**Sample Unit – Earth and Environmental Science - Year 11**

***Sample for implementation from Year 11 from 2018***

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| **Module 1: Earth’s resources** | **Duration** | 30 hours including a 5 hour Depth Study |
| **Content Focus**Students investigate compositional layers of the Earth. They examine rock composition and the origins of the component materials, including minerals. They extend their knowledge of Earth and space from Stage 5 Science by learning about soil, the rock cycle and technologies used to gather geological data.Students explore 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.**Module Focus**As the first module in the Earth and Environmental Science course, there is an emphasis on reviewing and developing student’s prior knowledge gained in Stage 4 and Stage 5 Science.**Working Scientifically**Students focus on conducting investigations to collect, process and analyse data in order to identify trends, patterns and relationships of the Earth’s resources. Students are provided with opportunities to engage with all Working Scientifically skills throughout the course. |
| **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
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| **Resources*** Space – Episode 1 Star stuff <http://www.dailymotion.com/video/x11afti_space-with-sam-neill-episode-1-star-stuff_tech>
* graphs of seismic wave velocities
* oil, corn syrup, pvc glue
* samples of granite, basalt, olivine, and haematite
* diverse range of igneous rock samples
* balances, displacement cans/measuring cylinders
* saturated potassium nitrate solution
* Smithsonian Environmental Research Centre <forces.si.edu/soils/>
* CSIRO Soil Landscape grid of Australia <http://www.clw.csiro.au/aclep/soilandlandscapegrid/>
 | **Formal assessment****Field study:** Students engage in a geological field study and investigate soil profiles.They compare a site that has an agricultural use and a natural site. **Depth Study for assessment**Students choose one area of soils from the field study that interests them and develop an inquiry question. They must include a practical investigation and research in their investigation. Students report their findings in 5 minute oral presentation.  |
| **Inquiry questions**1. How did the compositional layers of the Earth develop?
2. What are the components of rocks and soils?
3. How is the age of geological materials determined?
4. How are non-renewable geological resources discovered and extracted?
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| **Working Scientifically Skills****Questioning and Predicting - ESS11/12-1**A student develops and evaluates questions and hypotheses for scientific investigationStudents:* develop and evaluate inquiry questions and hypotheses to identify a concept that can be investigated scientifically, involving primary and secondary data (ACSES001, ACSES061, ACSES096)
* modify questions and hypotheses to reflect new evidence

**Planning Investigations - ESS11/12-2**A student designs and evaluates investigations in order to obtain primary and secondary data and informationStudents:* assess risks, consider ethical issues and select appropriate materials and technologies when designing and planning an investigation (ACSES031, ACSES097)
* justify and evaluate the use of variables and experimental controls to ensure that a valid procedure is developed that allows for the reliable collection of data (ACSES002)
* evaluate and modify an investigation in response to new evidence

**Problem Solving - ESS11/12-6**A student solves scientific problems using primary and secondary data, critical thinking skills and scientific processesStudents:* use modelling (including mathematical examples) to explain phenomena, make predictions and solve problems using evidence from primary and secondary sources (ACSES006, ACSES010)
* use scientific evidence and critical thinking skills to solve problems

**Communicating - ESS11/12-7**A student communicates scientific understanding using suitable language and terminology for a specific audience or purposeStudents:* select and use suitable forms of digital, visual, written and/or oral forms of communication
* select and apply appropriate scientific notations, nomenclature and scientific language to communicate in a variety of contexts (ACSES008, ACSES036, ACSES067, ACSES102)
* construct evidence-based arguments and engage in peer feedback to evaluate an argument or conclusion (ACSES034, ACSES036)
 | **Targeted Working Scientifically skills****Conducting Investigations - ESS11/12-3**A student conducts investigations to collect valid and reliable primary and secondary data and informationStudents:* employ and evaluate safe work practices and manage risks (ACSES031)
* use appropriate technologies to ensure and evaluate accuracy
* select and extract information from a wide range of reliable secondary sources and acknowledge them using an accepted referencing style

**Processing Data and Information - ESS11/12-4**A student selects and processes appropriate qualitative and quantitative data and information using a range of appropriate mediaStudents:* select qualitative and quantitative data and information and represent them using a range of formats, digital technologies and appropriate media (ACSES004, ACSES007, ACSES064, ACSES101)
* apply quantitative processes where appropriate
* evaluate and improve the quality of data

**Analysing Data and Information - ESS11/12-5**A student analyses and evaluates primary and secondary data and informationStudents:* derive trends, patterns and relationships in data and information
* assess error, uncertainty and limitations in data (ACSES004, ACSES005, ACSES033, ACSES099)
* assess the relevance, accuracy, validity and reliability of primary and secondary data and suggest improvements to investigations (ACSES005)
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| Topic: Structure of the Earth, the Early Geosphere, Atmosphere and Hydrosphere |
| **Inquiry question:** How did the compositional layers of the Earth develop? |
| **Content** | **Teaching, learning and assessment** | **Resources** |
| **Students:*** investigate and model the processes that formed the geosphere (ACSES018), atmosphere (ACSES022) and hydrosphere (ACSES023)  Information and communication technology capability icon
 | * use secondary resources, eg video *Space (Star Stuff ep 1)* to describe the formation of the Earth and universe using the terms:  Information and communication technology capability icon
* gravity
* accretion
* differentiation
* outline how this model of Earth’s formation accounts for the formation and distribution of the geosphere, atmosphere and hydrosphere
 | video *Space (Star Stuff ep 1)* [*http://www.dailymotion.com/video/x11afti\_space-with-sam-neill-episode-1-star-stuff\_tech*](http://www.dailymotion.com/video/x11afti_space-with-sam-neill-episode-1-star-stuff_tech) |
| **Students:*** investigate evidence for the structure of the Earth using technologies, including:
* seismic wave velocities Critical and creative thinking icon
* meteorite evidence to demonstrate differences in density and composition (ACSES009, ACSES018)
 | * observe and interpret graphs of seismic wave velocities to view changes at the Mohorovičić discontinuity (MOHO) and sphere boundaries
* analyse the types of information that can be gained by these direct methods of observation:
* mines and boreholes
* geothermal gradient
* volcanoes bringing magma from depth
* Ophiolite suites and indirect methods of observation
* seismic wave velocities
* shadow zones
* average densities
* meteorites
 | Seismic waves from Sumatra 2004 <http://ds.iris.edu/seismon/swaves/>Meteorites <http://www.tulane.edu/~sanelson/Natural_Disasters/impacts.htm>  |
| **Students:*** conduct a practical investigation to compare the differences in the density of representative rock samples found in the crust, mantle and core (ACSES003) Numeracy icon
 | * investigate the density of different liquids and observe their behaviour when mixed, eg mixture of oil, water and corn syrup
* calculate the density (D= M/V) of granite (Continental crust), basalt (oceanic crust), olivine (mantle) and haematite (core) using balances and displacement cans/measuring cylinders.
* use this data to explain the occurrence of layers within Earth
 | Oil, water, corn syrup, measuring cylinder |
| **Students:*** describe the compositional layers and thickness of the Earth’s layers, including:  Literacy icon Numeracy icon
* lithosphere (ACSES015)
* asthenosphere
* crust, mantle and core and their compositional layers (ACSES006)
 | * explore how the shadow zones of P and S wave patterns provide evidence concerning the structure of the Earth
* construct a table to compare the layers of the Earth in terms of composition and thickness
* using a suitable technology, construct a cross sectional, model of the Earth to scale to clearly show the relative thickness and composition of the layers of the Earth
 | Layers of the Earth <https://sites.google.com/site/missiontomarsatvssec/home/mission-background-briefing-students/earth-vs-mars/structure-of-the-earth>  |
| **Students:*** analyse evidence of the Earth’s age, including: Critical and creative thinking icon
* formation and age of zircon crystals Numeracy icon
* radiometric techniques Numeracy icon
* meteorite evidence (ACSES009)
 | * investigate ways in which the age of the Earth can be determined
* explain how the following can be used to provide data to determine the age of the Earth:
* zircon crystals
* radiometric techniques
* meteorites
 | Zircon crystals <http://www.abc.net.au/science/audio/2014/02/26/3952105.htm> and <http://www.abc.net.au/science/audio/2014/02/26/3952105.htm>  |

| Topic: Rocks, Minerals and the Rock Cycle |
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| **Inquiry question:** What are the components of rocks and soils? |
| **Content** | **Teaching, learning and assessment** | **Resources** |
| **Students:*** investigate methods of classifying rocks and minerals used by Aboriginal and Torres Strait Islander Peoples
 | * research how ochre has been classified by Aboriginal miners
* research the different stones that are used as tools by Aboriginal Peoples
* research the methods used by Aboriginal Peoples to determine whether a rock is suitable to be made into a tool or implement?
 | Ochre<http://koorihistory.com/earth-pigments-ochre/>Use of rocks <https://museumvictoria.com.au/melbournemuseum/discoverycentre/dynamic-earth/videos/aboriginal-use-of-rocks-and-minerals/><http://www.oldcourthousemuseum.com/Stone%20tools_web.pdf> |
| **Students:*** investigate the chemical composition of a variety of minerals and explain their formation, including:
* felsic minerals
* mafic minerals
 | * research the relative abundance of elements in the crust as opposed to the entire Earth
* construct bar charts to show the relative abundance of elements in these areas and account for any observed discrepancies
* observe a range of igneous rocks (basalt, gabbro, diorite, andesite, rhyolite, granite) and group them in different ways
* identify and summarise the characteristics of rocks formed by:
* felsic minerals
* mafic minerals
* investigate the characteristics of mafic minerals (eg biotite, hornblende, olivine) in relation to chemical composition, colour and hardness. Research the chemical composition of each sample.
 | Samples of igneous rocksSamples of minerals |
| **Students:*** investigate the physical properties of minerals that are used to assist in classification
 | * identify a range of minerals using a key and the minerals’ characteristics:
* hardness
* streak
* lustre
* cleavage
* use this information to complete a table titled ‘Properties of some minerals’
* investigate the relationship between rate of cooling on crystal size using, eg saturated potassium nitrate solution
* construct a 3D model of the silica tetrahedron. SiO4
* give the chemical formulae for the following mafic minerals: quartz and feldspar.
* explain the abundance of silicate minerals in the Earth’s crust
 | Samples of mineralsSaturated solution of potassium nitrate (KNO3)Molecular model of silica (SiO4)Mineral identification <https://www.thoughtco.com/how-to-identify-minerals-1440936>  |
| **Students:*** examine a range of rocks and minerals and classify samples using dichotomous keys
 | * examine a wide range of rocks and using the data obtained previously, classify the rocks using a dichotomous key
* examine a range of rocks, eg marble, chalk, chert, pumice, slate and match them to a use, eg benchtops, tiles, spearheads, removing calloused skin, preventing slipping
* construct a key using the physical properties of the rocks to justify their function
 | Various rock samples |
| **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)
 | * review the processes involved in the Rock Cycle by engaging with digital animations
* examine a range of parent rocks and their metamorphic equivalents to identify and describe similarities and differences
* create an infographic or flowchart to describe the processes that form/change rocks through the rock cycle
 | ‘Rock Recipes’ YouTube video <https://www.youtube.com/watch?v=MZn0I3J2RTg> Rock cycle: <https://www.learner.org/interactives/rockcycle/rockdiagram/>  |
| **Students:*** explain the formation of soil in terms of the interaction of atmospheric, geologic, hydrologic and biotic processes (ACSES020)
 | * investigate a range of computer interactives that demonstrate the formation of soil, eg Smithsonian Environmental Research Centre
* describe the interactions resulting in the formation of soils:
* atmospheric
* geologic
* hydrologic
* biotic
* create an infographic or flowchart to summarise the factors affecting soil formation
 | Smithsonian Institute Dig It <http://forces.si.edu/soils/> |
| **Students:*** conduct a practical investigation to examine soil types and component materials (ACSES020)
 | * collect soil samples from an augured hole or trench
* construct a soil sedimentation column. Measure the proportions of:
* organic material
* sand
* clay/silt
* compare a range of soil profiles to note similarities and differences
* relate the processes of soil formation to the differences in soil profiles
* gather evidence to show that soil is a mixture not just sediment grains
* classify soils based on their composition of:
* clay
* silt
* sand
* moisture content
* organic content
* create a diagram describing these relationships

**Depth Study for assessment*** Students choose one area of soils from the field study that interests them and develop an inquiry question. They must include a practical investigation and research in their investigation. Students report their findings in 5 minute oral presentation.
 | Augur to collect soil samples |

| Topic: Geological Timescale |
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| **Inquiry question:** How is the age of geological materials determined? |
| **Content** | **Teaching, learning and assessment** | **Resources** |
| **Students:*** describe relative and absolute dating of the geosphere (ACSES017)
 | * define the terms relative and absolute dating
* investigate different methods used to determine the age of the geosphere by:
* relative dating
* absolute dating
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| **Students:*** use data of both relative and absolute dating from secondary sources to determine the age of geological materials (ACSES013, ACSES015, ACSES016, ACSES017)  Information and communication technology capability icon
 | * determine the relative ages of objects, such as fossils, by using simple geologic principles, eg:
* the principle of superposition
* cross cutting relationships
* floral and faunal succession
* describe and justify the processes that could be used to date a fossil found in the local area
* using half-life data, calculate the absolute the ages of rocks
* determine the geologic history of an area using both relative and absolute principles
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| Topic: Geological Resources |
| **Inquiry question:** How are non-renewable geological resources discovered and extracted? |
| **Content** | **Teaching, learning and assessment** | **Resources** |
| **Students:*** investigate traditional Aboriginal quarrying and mining methods Aboriginal and Torres Strait Islander histories and cultures icon
 | * research the types and locations of Aboriginal quarries and mines
* describe the geology of these areas
* discuss the uses and trade generated by these quarries and mines
 | <http://www.ancient-origins.net/ancient-places-australia-oceania/wilgie-mia-ancient-mine-where-ochre-runs-red-kangaroo-blood-001425?nopaging=1><https://www.communityheritage.net.au/mount-william-stone-hatchet-quarry>  <http://www.vic.gov.au/system/user_files/Documents/av/Quarries.pdf>Consult with Local Aboriginal Land Councils |
| **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)
 | * recall and compare the meanings of:
* renewable resources
* non-renewable resources
* sustainable resources
* access data to locate and mark on a map of Australia, important economic deposits of:
* minerals
* ores
* fossil fuels
* use this data to justify why these deposits are considered to be economically important
 | Operating mines <http://www.australianminesatlas.gov.au/> |
| **Students:*** analyse the economic importance of Australia’s non-renewable resources (ACSES061) Critical and creative thinking icon  Numeracy icon Work and enterprise
 | * access graphs/charts of the percentage of Australia’s GDP over time
* determine the relative importance of non-renewable resources on Australia’s GDP
* discuss the impact on GDP if Australia were to reduce mining and production of fossil fuels over the next 30 years
* discuss alternatives that could replace the fossil fuel component of GDP
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| **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
 | * identify and describe a range of techniques used in:
* direct sampling
* remote sensing
* assess the usefulness of data obtained to identify the location, type, quality and amount of non-renewable resources gained by:
* magnetic survey
* radiometric survey
* aerial photography
* satellite images
* assess an area for drilling using raw data of a given area using resources such as geological maps
 | Geological maps <http://www.resourcesandenergy.nsw.gov.au/__data/assets/pdf_file/0011/279623/00121-quarterly_notes_jun06.pdf> |
| **Students:*** investigate the locations and extraction methods of, for example: (ACSES074)
* open-pit mining
* underground mining methods
* offshore and onshore drilling
 | * investigate a nominated mine or resource, in groups, and share the following information:
* using the data previously gathered on Australia’s non-renewable resources, identify the locations using the following extraction methods:
* open-pit mining
* underground mining methods
* offshore and onshore drilling
* describe the environmental effects of the extraction methods used
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**Reflection and Evaluation**

**TEACHER: CLASS:**

**DATE UNIT COMMENCED: DATE UNIT CONCLUDED:**

* **Variations to program:** (List additional resources and outline alternative strategies used.
* **The most effective teaching/ learning strategies and resources in this unit were:** (Please nominate 3 at least)
* **Less effective teaching strategies and resources for this unit were:** (Please nominate 2 at least)

**TEACHER’S SIGNATURE\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

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