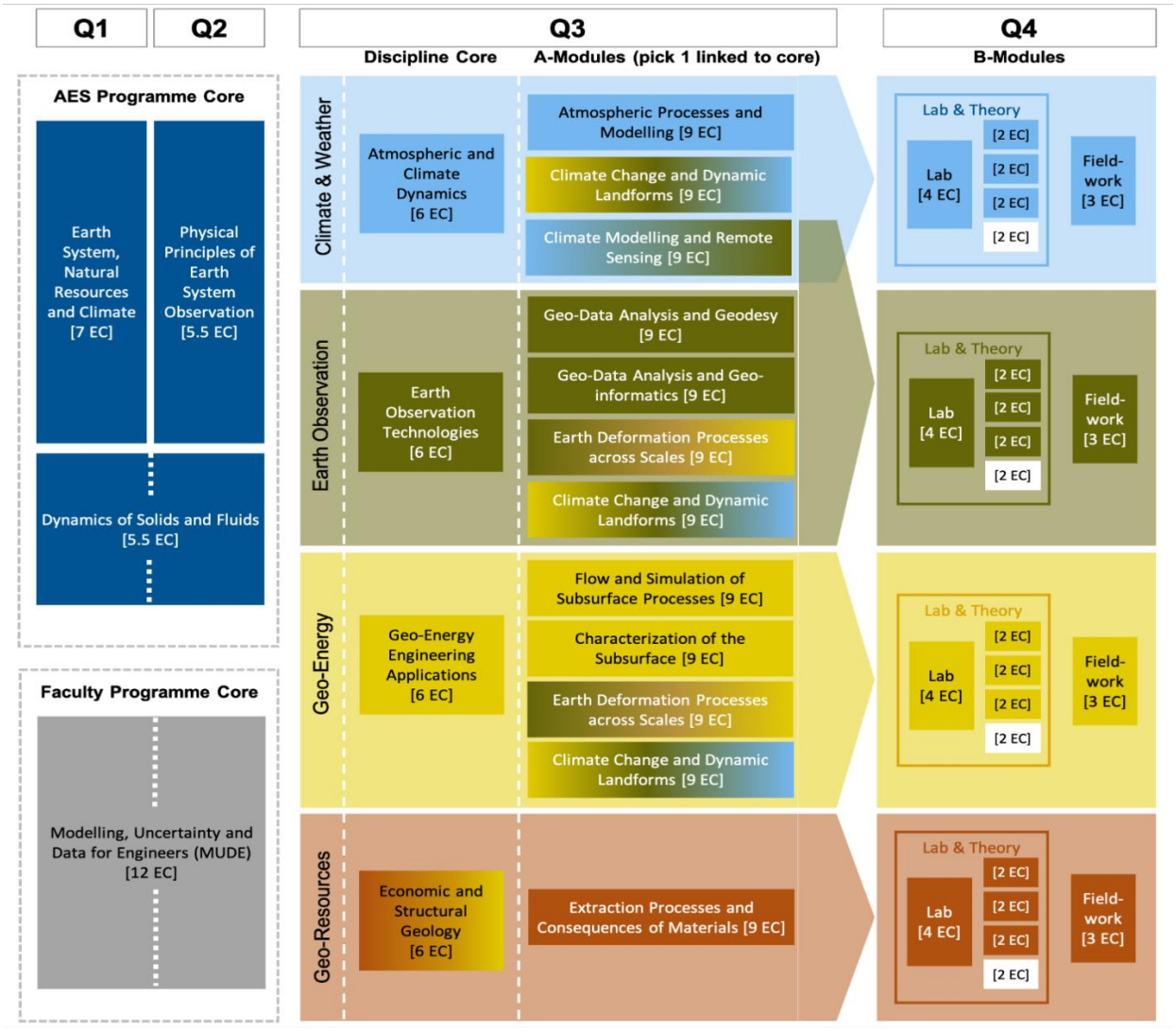
MSC APPLIED EARTH SCIENCES YEAR 1: DISCIPLINE GEO-RESOURCES MODULE DESCRIPTIONS

The programme starts with a common core where you gain a solid foundation in earth science, physics, and modelling & data skills. Thereafter you develop your own path, and specialise in specific topics:

- you select one of four defined disciplines: Climate & Weather, Earth Observation, Geo-Energy, and Geo-Resources.
- you choose a mix of modules and electives, developing in-depth knowledge within the discipline or complementing your interests with electives from other disciplines.
- You gain hands on experience by applying theory learned to current engineering case studies from governmental institutes and companies.

This document presents an overview of the curriculum and module descriptions specifically for Discipline Geo Energy in year 1 of the programme.



GEO-RESOURCES: DISCIPLINE CORE AND A-MODULES

ECONOMIC AND STRUCTURAL GEOLOGY (DISCIPLINE CORE)

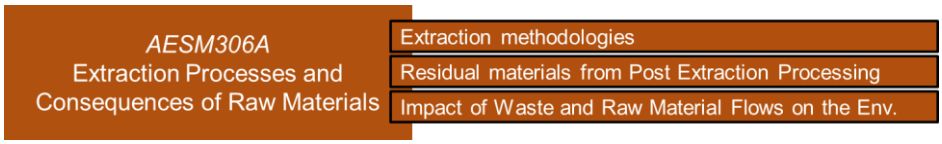
This discipline core module will give you a deep understanding of the origin, nature, and factors controlling primary solid minerals and raw materials, and how they can be recovered and utilised. The module is comprised of two parts.

In the first part, you will be introduced to different types of mineral/metalliferous deposits, their geology, and how they evolved. You will learn about the evolutionary concepts and magmatic, sedimentary, hydrothermal, and metamorphic ore-forming processes. The focus will be on metalliferous deposits, including iron, base metals, precious metals, light metals, and minor and specialty metals, all important for our society and economy.

The second part of the module covers geomechanics and structural geology, including the concepts of stress and strain, the properties of semi-lithified to lithified sediments, and the rheology of semi-lithified to lithified sediments. You will also learn about low-strain and high strain geological structures such as mode I and mode II fractures, faults, and folds, and how these structures and deformation processes are formed, expressed, measured, and predicted in boreholes and on the Earth's surface. This part of the module is shared with the Discipline Geo-Energy.

By the end of the module, you will have gained a thorough understanding of the geological processes that create different types of mineral deposits, and the tools to predict and measure geological structures and deformation processes.

EXTRACTION PROCESSES AND CONSEQUENCES OF MATERIALS (A-MODULE)



This module covers different topics related to mining, focusing on three units: Extraction Methodologies, Residual Materials from Post Extraction processing, and Impact of Waste and Raw material Flows on the Environment. In these units you will learn about selecting the best method for mining, planning, and extracting minerals in an optimized way, prioritizing safety, environmental impact, and resource efficiency. You will also cover designing storage facilities for waste products produced during the extraction process, and understanding the potential environmental impacts and hazards associated with waste flows resulting from mining activities.

After completing this module you will be able to minimize the negative impacts of mining on society and the environment. You will also be able to contribute to the development of sustainable mining practices that prioritize the well-being of local communities and the environment.

GEO-RESOURCES: B-MODULES

The B-modules for all disciplines comprises a Theory & Lab component (12 EC) and a fieldwork (3 EC).

The lab has a central place in the module, triggering the inquiries and as the place where the students apply the theory they learn in the theory units to a challenge related to monitoring and/or prediction of climate impacts or geohazards, energy transition, or responsible resource extraction (depending on the discipline). The student (team) selects a topic related to the challenge within a predefined theme that they will work on during the Lab. They collect analyse and interpret data to address or solve their posed problem.

Next to the lab project, students follow three compulsory units and one elective unit. The available options are indicated in the table below per discipline.

Discipline	Theory components (colour indicates with discipline offers it)	B-CW	B-EO	B-GE	B-GR
C&W	Climate data analysis	C	E	E	
	Remote sensing of precipitation	E	E		
	Multi-sensor cloud and atmospheric observations	E	E		
	Cryosphere dynamics	E	E		
	Sea level change and extremes	E	E	E	
EO	Time series analysis	E	C	E	
	GNSS	E	E		
	(In)SAR	E	E	E	
	Optical remote sensing	E	E	E	E
GE	Induced seismicity		E	C	
	Geophysical prospecting		E	E	E
	Production science and technology	E		E	
	Geological interpretation of geophysical data		E	E	
GR	Exploration tools and methods			E	C
	Advanced resource modelling			E	C
GR + EO	Geostatistical data analysis		E	E	C

C	compulsory
E	elective

During the fieldwork, students will work in teams to define an objective related to their discipline. Students start with a project planning phase (0.5EC), in which they receive instruction, and they design a measurement experiment or a fieldwork campaign, which will be reviewed. In a second phase they will implement the measurements, collect data and process the data (1.5EC). Thereafter they will analyse and interpret the data, present their findings, and provide recommendations for future work or answer questions in different formats (1EC).

GEO-RESOURCES – THEORY COMPONENTS

Exploration Tools and Methods

Topics:

- Use of geological mapping, remote sensing, geophysical techniques or mineral exploration.
- Surface sampling media for geochemistry (soil, water, stream sediments, rock)
- Subsurface sampling (RC drilling, diamond core drilling)
- Small scale (hand specimen) spectral mapping (FTIR, Raman, LIBS)
- Resulting data outputs.
- Precision, accuracy, resolution and limitations of data.

Advanced Resource Modelling

Topics:

- Introduction to the block model and smallest mining unit (SMU) concepts in the context of mineral resource modelling.
- Linear geostatistics (Block Kriging and Indicator Kriging)
- Multivariate geostatistics (Collocated Co-Kriging, properties of Co-Kriging, Kriging with External Drift).
- Geostatistical Simulation (Conditional simulation).
- Dispersion variance (correcting for the support effect).
- Conversion of mineral resources to mineral reserves.
- Mineral resources reporting standards (e.g. JORC)