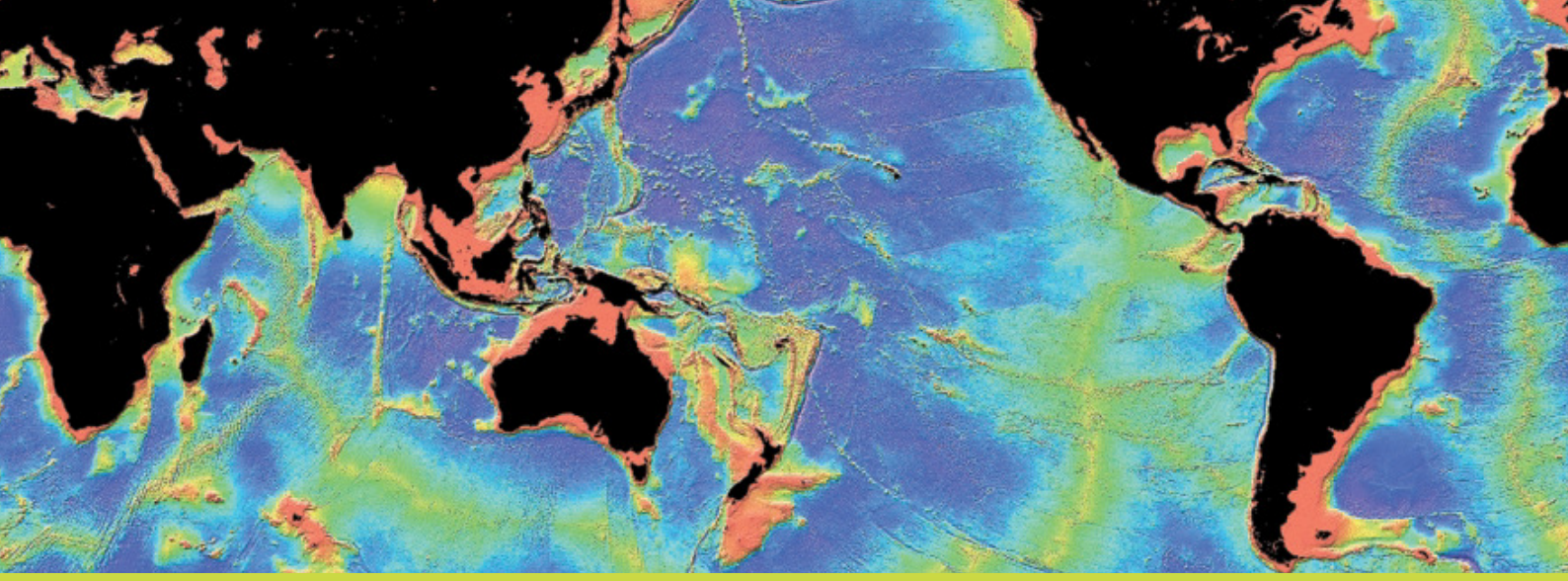

The study of Earth and Environmental Science in Stage 6 enables students to develop an appreciation and understanding of geological and environmental concepts that help explain the changing face of the Earth over time. Through applying Working Scientifically skills processes, the course aims to examine how earth and environmental science models and practices are used and developed.

Earth & Environmental Science

- Modules
- 1) Earth's Resources
- 2) Plate Tectonics
- 3) Energy Transformations
- 4) Human Impacts

Geology n noun
1 the science which deals with the physical structure and substance of the earth.
2 the geological features of a district.
ORIGIN C18: from modern Latin geologia, from Greek ge 'earth' + -logia (see -logy).

Year 11

Module 1: Earth's Resources

Outcomes

A student:

- conducts investigations to collect valid and reliable primary and secondary data and information EES11/12-3
- selects and processes appropriate qualitative and quantitative data and information using a range of appropriate media EES11/12-4
- analyses and evaluates primary and secondary data and information EES11/12-5
- describes the key features of the Earth's systems, including the geosphere, atmosphere, hydrosphere and biosphere and how they are interrelated EES11-8

Content Focus

This module investigates compositional layers of the Earth. Students engage with rock composition and the origins of the component materials, including minerals. They extend their knowledge of the Earth and space from Science Stage 5 by learning about soil, the Rock Cycle and technologies used to gather geological data.

Students explore science as a human endeavour in relation to the work of geologists, including the significance of this work to the mining of non-renewable resources. They also explore technologies used to gather and interpret data, including absolute and relative dating of rocks.

Working Scientifically

In this module, students focus on conducting investigations to collect, process and analyse data in order to identify trends, patterns and relationships in the Earth's resources. Students should be provided with opportunities to engage with all Working Scientifically skills throughout the course.

Content

Structure of the Earth, the Early Geosphere, Atmosphere and Hydrosphere

Inquiry question: How did the compositional layers of the Earth develop?

Students:

- investigate and model the processes that formed the geosphere (ACSES018), atmosphere (ACSES022) and hydrosphere (ACSES023)

Students:

- investigate evidence for the structure of the Earth using technologies, including:
  - seismic wave velocities
  - meteorite evidence to demonstrate differences in density and composition (ACSES009, ACSES018)

Students:

- describe the compositional layers and thickness of the Earth's layers, including:
  - lithosphere (ACSES015)
  - asthenosphere
  - crust, mantle and core and their compositional layers (ACSES006)

Students:

- conduct a practical investigation to compare the differences in the density of representative rock samples found in the crust, mantle and core (ACSES003)

Students:

- analyse evidence of the Earth's age, including:
  - formation and age of zircon crystals
  - radiometric techniques
  - meteorite evidence (ACSES009)

Rocks, Minerals and the Rock Cycle

Inquiry question: What are the components of rocks and soils?

Students:

- investigate methods of classifying rocks and minerals used by Aboriginal and Torres Strait Islander Peoples

Students:

- investigate the chemical composition of a variety of minerals and explain their formation, including:
  - felsic minerals
  - mafic minerals

Students:

- investigate the physical properties of minerals that are used to assist in classification

Students:

- investigate a range of rocks and minerals and classify samples using dichotomous keys

Students:

- explain the formation of rocks as characteristic assemblages of mineral crystals or grains that are formed through igneous, sedimentary and metamorphic processes, as part of the Rock Cycle (ACSES019)

Students:

- explain the formation of rocks as characteristic assemblages of mineral crystals or grains that are formed through igneous, sedimentary and metamorphic processes, as part of the Rock Cycle (ACSES019)

Students:

- explain the formation of soil in terms of the interaction of atmospheric, geologic, hydrologic and biotic processes (ACSES020)

Students:

- conduct a practical investigation to examine soil types and component materials (ACSES020)

Geological Timescale

Inquiry question: How is the age of geological materials determined?

Students:

- describe relative and absolute dating of the geosphere (ACSES017)

Students:

- use data of both relative and absolute dating from secondary sources to determine the age of geological materials (ACSES013, ACSES015, ACSES016, ACSES017)

Geological Resources

Inquiry question: How are non-renewable geological resources discovered and extracted?

Students:

- investigate traditional Aboriginal quarrying and mining methods

Students:

- locate and relate a range of non-renewable resources to their location, for example:
  - minerals
  - fossil fuels (ACSES072)
  - ores of economic significance (ACSES071, ACSES072)

Students:

- analyse the economic importance of Australia's non-renewable resources (ACSES061)

Students:

- investigate and assess the appropriateness of direct sampling techniques and remote sensing techniques in discovering non-renewable resources (ACSES073), including but not limited to:
  - satellite images
  - aerial photographs
  - geophysical data

Students:

- investigate the locations and extraction methods of, for example: (ACSES074)
  - open-pit mining
  - underground mining methods
  - offshore and onshore drilling

Module 2: Plate Tectonics

Outcomes

A student:

- develops and evaluates questions and hypotheses for scientific investigation EES11/12-1
- designs and evaluates investigations in order to obtain primary and secondary data and information EES11/12-2
- conducts investigations to collect valid and reliable primary and secondary data and information EES11/12-3
- selects and processes appropriate qualitative and quantitative data and information using a range of appropriate media EES11/12-4
- analyses and evaluates primary and secondary data and information EES11/12-5
- describes the evidence for the theory of plate tectonics and the energy and geological changes that occur at plate boundaries EES11-9

Content Focus

The Earth's surface is made of a series of tectonic plates that move and interact with one another. Solid evidence for the theory of plate tectonics was not proposed until the early 20th century. Initially, the theory was dismissed because of a lack of evidence. Eventually, however, the work of a series of scientists was combined to produce enough evidence to support acceptance of the theory. In many cases, the development of new technologies has allowed the individual pieces of this scientific puzzle be put together.

The theory of plate tectonics can explain not only the location and causes of earthquakes and volcanoes, but also the location of mountain ranges (both above and under the oceans) and deep ocean floor trenches. This theory also helps to explain many aspects of climate, evolution and extinction, and supports predictions about the future.

Working Scientifically

In this module, students focus on developing questions and hypotheses when processing data while conducting investigations to analyse trends, patterns and relationships in plate tectonics, and the energy transformations and geological changes that continue to occur. Students should be provided with opportunities to engage with all Working Scientifically skills throughout the course.

Content

Evidence for the Theory of Plate Tectonics

Inquiry question: What is the current evidence for the theory of plate tectonics and how did the theory develop?

Students:

- analyse evidence, including data and models, that supports the theory of plate tectonics, including but not limited to:
  - the 'jigsaw fit' of the continental shelves (ACSES004, ACSES006)
  - matching up identical fossils on different continents (ACSES004, ACSES006)
  - the profile of the ocean floor
  - the age of sea floor rocks (ACSES004)
  - magnetic reversals in sea floor rocks (ACSES035)

Students:

- evaluate the contributions of the following theories, models and research to our understanding of the movement of plates, including but not limited to: (ACSES005, ACSES009, ACSES035, ACSES038)
  - Wegener – continental drift
  - Holmes – convection in the mantle
  - Hess – sea floor spreading
  - Vine and Matthews – magnetic reversals (ACSES004)
  - *Glomar Challenger* – age of oceanic floors

Plate Boundaries

Inquiry question: What occurs at plate boundaries?

Students:

- use geological maps of the Earth to locate boundary types and model the processes that have contributed to their formation, including: (ACSES006, ACSES035, ACSES099)
  - divergent boundaries
  - convergent boundaries
  - transform boundaries

Plate Boundaries and Tectonic Structures

Inquiry question: What are the geological and topographic features that have resulted from plate tectonics at each plate boundary type?

Students:

- model types of plate boundaries showing the dominant topographic and geological features, including: (ACSES006)
  - divergent boundaries: rift valley, mid-ocean ridge, normal and transform faults
  - convergent boundaries: mountain range, trench, reverse faults and folds

Students:

Module 3: Energy Transformations

Outcomes

A student:

› analyses and evaluates primary and secondary data and information EES11/12-5
› solves scientific problems using primary and secondary data, critical thinking skills and scientific processes EES11/12-6
› communicates scientific understanding using suitable language and terminology for a specific audience or purpose EES11/12-7
› describes the factors that influence how energy is transferred and transformed in the Earth's systems EES11-10

Content Focus

Earth's processes require energy. This energy may be transformed from one form into another or transferred between objects. Energy from the Sun and the Earth's interior control processes within and between the Earth's spheres. Heat and gravitational energy in the Earth's interior also drives the movements of tectonic plates. Energy transfers that occur on different timescales between the atmosphere, oceans and land generate weather and climate phenomena. The influence of cyclic phenomena, including El Niño and La Niña, affect global weather patterns.

Knowledge of the Earth's processes and of energy transfer allows scientists to explain phenomena and predict areas at risk.

Working Scientifically

In this module, students focus on collecting, processing and analysing data and information in order to solve problems and communicate ideas about energy transformations in the Earth's systems. Students should be provided with opportunities to engage with all Working Scientifically skills throughout the course.

Content

Role of Energy in the Earth's Processes

Inquiry question: How does energy drive the Earth's processes?

Students:

- conduct a practical investigation to demonstrate convection currents (ACSES031)

Students:

- analyse the role of solar radiation in driving the Earth's processes, eg photosynthesis and the water cycle (ACSES046, ACSES048)

Students:

- investigate the role of gravity and heat in tectonic plate movements, including: (ACSES033, ACSES047)
  - comparing the movement of the Earth's plates to surface movements of other bodies in the solar system
  - modelling movement caused by gravity and heat (ACSES048, ACSES049)
  - describing the contributions of convection and slab pull to plate speed

Geological Transformations: Earthquakes, Volcanoes and Mountain Ranges

Inquiry question: How do energy transfers and transformations alter the lithosphere? (ACSES055, ACSES056)

Students:

- explain how the release of elastic potential energy in rock leads to earthquakes (ACSES044, ACSES047)

Students:

- describe the role of heat and its interactions with the lithosphere in creating different types of volcanic eruptions and magma compositions, including but not limited to: (ACSES099)
  - thermal plumes resulting in effusive mafic eruptions
  - partial melting of subducted oceanic plates resulting in explosive felsic eruptions
  - interactions of magma and overlying ice resulting in ash clouds

Students:

- represent these energy transformations in the formation of mountains due to:
  - thermal expansion
  - deformation of the lithosphere (ACSES035)

Students:

Transformations in the Oceans, Biosphere and Cryosphere

Inquiry question: How do energy transformations influence the atmosphere, oceans, biosphere and cryosphere?

Students:

- investigate the unique properties of water that make it such an important component of the Earth's systems, including: (ACSES024)
  - boiling point
  - ability to act as a solvent
  - density
  - thermal capacity
  - surface tension

Students:

- outline the roles of energy, water masses and salinity in producing ocean currents (ACSES051)

Students:

- explain the role of heat transfer by ocean currents and atmospheric movement in causing phenomena, eg El Niño and La Niña (ACSES052)

Students:

- extract information from secondary sources to document and investigate changes in the cryosphere (ACSES034)

Module 4: Human Impacts

Outcomes

A student:

- develops and evaluates questions and hypotheses for scientific investigation EES11/12-1
- designs and evaluates investigations in order to obtain primary and secondary data and information EES11/12-2
- conducts investigations to collect valid and reliable primary and secondary data and information EES11/12-3
- describes human impact on the Earth in relation to hydrological processes, geological processes and biological changes EES11-11

Content Focus

Humans use the Earth's resources to maintain life and provide infrastructure. However, natural resources are not infinite. Renewable resources such as water, soil, plants and animals can be managed sustainably using scientific knowledge. Incomplete information or failure to consider the impact of resources use may cause environmental damage.

Scientific knowledge enables efficient use of resources and also the rehabilitation of damaged ecosystems. Healthy ecosystems provide renewable resources, purify air and water, regulate climate and provide cultural services.

Working Scientifically

In this module, students focus on developing questions and hypotheses when planning and conducting investigations about human impacts on the Earth. Students should be provided with opportunities to engage with all Working Scientifically skills throughout the course.

Content

Water Management

Inquiry question: How can water be managed for use by humans and ecosystems?

Students:

- represent the distribution of the Earth's water, including the amount available to plants and animals (ACSES060)

Students:

- investigate the treatment and potential reuse of different types of water, including but not limited to: (ACSES058)
  - industrial wastewater
  - sewage
  - stormwater

Students:

- Describe ways in which human activity can influence the availability and quality of water both directly (eg over-extraction) or indirectly (eg algal blooms) (ACSES080)

Salinity and Erosion

Inquiry question: How does human use of land affect soil?

Students:

- explain causes of salinisation, including but not limited to: (ACSES024)
  - land clearing
  - irrigation

Students:

- investigate the rehabilitation of salinity-affected area(s) by preparing a case study (ACSES070)

Students:

- conduct a practical investigation into soil erosion prevention and analyse the efficacy of the method(s) used (ACSES060, ACSES102)

Students:

- investigate sources and effects of soil contamination, including but not limited to:
  - heavy metal contamination

Effects of Introduced Species

Inquiry question: How do introduced species affect the Australian environment and ecosystems?

Students:

- outline the biotic and abiotic effects of introduced species

Students:

- conduct an investigation into a local introduced species, including:
  - reason for introducing the species
  - biotic and abiotic effects of the species
  - area affected by the species
  - human impacts that favour the introduced species
  - control or mitigation methods
  - economic impact of the species
  - different views about the value of and/or harm caused by the introduced species, including the views of Aboriginal and Torres Strait Islander Peoples

Students:

Students:

- analyse ways in which human activity can upset the balance of ecosystems and favour introduced species (ACSES027)

Students:

- describe ways in which introduced species contribute to the decline or extinction of native Australian species (ACSES081)