learn to develop and use geometallurgical models to forecast and enhance mining processes, improving their ability to make data-driven decisions.

Course **Content**

The course content addresses the following topics:

- Introduction to Predictive Geometallurgy.
- Geometallurgical Modelling Techniques.
- Forecasting Methods.
- Optimisation Strategies.
- Case Studies.

Course **Outcomes**

By the end of the course, the student should be able to:

- Explain predictive geometallurgy principles.
- Develop geometallurgical models.
- Apply forecasting methods.
- Optimise mining operations.
- Communicate predictive findings.

Machine Learning for Geological Modelling

Course **Requirements**

- NQF Level 7 qualification
- **2+ years' experience**

Training records related to machine learning or geological modelling

Course **Dates**

Visit our website for the latest updated dates

Duration: 5 weeks

Lectures 7 hours per day x 3 days, 5 hours x 2 days (block release in week 1)

Class presentation 2 hours

Independent reading time: 6 hours per week x 5 weeks

Exam at the end of week 2

Assignment due at the end of week 5

Course **Format**

Students can choose to attend the live classes on campus or via Zoom.

Course **Fees**

Visit our website for the latest updated fees

Course **Aims**

This course aims to:

- This course aims to provide students with knowledge of machine learning techniques and demonstrate their usefulness in geoscientific modelling.
- Students will learn to apply various machine learning algorithms, preprocess geological data, and train and validate models, enhancing their ability to make data-driven decisions.

Course **Content**

The course content addresses the following topics:

- Introduction to machine learning for geological modelling.
- Machine learning algorithms for geological modelling.
- Geological data preprocessing.
- Geological model training and validation.
- Case studies.

Course **Outcomes**

By the end of the course, the student should be able to:

- Critique machine learning principles in geological modelling.
- Analyse machine learning algorithms for geological modelling.
- Preprocess and analyse geological data.
- Evaluate and train geological models.
- Critically analyse and communicate machine learning findings.

Exploration Targeting using **Geophysics**

Course **Requirements**

- National Senior Certificate, and at least
- 2 years' work experience in the Geoscience or Engineering fields.
- National Diploma/Degree in Geoscience or engineering fields.

Course **Dates**

Visit our website for the latest updated dates

Duration: 6 weeks

Lectures 40 hours of interactive lectures where 10 hours are allocated for lectures and 20 hours are dedicated to lab work. There will also be 10 hours dedicated to the field trip.

Total additional hours (inc assessments) 160 hours

Course **Format**

Students to attend the live classes at the School of Geosciences

Course **Fees**

Visit our website for the latest updated fees

Course **Aims**

This course aims to:

- This course aims to highlight the relevant strengths and weaknesses of the different geophysical techniques in exploration of different types of ore deposits in a variety of terranes.

Course **Content**

The course content addresses the following topics:

- Application of geophysical techniques at a variety of scales in mineral exploration.
- Geophysical techniques, including gravity, magnetic, and electromagnetic techniques in regional exploration.
- The use of 3D seismics in regional and existing underground operations.
- Techniques used to gain an understanding of the integration of different datasets using computer-based methods.

Course **Outcomes**

By the end of the course, the student should be able to:

- Elucidate, both orally and in writing, the different techniques that can be used in geophysical exploration for ore deposits and analyse the relative strengths and weaknesses of each method or combination of methods in different exploration settings.
- Design the most appropriate plan for a geophysical survey pertinent to a particular commodity and setting.
- Integrate geophysical datasets and present the data in a coherent manner via computer-generated spreadsheets and appropriate diagrams and maps, to arrive at a prospective exploration target.

Geometallurgical **Simulation**

Course **Requirements**

- NQF Level 7 undergraduate qualification or equivalent

Prerequisite short course:

- Fundamentals of Geometallurgy

Course **Aims**

This course aims to:

- This course aims to provide students with a thorough assessment of geometallurgical simulation techniques and their applications in optimising mining processes.
- Students will learn to develop and use simulation models to enhance process efficiency, improving their ability to make data-driven decisions.

Course **Dates**

Visit our website for the latest updated dates

Duration: 5 weeks

Lectures 7 hours per day x 3 days, 5 hours x 2 days (block release in week 1)

Class presentation 2 hours

Independent reading time: 6 hours per week x 5 weeks

Exam at the end of week 2

Assignment due at the end of week 5

Course **Format**

Students can choose to attend the live classes on campus or via Zoom.

Course **Fees**

Visit our website for the latest updated fees

Course **Content**

The course content addresses the following topics:

- Introduction to geometallurgical simulation.
- Simulation modelling techniques.
- Data integration in simulations.
- Optimisation of simulation models.
- Case studies.

Course **Outcomes**

By the end of the course, the student should be able to:

- Compare and apply simulation principles.
- Develop geometallurgical simulation models.
- Integrate data into simulations.
- Optimise mining processes using simulations.
- Communicate simulation results.

Remote Sensing For Mineral Exploration

Course **Requirements**

- NQF Level 7 undergraduate qualification or equivalent

Prerequisite short course:

- Fundamentals of Geometallurgy

Course **Aims**

This course aims to:

- This course aims to provide students with a thorough assessment of remote sensing techniques and their applications in mineral exploration.
- Notably, students will learn to acquire and interpret remote sensing data, enhancing their ability to identify mineral deposits accurately.

Course **Dates**

Visit our website for the latest updated dates

Duration: 5 weeks
Lectures 7 hours per day x 3 days, 5 hours x 2 days
Class presentation 2 hours
Exam 2 hours
Independent reading time: 6 hours per week x 5 weeks
Preparation and completion of assessments: 6 hours per week x 5 weeks
Exam at the end of Week 2
Assignment due at the end of Week 5

Course **Format**

Students can choose to attend the live classes on campus or via Zoom.

Course **Fees**

Visit our website for the latest updated fees

Course **Content**

The course content addresses the following topics:

- Introduction to remote sensing.
- Remote sensing technologies.
- Data acquisition methods.
- Data interpretation techniques.
- Case studies.

Course **Outcomes**

By the end of the course, the student should be able to:

- Describe remote sensing principles.
- Use remote sensing technologies.
- Acquire and interpret remote sensing data.
- Apply remote sensing in mineral exploration.
- Communicate remote sensing findings.

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Principles of **Flotation**

Course **Requirements**

- NQF Level 7 undergraduate qualification or equivalent

Prerequisite short course:

- Fundamentals of Geometallurgy or
- Geometallurgical Processes and Equipment

Course **Dates**

Visit our website for the latest updated dates

Duration: 5 weeks

Lectures 7 hours per day x 3 days, 5 hours x 2 days

Class presentation 2 hours

Independent reading time: 6 hours per week x 5 weeks

Exam at the end of Week 2

Assignment due at the end of Week 5

Course **Format**

Students can choose to attend the live classes on campus or via Zoom.

Course **Fees**

Visit our website for the latest updated fees

Course **Aims**

This course aims to:

- This course aims to provide students with a solid foundation in the principles and techniques of flotation.
- Students will learn about the different types of flotation reagents and equipment, and about their practical applications through case studies. This knowledge is essential for advancing their careers and supporting the mining industry's efforts to improve flotation efficiency and resource utilisation.

Course **Content**

The course content addresses the following topics:

- Introduction to flotation.
- Flotation principles.
- Flotation reagents.
- Flotation equipment.
- Case studies.
- Safety and environmental considerations.
- Future trends in flotation.

Course **Outcomes**

By the end of the course, the student should be able to:

- Describe flotation principles.
- Apply flotation techniques.
- Use flotation reagents effectively.
- Operate flotation equipment.

Critical **Raw Materials**

Attendance Course:

Course **Dates**

Visit our website for the latest updated dates

Duration: 1 week **(Attendance Certificate)**
4-hour live classes per day x 5 days.

Course **Format**

Students can choose to attend the live classes on campus or via Zoom.

Course **Fees**

Visit our website for the latest updated Fees

Course **Requirements**

- **NQF 6 qualification in a relevant field**
- **2+ years' experience** in a hands-on role working with minerals

Competence Course:

Course **Dates**

Visit our website for the latest updated dates

Duration: 6 weeks (Extended to 8 weeks to accommodate the holiday season)
4-hour live classes per day x 5 days, 2-hour workshop in Week 2, online presentation in Week 2, summative assessment in Week 5, assignment in Week 6

Course **Format**

Students can choose to attend the live classes on campus or via Zoom.

Course **Fees**

Visit our website for the latest updated fees

Course **Requirements**

- **NQF 8 degree in a relevant field**
- **2+ years' experience** in hands-on role working with minerals

The School of Geosciences at Wits University recognises this course for 15 credits towards the Coursework and Research Report in the field of Economic Geology (GEOL7046A) Critical Metal Deposits for students registered for MSc Course Work and Research Report in Economic Geology.

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The information presented serves as a guide to our course offerings and is subject to change over time to ensure relevance and alignment with evolving industry needs.

Course **Aim**

This course aims to:

This course aims to provide students with an overview of the global critical metals industry, the diverse types of mineralisation that exist globally and in Africa, and how these can be identified and evaluated. Students will critically engage, evaluate, and generate knowledge of the geological models that explain the different types of deposits to underpin exploration methodologies and the economic factors governing supply and demand and viability of mining globally and in Africa. A quality-assured certificate from the University of the Witwatersrand is issued on successful completion.

Course **Content**

The course content addresses the following topics:

- Towards a greener economy, critical raw materials, history and definitions, the materials transition.
- Critical raw material usage in the modern world: in high-tech electronics, in batteries, in electric vehicles, and in energy storage.
- The critical elements needed for a greener world.
- Mechanisms responsible for the concentration of critical metals into viable ore deposits.
- Supply and demand of critical raw materials: a global perspective.
- Supply and demand of critical raw materials: an African perspective.
- Costs of production and industry challenges.
- Governance of critical raw materials (ethics and leadership in sustainability).

Course **Outcomes**

By the end of the course, the student should be able to:

- Describe the importance of a greener economy and the role of critical raw materials in the energy transition.
- Evaluate how critical raw materials are used in the modern digital transition Globally, in Africa, and in South Africa.
- Analyse the critical elements needed for a greener world and suggest how Africa could generate these.
- Critically evaluate the mechanisms responsible for concentration of critical metals into viable ore deposits.
- Evaluate the supply and demand dynamics globally and in Africa and propose strategies for African countries and industries.
- Assess the production and cost curves of critical raw materials.
- Evaluate the environmental, social, and governance challenges and how these could be addressed in Africa at regional and local levels.

Meet Your Facilitators

Dr. Nelson Solan Chipangamate — Social Innovation

Dr Nelson Solan Chipangamate is a Researcher at the University of the Witwatersrand's School of Geosciences, with a PhD in Management (UP), an MBA from Midlands State University, and a BSc (Hons) in Economics from the University of Zimbabwe. His work focuses on stakeholder engagement, social licence to operate, energy transitions, and mining modernisation, with publications in Resources Policy and Extractive Industries and Society. He has held roles including Acting Research Centre Lead at the Wits Mining Institute and African Markets Coordinator at CSIRO, has supervised multiple postgraduate students, and secured over R15 million in research funding. He also consults on ESG and transparency projects across Africa and is a frequent speaker at industry events.

Dr. Mulundumina Shimaponda-Nawa — Systems Engineering

Dr Mulundumina Shimaponda-Nawa is a researcher and lecturer specialising in data analytics, communication systems, and the development of critical minerals. She holds a PhD in Electrical and Information Engineering from Wits, an MEng from the University of Johannesburg, and a BEng from Copperbelt University. She is a Research Fellow at Wits' African Research Centre for Ore Systems Science (CORES) and a Lecturer in Electrical and Electronic Engineering at the University of Zambia. Previously, she led the RTIMS Research Centre at the Wits Mining Institute, contributing to SAMERDI digital innovation projects. Her work is published in Resources Policy, Minerals Engineering, and IEEE journals, advancing inclusive, data-driven engineering solutions.

Prof Glen Nwaila — Director; Associate Professor of Geometallurgy & Machine Learning

Prof Glen Nwaila is an Associate Professor of Geometallurgy and Machine Learning, Deputy Head of the School of Geosciences, and Director of the African Research Centre for Ore Systems Science (CORES) at Wits. He holds a PhD in Geosciences from Julius-Maximilians-Universität Würzburg and an MSc in Chemical Engineering from the University of Cape Town. His career spans mining operations, consulting, and academia, specialising in mineral resources management, spatial data analytics, and geometallurgy. He has published over 70 scientific papers, delivered international keynotes, and integrates machine learning and numerical modelling to drive innovation in the minerals sector while supervising postgraduate researchers and contributing to bodies such as SACNASP, SAIMM, SGA, and GSSA.

Dr Muhammad Ahsan Mahboob — Sibanye-Stillwater Digital Mining Laboratory (DigiMine)

Dr Muhammad Ahsan Mahboob is Head of the Sibanye-Stillwater Digital Mining Laboratory (DigiMine) and Interim Director of the Wits Mining Institute, specialising in digital mining, spatial data science, underground communications, and real-time monitoring. He holds a PhD in Mining Engineering from Wits and postgraduate training in innovation, remote sensing, and higher education. His work spans AI-driven mineral exploration, IoT-based sensing, geohazard modelling, and mine automation, supported by experience at the National University of Sciences and Technology in Pakistan. He has published over fifty papers, delivered global keynote talks, and led projects including Horizon Europe collaborations and Sibanye-Stillwater digital safety initiatives, advancing safe, data-driven mining systems.

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Faculty of **Science**

School of **Geosciences**

About the **School of Geosciences**

The Wits School of Geosciences is the largest and most diverse academic Earth Science institution in Africa, with courses in Geology, Geochemistry, Geophysics, Palaeontology, Palaeoanthropology, Geochronology, Environmental Science, Atmospheric Science, Hydrogeology, Economic Geology, and Exploration and Mining Geoscience. In many of these fields, Wits is the main (and in some cases, sole) centre of study in Africa and South Africa.

Why study **Geosciences** at Wits?

Amongst the **top 1% in Geoscience research** worldwide

Greatest diversity of Geoscience subdisciplines in Africa:

- Geology
- Mining Geology
- Geochemistry
- Geophysics
- Palaeontology
- Palaeoanthropology

Research and Teaching **Facilities**

The WITS Earth Observatory

The Earth Observatory in the School of Geosciences represents a world-class geoanalytical facility and the only one of its kind on the African continent. The facility allows researchers, students, and industry colleagues to complete analysis across the entire geoanalytical chain, from sample preparation to state-of-the-art automated mineralogy, geophysical measurements, and isotopic analyses, including U-Pb age determination and traditional/non-traditional analysis.

- Geometallurgy Laboratory
- Hydrogeology Laboratory
- Physical Properties Laboratory
- Sample Preparation and Mineral Separation Laboratory
- Virtual SIMS Laboratory
- Wits Automated Mineralogy Laboratory
- X-Ray Fluorescence Laboratory
- Wits Isotope Geoscience Laboratory and Advanced Mass Spectrometry Facility
- Other Infrastructure

These short courses are certified and quality assured by the University of the Witwatersrand in accordance with its statutory mandate. It does not automatically lead to a qualification registered on the National Qualifications Framework (NQF).

Short Course **Coordinator:**

Nozi Letswalo
Email: **nozi.letswalo**@wits.ac.za
Tel: 011 717 9351 | 011 717 4208

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