 Year 11 Earth and Environmental Science

Module 1 – Earth’s Resources[[1]](#footnote-1)

Duration: 3 Weeks

This section investigates the Earth’s lithosphere and its composition. Students be­come familiar with common minerals, the formation of different types of rocks and their classification. They extend their knowledge of the Earth and Space from Science Stage 5 by learning about the changes involved in the rock cycle and the development and composition of soils.

Inquiry question

What are the components of rocks and soils?

Outcomes

* EES11/12-1 develops and evaluates questions and hypotheses for scientific investigation
* EES11/12-3 conducts investigations to collect valid and reliable primary and secondary data and information
* EES11/12-4 selects and processes appropriate qualitative and quantitative data and information using a range of appropriate media
* EES11-8 describes the key features of the Earth’s systems, including the geosphere, atmosphere, hydrosphere and biosphere and how they are interrelated

| Content descriptor | Teaching and learning | Evidence of learning |
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| Investigate methods of classifying rocks and minerals used by Aboriginal and Torres Strait Islander Peoples | Background:Aboriginal and Torres Strait Islander Peoples have generally classified rocks and minerals based on their uses in the community. Their chemical makeup and physical properties (e.g. grain size, colour, hardness) will determine these uses, such as stone tools for grinding grains and pigments for art making or ceremonies.Research Task:Students access a variety of resources to investi­gate various properties of rocks and minerals and their uses by Aboriginal and Torres Strait Islander Peoples. Some examples could include grinding or cutting tools, ceremonial pigments, medicinal purposes, fish trapping and hooking methods and building structures.[Article and video on Aboriginal use of rocks and minerals](https://museumsvictoria.com.au/website/melbournemuseum/discoverycentre/dynamic-earth/videos/aboriginal-use-of-rocks-and-minerals/index.html)[Article on ancient Aboriginal fish traps](https://www.theguardian.com/australia-news/2015/jul/10/fish-traps-brewarrina-extraordinary-ancient-structures-protection)[Website on methods of fishing used by Aboriginal people around Sydney](https://australianmuseum.net.au/learn/cultures/atsi-collection/sydney/)Activity:Create a table that summarises and compares at least three examples of known rocks/minerals used by Aboriginal and Torres Strait Islander Peoples. Include information about their uses, physical properties and if possible, their names used by local people. Include bibliography that lists resources accessed. Discuss the need to access relevant and reliable information from secondary sources. | * Students appreciate the indigenous perspectives on classification, which is based on uses rather than their mode of formation or their chemical makeup.
* Students can provide multiple examples of uses of rocks/minerals by Aboriginal, and Torres Strait Islander Peoples and relate them to physical properties.
* Students can select and process information from a range of relevant and reliable secondary sources.
* Students can collate and organise information into a table which allows them to communicate their understanding of Aboriginal uses of rocks/minerals effectively.
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| Investigate the chemical composition of a variety of minerals and explain their for­mation, including:felsic mineralsmafic minerals | Background:Rocks of the lithosphere are made up of minerals. These are naturally forming inorganic substances with particular chemical makeup and physical properties. Common examples include quartz, mica and feldspar. It is important that students do not confuse the term “mineral” with “rock”.Students need to be aware that a “crystal” is simply a form of a mineral that has an orderly chemical structure and therefore a more structured appearance. [Video on “What is a mineral”?](https://www.youtube.com/watch?v=8a7p1NFn64s)The chemical makeup of minerals:Explain the formation of minerals, using common examples such as quartz, feldspar, mica, olivine, plagioclase (these are not to be confused with types of rocks).Explain that igneous rocks form from magma, which cools and crystallises either above or below the surface of the crust. The crystal sizes (or mineral sizes) of these rocks is influenced by the rate of cooling of the magma.**First-hand investigation:**Problem: How does the rate of cooling affect crystal size? They could be asked to predict the relationship between cooling rate and crystal size by designing and conducting a practical investigation using copper sulphate or alum solution. This can be then related to the formation of extrusive and intru­sive igneous rocks.[Worksheet with a practical investigation on the rate of cooling and crystal size.](https://www.rsc.org/education/teachers/resources/jesei/cooling/teachers.pdf)Note: the terms “felsic” and “mafic” are more commonly used when referring to rocks, rather than minerals. When discussing various types of minerals and classifying them as “felsic” or “mafic”, it may be useful to re-visit this concept when teaching about igneous rock types.Extension activities:The crystallisation of an igneous rock occurs in a set pattern; different minerals crystallise at different temperatures - this is Bowen’s Reaction Series. Introduce Bowen’s reaction series using digital media; some possible links are listed below. Students could be provided with the diagram and posed scenarios that require them to solve problems with the use of the diagram.[Video on Bowen’s reaction series](https://www.youtube.com/watch?v=ZggKhS4hr_Y)[A diagram on Bowen’s reaction series](http://kanat.jsc.vsc.edu/env1050/bowen.pdf) | * Students can accurately distinguish between a mineral, crystal and rock, with common examples of each.
* Students can appreciate that different minerals are based on different chemical compositions.
* Students can hypothesise, design and conduct a first-hand investigation to relate the rate of cooling to crystal size (and therefore mafic/felsic makeup of rocks).
* Students correctly interpret diagrams from secondary sources to gain knowledge and make predictions.
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| Investigate the physical properties of minerals that are used to assist in classification | Research Task:Students research and create a table that defines each of the properties listed below and outlines how they are used to identify common minerals. These could include:* Hardness
* Lustre
* Streak
* Cleavage
* Colour
* Fracture

[Video on identifying minerals](https://www.youtube.com/watch?v=32NG9aeZ7_c) Firsthand investigation:Students are provided with samples of common rock-forming minerals, and any necessary equipment (e.g. magnifying glass), then they will use observed physical properties and secondary sources to classify them. | * Students can collate and organise information into a table which allows them to communicate their understanding of the physical properties of minerals effectively.
* Students can observe and accurately record information from first-hand and secondary sources.
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| 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 | The Rock Cycle:Use forms of diagnostic assessment to gauge students’ prior knowledge of the rock cycle, e.g. Mind maps, online quizzes, or simply asking them to draw the rock cycle.Explain the primary mode of formation for extrusive (volcanic) and intrusive (plutonic) igneous, with common examples for both, including basalt and gabbro. Relate the findings to the first-hand investigation already conducted on crystal size and cooling.Explain the primary mode of formation for common sedimentary rocks, acknowledging that classification is generally based on grain size (e.g. sandstone, mudstone and conglomerate). In other cases, sedimentary rocks can be formed from pre-existing organisms (e.g. limestone, coal).Explain the mode of formation of metamorphic rocks, using common examples including marble (from limestone). Students could use diagrams to demonstrate how temperature and pressure beneath the crust can allow formation.**First-hand investigation:**Students model the formation of different types of sedimentary rocks (e.g. sandstone, mudstone, conglomerate) using sediments or rock fragments of various sizes and plaster to allow cementation, relating grain size to rock type. Discuss the success and limitations of the model.**Research Task:**In small groups, students use secondary sources to help them to create an intricate diagram of the rock cycle. It should include the processes that allow all changes from one rock type to another.[Resource booklet with diagrams and information on the rock cycle](https://www.dvusd.org/cms/lib/AZ01901092/Centricity/Domain/4994/Sedimentary%20Rock%20Formation%20Models.pdf)**Summative Task:**Assess students’ ability to draw the rock cycle with no assistance from resources. | * Diagnostic assessment will allow for a comparison of student understanding of the rock cycle before and after the teaching of the concept. Doing activities and investigations related to the concept may allow for a deeper understanding and retention of knowledge.
* Modelling a real scientific process that not visible and occurs over a long period is a valuable tool in science. Student can develop an appreciation of this and be able to discuss the limitations of such models.
* Develop an intricate diagram of the rock cycle in­corporating all necessary components and processes. This allows for simplification of quite a complex set of processes essential to understanding basic geology.
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| Investigate a range of rocks and minerals and classify samples using dichotomous keys | Background:Explain the uses of keys in science to help identify and classify things. This could be an opportunity to introduce dichotomous keys using objects such as laboratory equipment or components of a pencil case.Activity:Teachers could provide students with a copy of a key (dichotomous or otherwise) to allow identification of common rock types.[An example of a key (not dichotomous) used to classify rocks](http://vhmsscience.weebly.com/uploads/1/2/7/6/12762866/423293_orig.jpg)[An interactive dichotomous key activity for common minerals](http://exchange.smarttech.com/details.html?id=cdce8076-9416-4d46-b405-2bba511b1c05)[Video showing common minerals and rocks](https://www.youtube.com/watch?v=7MvXv66b5h4) – this could be useful in aiding classification for teachers and students.First-hand investigation:Students are provided with a selection of common minerals or rocks (or images of these if none are available) and are required to construct a dichotomous key so other students could identify them. | * Student can construct and use dichotomous keys that they have constructed themselves to identify and classify things.
* Students can appreciate that physical properties of rocks and minerals can be used to classify them.
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| Explain the formation of soil in terms of the interaction of atmospheric, geologic, hydrologic and biotic processes | Inquiry-based activity:The topic of soil could be investigated as an open-ended inquiry. Some lead-up questions to brainstorm could include:What is soil? Where does it come from? How long does it take to make soil? Why is soil so important for life on Earth?The student responses could then be evolved to introduce the inquiry question: What are the different processes responsible for making soil? In groups, students could research the processes that are occurring in each “sphere” (atmosphere, hydrosphere, biosphere and lithosphere) to determine contributions to the formation of soil through the breakdown of the parent material. A poster or large diagram can be constructed by the class to illustrate the interactions between each one.[Website on Soil Science Activities](https://www.soils4teachers.org/lessons-and-activities) – useful links to lesson ideas and activities students could conduct on soils. | * Students can use skills in secondary source research to collaboratively explain the concept of soil formation and the interactions between each “sphere”.
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| Conduct a practical investigation to examine soil types and component materials | First-hand investigation:Students could collect samples of soil from different regions of their local environment (preferably from areas with different parent material, e.g. coastal soils formed on sandstone, volcanic soils formed on basalt, etc.).They could conduct a series of physical and chemical tests (e.g. soil structure, pH, drainage ability, organic content, moisture) to compare the different samples.This task could be scaffolded in such a way that students could potentially devise their hypotheses, design their investigations, collect and analyse data and construct their learning using fair testing principles. It would also be a good opportunity for them to produce a scientific report. | * Students can propose hypotheses, design a valid investigation, collect, analyse and evaluate data and produce a scientific report.
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Reflection and evaluation:

1. This document references the Stage 6 Earth and Environmental Science syllabus © 2019 [NSW Education Standards Authority (NESA) for and on behalf of the Crown in right of the State of New South Wales.](http://syllabus.nesa.nsw.edu.au/copyright/) [↑](#footnote-ref-1)