Unit Guide: The Rock Cycle & Soils

LEARNING AREA: Science
GRADE: 8
DURATION OF UNIT: 5-6 Weeks

Topic of study: The Rock Cycle & Soils
LEARNING INTENTION for this unit of work We are learning to (verb)… • Understand key rock cycle processes, drawing upon a variety of real-world examples. • Understand linkages of these rock cycle processes to the properties of rocks and soils. • Link to the rock cycle and Earth's spheres (including the geosphere, hydrosphere, atmosphere and biosphere), using several examples. • Understand geological time periods, and how people can assign time periods to rock samples from thousands or millions of years ago. • Develop observation skills to describe the diagnostic properties of rocks and minerals. • Use our understanding of rocks to explain how their properties influence soils and soil nutrients. • Understand how soils are formed, their properties and importance to biotic and abiotic systems (living & non-living). • Describe and explain how rocks and soil types can influence the types of agriculture and food systems supported in an environment. • Apply knowledge of soil to case studies by describing and explaining soil profiles. • Explain and describe examples of the cultural importance and role of various rocks and minerals in cultural practices with respect to First Nations Australians, including drawing upon primary evidence sources. • Use different forms of information and evidence sources, and critically evaluate the validity and robustness of these sources. • Understand society and humans' influence upon the rock cycle, and our use of its resources – including fossil fuels.
SUCCESS CRITERIA for this unit of work (What will a successful unit look like?) • Students actively participate & contribute to class discussions • Students can identify and describe various key processes involved in the rock cycle, drawing upon specific real-world examples • Students grasp geological time periods, and the processes that occur over these periods • Students can clearly link processes within the rock cycle with the Earth's spheres, identifying their relationship and providing examples of these • Students gain a greater understanding of the formation of soils, their properties, and importance with supporting abiotic and biotic systems – including supporting society through food production • Students achieve an understanding of the cultural importance of rocks and minerals • for First Nations peoples, and draw upon evidence to support this understanding. • Linkages are clearly made between the rock cycle, soils and the development of sustainable agricultural practices.

Compiled for TIA's Professional Learning Workshops *Engaging Students in STEM using Agriculture (2023).*
Contact bianca.deans@utas.edu.au for further information.

- Students can explain the importance of peer-review and rigorous scientific research and its role in informing society of scientific understanding
- Students can identify and describe the ways that humans are impacted by and supported by (use resources) from the rock cycle, including specific examples (e.g., cultivation of agricultural land, use of fossil fuels)

We are doing this because… (The Why)

Understanding the rock cycle and its processes are fundamental to all living and non-living forms, especially as they are inter-linked with the Earth's spheres (biosphere, atmosphere, hydrosphere, geosphere).

Our environment and society are directly influenced by the rock cycle and its processes. These impact many aspects of society, the environment, culture, and the economy. This includes for our agricultural industry and food security.

It is important to gain an understanding the cultural significance of rocks and minerals for First Nations Australians, including drawing upon specific examples and primary evidence.

Understanding the rock cycle can help us appreciate how agriculture is supported, and ways that more sustainable practices can be developed and adopted in food and fibre systems.

Unpacking the science behind topical and relevant issues in society make us better-informed learners and real-world citizens.

Understanding geological time periods allows us to be more big-picture thinkers and learners, and understand what has occurred in time period now, and how this shapes what we see and experience today.

Critically evaluating sources and the validity of evidence makes us better critical thinkers and grows our respect for the science that has been conducted in the past, and the scientific knowledge that is to come.

Students will know… (Knowledge)	Students will be able to… (Skills)
• The key processes within the rock cycle, and be able to apply this knowledge to explain how different types of rocks and soils form • The interlinking elements of the rock cycle across the Earth's spheres: biosphere, atmosphere, hydrosphere, geosphere • A general understanding of geological time scales, and the processes that occur over these (abiotic and biotic factors) • Diagnostic features of different rock types and soils • How the rock cycle and its products influence society and cultural practices, including specific examples of where we live, agriculture, and fossil fuels. • Understand the significance and role of rocks and minerals in cultural practices with respect to First Nations Australians. • The importance of the rock cycle in agricultural systems, including the food production industry.	• Identify and describe various key processes involved in the rock cycle, drawing upon specific real-world examples • Connect the rock cycle processes to the Earth's spheres (biosphere, geosphere, atmosphere, hydrosphere) • Identify and describe the ways that society and the environmental are impacted by the rock cycle • Develop and apply observation skills to identify rock and soil types. • Relate properties of rocks and soils to rock cycle processes, and agriculture systems • Explain and describe how rocks and soils influence agriculture, including crop productivity, sustainability and environmental resilience, including erosion • Explain and describe examples of the cultural importance and role of various rocks and minerals in cultural practices with respect to First Nations Australians, including drawing upon primary and secondary evidence sources.

• Understand ancient agricultural evidence and insect ecology via primary sources (fossil records) • Ways to critically evaluate the legitimacy and authenticity of scientific information and its sources • The importance of rigorous, peer-reviewed scientific research for development of scientific understanding • Understand the influence of society upon what research is conducted	• Explain and critically evaluate ancient agricultural evidence and insect ecology via primary sources (fossil records) • Critically evaluate the legitimacy and validity of evidence regarding the rock cycle and geological time periods • Explain the importance of peer-review and rigorous scientific research and its role in informing society of scientific understanding

Established Goals & Direct Links to the Australian Curriculum 9.0

This unit will provide students opportunities to develop their understanding of the carbon cycle and its inter-relations with the Earth's spheres, whilst also developing their understanding of the role and development of science within society. Students will develop their understanding of the importance of soils for society and the environment, and the career opportunities that exist relating to soil sciences and land management. This unit provides students with opportunities to address core inquiry aspects of the Australian Curriculum including evaluation and communication.

Each of the **three strands of the Australian Curriculum** that are covered within this unit include:

Strand: Science Understanding

- Earth and Space Sciences: AC9S8U04- *describe the key processes of the rock cycle, including the timescales over which they occur, and examine how the properties of sedimentary, igneous and metamorphic rocks reflect their formation and influence their use*

Strand: Science as a Human Endeavour

- Nature and development of science
  - AC9S8H01 *explain how new evidence or different perspectives can lead to changes in scientific knowledge*
  - AC9S8H02 *investigate how cultural perspectives and world views influence the development of scientific knowledge*
- Use & Influence
  - AC9S8H04 *explore the role of science communication in informing individual viewpoints and community policies and regulations*

Strand: Science inquiry

- Questioning and predicting:
  - AC9S8I01 *develop investigable questions, reasoned predictions and hypotheses to explore scientific models, identify patterns and test relationships*
- Planning and conducting
  - AC9S8I02 *plan and conduct reproducible investigations to answer questions and test hypotheses, including identifying variables and assumptions and, as appropriate, recognising and managing risks, considering ethical issues and recognising key considerations regarding heritage sites and artefacts on Country/Place*
  - AC9S8I03 *select and use equipment to generate and record data with precision, using digital tools as appropriate*
- Processing, modelling & analysing
  - AC9S8I04 *select and construct appropriate representations, including tables, graphs, models and mathematical relationships, to organise and process data and information*
  - AC9S8I05 *analyse data and information to describe patterns, trends and relationships and identify anomalies*
- Evaluating:
  - AC9S8I06 *analyse methods, conclusions and claims for assumptions, possible sources of error, conflicting evidence and unanswered questions*
  - AC9S8I07 *construct evidence-based arguments to support conclusions or evaluate claims and consider any ethical issues and cultural protocols associated with using or citing secondary data or information*
- Communicating:
  - AC9S8I08 *write and create texts to communicate ideas, findings and arguments for specific purposes and audiences, including selection of appropriate language and text features, using digital tools as appropriate*

Year 8 Achievement Standard

Addressed Achievement Standards are highlighted below. Respective Curriculum Streams & CD codes are listed below.

By the end of Year 8 students explain the role of specialised cell structures and organelles in cellular function and analyse the relationship between structure and function at organ and body system levels. They apply an understanding of the theory of plate tectonics to explain patterns of change in the geosphere. They explain how the properties of rocks relate to their formation and influence their use. They compare different forms of energy and represent transfer and transformation of energy in simple systems. They classify and represent different types of matter and distinguish between physical and chemical change. Students analyse how different factors influence development of and lead to changes in scientific knowledge. They analyse the key considerations that inform scientific responses and how these responses impact society. They analyse the importance of science communication in shaping viewpoints, policies and regulations.

Students plan and conduct safe, reproducible investigations to test relationships and explore models. They describe potential ethical issues and intercultural considerations needed for specific field locations or use of secondary data. They select and use equipment to generate and record data with precision. They select and construct appropriate representations to organise and process data and information. They analyse data and information to describe patterns, trends and relationships and identify anomalies. They identify assumptions and sources of error in methods and analyse conclusions and claims with reference to conflicting evidence and unanswered questions. They construct evidence-based arguments to support conclusions and evaluate claims. They select and use language and text features appropriately for their purpose when communicating their ideas, findings and arguments to specific audiences.

- They describe the key processes of the rock cycle, including timescales and properties of rocks [Science Understanding: Earth & Space Science (AC9S8U04)]
- They explain how new evidence or different perspectives can lead to changes in scientific knowledge (Science as a Human Endeavour: Nature and Development of Science (AC9S8H01)]
- They investigate how cultural perspectives and world views influence the development of scientific knowledge (Science as a Human Endeavour: Nature and Development of Science (AC9S8H02)]
- They explore the role of science communication in informing viewpoints, policies and regulations (Science as a Human Endeavour: Use and Influence of Science (AC9S8H04)
- They analyse the impact of assumptions and sources of error in methods and evaluate the validity of conclusions and claims (Science Inquiry: Evaluating (AC9S9I06)
- They construct logical arguments based on evidence to support conclusions and evaluate claims (Science Inquiry: Evaluating (AC9S9I07)
- They select and use content, language and text features effectively to achieve their purpose when communicating their ideas, findings and arguments to specific audiences (Science Inquiry: Communicating (AC9S9I08)

Assessment Evidence

Performance Task/s (Summative):	Other Evidence (Formative):
Example summative tasks	• Active participation & contributions to overall class discussions

• Summative task 1: Rock Cycle Processes assessment task (individual or group)
  o identification and illustration of rock cycle processes for an environment/cross section of the earth
• Summative task 2: Rock Type Spotlight Project assessment task (individual or group)
  o Spotlight project on a specific type of rock, including explanations of: the type of rock, how it is generally formed, its composition, properties, where found, and uses (plus other information).
• Summative task 3: Agriculture Case Study Portfolio
  o Theme: Soils – structure, importance, and sustainability
  o Case study project containing multiple parts, can be linked with a field trip or inquiry excursion.
  o Soils in Schools content;
  o Soil horizon (structure & substance)
  o Digital inquiry (ListMap for region)
  o Case study – soil compaction
  o Case study – careers in soils
 	
• Higher Level Vocabulary & Understanding examples:
  o Igneous
  o Metamorphic
  o Sedimentary
  o Erosion (process)
  o Weathering (process)
  o Transportation (process)
  o Lithification (process)
  o Metamorphism (process)
  o Crystallisation (process)
  o Extrusion (process)
  o Intrusion (process)
  o Extrusive igneous rock
  o Intrusive igneous rock
  o Geosphere
  o Mineral
  o Respiration
  o Soil cycle
  o Anaerobic respiration
  o Aerobic respiration
  o Decomposition
  o Soil compaction
	• Active contribution to small group discussions & presentations
	• Self-evaluation process opportunities (reflection)
	• Peer-evaluation (of group work)
	• Reflection feedback to educator (brief questionnaire/ sentences) about the unit – during and post unit.
	  o Could be qualitative or quantitative
	  o Spoken or written (more efficient for written/digital, but depends on resourcing)

Example Overview of Module Lesson Flow– adapt sequence as appropriate

Lesson 1: Rocks – introductory lesson:

- What is a Rock? (compare to a mineral)
- Rock cycle processes
- Time periods that these processes occur over (comparisons: fast, medium, long, extremely long)

Lesson 2-3: Rock Cycle Processes - summative task

- Group or Individual task that illustrates a rock cycle within an example environment or ecosystem.

Lesson 4: Properties of rocks – introduction lesson (characteristics of 3 main types; Moh's hardness scale) – practical & theory

Lesson 5: Properties Introduction continued - potential to continue lesson 4 introduction content or hands-on or integrative learning activity to explore some rock and mineral resources online. Introduce summative task (individual/ group activity) – e.g., GeoScience Australia resources.

Lesson 6: Summative task – individual/ group inquiry spotlight on specific rock type.

- Link rock type to place (geography and geology)
- The rock's influence on environment & society, such as links to agriculture (type of soil formed; supports particular industries based upon the underlying rock & soils etc.).

Lesson 7: Indigenous & First Nations geology, cultural significance & connection to place: potential to cover - stone tools, ochre & geoglyphs.

Lesson 8: Back in time: fossil records & agricultural links. Explain and critically evaluate ancient agricultural evidence and insect ecology via primary sources from fossil records.

Lesson 9. Layers of the Land (digital resource exploration) Rocks of Tasmania – profile of the ground beneath us! Exploring ListMap online resource with Geology layers, and add Land Systems of Tasmania layer. Includes location information: https://maps.thelist.tas.gov.au/listmap/app/list/map.

Lesson 10: Practical application: Local soils (pH test kit)

- Testing of local soils. Summative task opportunity – E.g., create a short report template for students to fill online/ drawing in a print-out etc. Links to place & geological features (e.g., ground rock).
- **Lesson 11: continue write up of summative task. Class discussion of findings.**

Lesson 12: Soils: Sustenance and Sustainability – Agriculture elements micro-module (5-6 lessons) – contribute to a 'Case Study Portfolio' for student. Multiple task options.

- **Lesson 13: Soil Science** – introductory videos: soils and the scientists who research them. E.g., TIA soil scientist Richard Doyle's on UTAS' Cambridge farm sit; *Soils in Schools* (Soil Science Australia Resource).
- **Lesson 14 –Soil Horizons: Soil structure & substance**
- **Lesson 15 & 16 – Digital inquiry – Example: exploring ListMap;** apply place, soil composition
- **Lesson 17: Soil compaction – Case study** (application to agriculture & sport)

Lesson 18 – Careers in soils

- Resources – e.g., utilise the Soil Science Australia's *Soil Science Careers* resources. (Videos, class discussions, unpack different roles in soil science).
- In-person visit from soil related fields - e.g., Natural Resource Management (NRM), soil scientist, an agronomist, land management specialist.
- Spotlight a career pathway: E.g., Agronomist – highlight the interdisciplinary links of soils to biology (plants, animals), environmental factors (water etc.) and its importance to the agriculture industry (food and fibre).

Lesson 19/20 – optional lessons: careers focus/ field trip. Examples include via field visit or visiting outreach by industry.

	Learning Intention and Success Criteria	*Suggested Lesson Sequence*	*Differentiation/Extension Tasks and/or Adjustments*
1	**Focus of lesson/s (1-2 lessons):** Introduction to rock cycle, including the formation of rocks, and introduce concepts to grow understanding of the role that rocks play in environments (e.g., nutrients in soil). **Australia Curriculum link:** Science Understanding Earth & Space Sciences (AC9S8U04)	**Example flow of lessons for rock cycle –** *adapt as appropriate* **Lesson 1: Rocks – introduction lesson:** • What is a Rock? (and compare to a mineral) • Example resources: Geoscience Australia (videos) https://www.ga.gov.au/education/classroom-resources/rocks **Rock cycle: Background & Processes** Key concepts and stages in the lesson: **Introduction activity type**: Discussion-based. Graphical organisers may assist. 1. **Background**: Rock cycle relates to the cycling of rock matter in different environments, relying on a variety of processes. Mention the conservation of matter – not created nor destroyed (i.e. not flow of energy). Show key processes in diagrammatic format to illustrate where and how these processes occur. 2. **Rock cycle fundamentals** – example resource video: Geoscience Australia: https://youtu.be/9qlQCSu-5is (12 min). Whole class discussion follows: 3. Discuss rock cycle core principles. This can be informed by the DCYP Curriculum Map (Science - Year 8). 4. Example resource: Geoscience Australia - *Our Changing Earth* (rock cycle poster). Includes example rock types for each of the 3 key formation processes: https://ecat.ga.gov.au/geonetwork/srv/eng/catalog.search#/metadata/79349 **Rock cycle processes** to consider (name them, and ask for contributions of their features, boundaries and some examples from their own experience). **Rock cycle processes can include:**	**Extension - Consideration of Time:** Think about time and age. Are all rock cycle stages and equal in time? How might these differ? Give specific examples from class lesson/s, and via your own experiences as to what timescales you can find for rock cycles. Including: ○ Formation of rock types ○ Processes within the rock cycle (e.g., weathering, deposition, erosion etc.) **Adjustments:** relate rock cycles to students' own experiences, interests and lifestyle. Illustrate/ capture this in a way that covers short and longer timespans. Communicate this in an

		- Erosion (process) - Weathering (process) - Transportation ((process) - Lithification (process) - Metamorphism (process) - Crystallisation (process) - Extrusion (process) - Intrusion (process) **<u>Earth's spheres diagram</u>** may assist prompting discussions and showing the inter-linking of these spheres for rock cycle processes: a. Biosphere b. Atmosphere c. Hydrosphere d. Geosphere	effective and clear way (e.g., visually) - Examples: bring a sense of "place" to learning module with students exploring their local environment surrounding the school, town/city/region, and Tasmania more generally. - Students could try to identify rocks in this local place, their age, and how they formed. - Ask: how do these rocks shape how humans interact with the land? Including farming & industry. - Invite students to explore a geological map: what it conveys, what types of rocks are found where in Tasmania/ region, and how this impacts the local area.

2	**Focus of lesson:** Demonstrate an informed understanding of the rock cycle via describing and illustrating processes, drawing upon examples from real-world processes, case studies and relationships to our society - such as where people live, agriculture/ food production systems. **Australia Curriculum link:** Science Understanding Earth & Space Sciences (AC9S8U04)	*(Lesson 1-2 continued from above descriptors)*	
	Australia Curriculum link: Science Understanding Earth & Space Sciences (AC9S8U04)	**Lesson: Types of Rocks & their properties– introduction** lesson (Characteristics of the 3 main rock types; Moh's hardness scale) – practical & theory. Example to demonstrate: Moh's hardness scale practical to enhance initial theory. • **Cover 3 key types of rocks (based upon their formation method)** – igneous, metamorphic & sedimentary. • **Lesson: Properties – Further depth continued -** potential to continue lesson 4 introduction content or hands-on (Moh's hardness scale practical), or integrative learning activity to explore some rock and mineral resources. • **Example resource:** ***Identifying minerals*** – Geoscience Australia online resource online (https://artsandculture.google.com/story/QgXh9pyyxhIYKQ) that leads student through characteristics of a mineral (colour, streak, lustre, hardness, crystal shape, cleavage, specific gravity,	

		habit). Clear photographs of examples of these. Introduce summative task (individual/ group activity). **Lesson: Summative task –** individual/ group inquiry spotlight on specific rock type: • Link rock type to place (geography and geology) • The rock's influence on environment & society, such as links to agriculture (type of soil formed; supports specific industries based upon the underlying rock & soils etc.). • **Resource** that may assist includes ***Nature*** article: [Soil Minerals & Plant Nutrition] • **Examples to guide choice:** Review the list in the above article to provide some mineral type examples, their abundance (%) in the earth's crust, and their impacts and influence on agriculture and food systems. Encourage students to connect the mineral type with the formation method; how does this impact its characteristics, composition etc.	
		Lesson: Indigenous & First Nations geology & connection to place: **Aims** • ***Knowledge:*** *Understand the significance and role of rocks and minerals in cultural practices with respect to First Nations Australians. Understand cultural practices that utilise earthen materials, across multiple purposes and scales.* • ***Application:*** *Explain and describe examples of the cultural importance and role of various rocks and minerals in cultural practices with respect to First Nations Australians, including drawing upon primary and secondary evidence sources.* • **Cross-curriculum alignment (Science 9.0):** *Exploring the traditional geological knowledges of First Nations Australians that are used in the selection of different rock types for different purposes* • **Resource:** Teacher Background Information – see https://v9.australiancurriculum.edu.au/teacher-resources/background-information/science_teacher_background_information_AC9S8U04_E6 **Examples of this learning content can include:** • Stone Tools • Ochre	

- **Aboriginal geoglyphs** (a design made from earthen materials that is so large it is best viewed from above).

Key resources: The Orb present module resources that provide linkages to the use and cultural significance of geological forms & ochres. Can cover both stone tools and ochre in 1 lesson (or single module). Could also flexibly extend to other aspects of indigenous geology such as culturally-significant landforms, or rituals.

- **Sequence:** may align well with lesson sequence following learning of different rock types and their formation and distribution.
- **Format of activities –**class discussions; small group work or individual reflective work can be conducted utilising the below resources as starting points for the educator. Formative assessments.

The Orb resources: https://www.theorb.tas.gov.au/learning-resources/

  - **Stone tools**: primary & secondary sources resource – article with discussion questions for overall class or small group work.
  - **Ochre** – find various resources in module menu. Including Touching The Earth video (4 min)

Resources: Aboriginal Geoglyphs
What is a geoglyph? (unpack the etymology/ origins of the term)

- i.e., a large-scale design made from earthen materials – some can be best viewed from above.

Option: discuss & explore examples of geoglyphs

- **Maree Man (South Australia)** – modern geoglyph formed in 1998. Since 1998, this geoglyph has increasingly faded, with satellite imagery able to track this. Could discuss Landsat satellite technology as well in this example, showing how various technology can increase our understanding of landscapes and cultural works (NASA feature: https://earthobservatory.nasa.gov/images/146061/marree-man#:~:text=Etched%20into%20a%20plateau%20in,is%20best%20viewed%20from%20above.)

- **Western Australian geoglyphs examples (2023):** ABC article discusses Aboriginal geoglyph formations developed in Western Australia. This represents an example of indigenous cultural

		practices that utilise earthen materials with cultural & environmental significance. Combines cultural connection to land, totem animals and conservation efforts. These large-scale artworks are visible from aerial (bird-eye view). Community engagement – development of the designs (cultural significance; planning the scale logistically in the landscape), formation of the designs in the earth, planting of native vegetation. Conservation of native plants and caring for the landscape are other themes covered.
		• **Resource: ABC article** (August 2023): https://www.abc.net.au/news/2023-08-10/giant-aboriginal-art-years-in-making-sprouting-acoss-wa/102711838
		
		• **Geoglyphs:** Suggested activities & resources
		• **Discussion** *(whole class or small groups) - examples of the cultural importance of geoglyphs* culturally with respect to First Nations Australians, including drawing upon primary and secondary evidence sources.
		• Using the Western Australian example (2023) as an example, students could identify and detail the diverse elements underpinning the formation of the geoglyphs. Highlight the inter-connected nature of art, culture, science, community:
		  ◦ cultural significance (geoglyphs; connection to place; significance of animal totems etc.)
		  ◦ community involvement (design, planting of native vegetation)
		  ◦ logistical elements (planning & design– technology considerations, how these geoglyphs may have been developed physically)
		  ◦ conservation (native plant vegetation – who may be involved? Indigenous community knowledge, botanists, horticulturalists etc.
		  ◦ Communication of the progress –who would be involved in communicating and promoting the geoglyph artwork/ progress of their development? What knowledge & understanding may need to be gained & communicated? (e.g., journalists, engagement with local indigenous community members; botanists or land conservationists)
		
		• **Inquiry** – personal or small group enquiry: students explore examples of Australian geoglyphs via internet searching.	

		• E.g.,: Locations in Australia, their designs, specific history surrounding their formation and significance. • Underlying geology of the area – location, significance • Technology involved (e.g., analysis of the geoglyphs using Lidar technology etc.) • • Could write a short feature (e.g., 250 words) on 1-2 geoglyphs For either activity • Present work style: e.g., physical poster, or digitally in Word or PowerPoint slide • Sharing of work: could share work amongst students by presenting in small groups or to whole class). Peer-review process potential. • Assessment: Peer-based assessment or a submitted summative assessment to educator (*develop assessment matrix specific to teaching standards for school).* **Lesson: Back in time: fossil records & agricultural links.** Explain and critically evaluate ancient agricultural evidence and insect ecology via primary sources from fossil records. Potential prompt questions: what makes a fossil record more reliable? What evidence is more reliable and why? What threats might evidence of ancient civilisations face in our modern world? (e.g., development, changing of landscape for development/ mining etc.). This could prompt a personal/group inquiry task to look for further examples of pe-historic food production or agriculture (e.g., pasture). Student can highlight the what, where, how, why of the fossil record, its source (and citing resource from which information was gained from). Could present to the class, discussion-based presentation or written assessment, for example. **Examples of fossil evidence of agriculture or designed production systems** are listed below. This includes those by termites (insects harvesting fungi!), and early agricultural systems harvesting weeds in the Middle East. **Activity suggestions:** Educators could present some examples, prompting students to evaluate the sources and evidence that underpin the claims. Alternatively, could split students into groups,	

		providing each/both examples of case studies, with guiding prompt questions to answer such as those provided above.
		
		- **Fossil evidence** – could link into pre-historic fossil evidence of agriculture: Examples could include:
		    ○ **'Insect agriculture' fossil evidence:** (dated to be 25 million years old!) was [discovered in 2016] from termite nests that were harvesting symbiotic fungus within their nests. The fungi was being cultivated by the termites because the fungus convert plant material into easier to digest forms for the termites. Fossils were key to dating this symbiotic termite-fungus symbiotic relationship.
		    ○ **Early agriculture evidence (23, 000 years ago) –** Middle Eastern evidence [discovered in 2015] shows fossil evidence of humans cultivating weeds for consumption. Whilst this finding in Israel show primitive forms of agriculture, this is still an example of cultivation that back-dates the previously accepted date of agriculture by a further 11,000 years.
		
		Lesson: Rocks to soils: how rocks shape society and the environment
		• **Includes: Soil structure & substance**
		
		Agriculture angle– video showcases soil and sustainability – feat. TIA soil scientist Richard Doyle. Good resource for showing the importance of soils, the training of soil scientists, career opportunities in science that link to soils. Land management long term.
		Video resource (10 min, 2023): https://www.youtube.com/watch?v=s7vurrWfWMg
		
		Key concepts to discuss/share include:
		• Soil is the window into understanding the history of landscapes (rocks, minerals, soils). All interlinked with biology.
		• Soils are the interface/meeting point of rocks and biology.
		    • Class could discuss these concepts
		    • Encourage students to link to their own region/ town (place)
		• Deep learning is through "doing" – practical application and exploration, hands-on
		• What sorts of investigations and observations are undertaken by soil scientists?	

		▪ 3:06 (soil profile – layers of soil and rocks)
		▪ 3:12 (soil core analysis in action). Why is this important? What sorts of answers?
		• Policy & resource management: national soil strategy (20 year strategy for Australia). Land management for long term.
		• Extension, networks, learning from experts and transfer of knowledge into practice.
		• Key terms: soils, extension
		
		Suggestion: This could form a pre-excursion/ field trip exercise
		
		Concept: Soil horizons – layers of soil
		• **Introduce the concept of a 'soil profile'**
		• Stimulus – example photos/ diagrams of a soil profile
		• Class discussion: Encourage students to contribute why they think understanding soil layers can be important for environment and society. Ask for examples and why.
		• **What components are present in the soil profiles?** (e.g., class discussion/ list/ small group work)
		• **What are their roles? What if they were removed or a lot of that component was present?**
		  • Physical geology: rocks, minerals, soils, macronutrients, micronutrients
		  • Water – presence of water where? What utilises this? How? What if too much (flooding/ poor drainage)? Too little (drought)?
		  • Living organisms: plants (roots, seeds),
		  • Living organisms: animals - invertebrates (earthworms, nematodes, insects – e.g., dung beetles mixing dung with soil). What are their roles? Ecosystem interactions
		• Connect to industry – Agriculture's reliance on soils (quality, care of soil, understanding of the soil health).
		• What other industries rely on soils? (Think: building, road infrastructure, horticulture, landscape, sports stadiums)
		
		• **Resource: formation of soil cards "CLORPT" – discuss & explore the influence of factors** including climate, organisms, parent rock material and time. Example US resource: https://cdn.agclassroom.org/media/uploads/2020/04/01/CLORPT_Cards_1.pdf	

- **Resources: soil profile** (e.g., Soil profile cards – US resource - https://cdn.agclassroom.org/media/uploads/2020/04/02/Soil_Horizon_Cards_1.pdf
- **Resource: Soil article** (Nature Knowledge Project) **"Soil – the foundation of agriculture"** https://www.nature.com/scitable/knowledge/library/soil-the-foundation-of-agriculture-84224268/
- **Suggestion:** Outreach opportunity **-** contact TIA or industry (e.g., Natural Resource Management (NRM) to explore the options of incursion/excursion potential for soil scientists and land management specialists to engage with your class.

- **Lesson: Layers of the Land (digital resource exploration)**
- **Rocks & Soils of Tasmania** – profile of the ground beneath us!
- Can include the following digital resources for an inquiry-based session:
- **Explore ListMap** online resource: https://maps.thelist.tas.gov.au/listmap/app/list/map
    - Demonstrate alongside students using **Layers** for Tasmania map:
    - Steps: "Add Layer"→ Geology → Land Systems of Tasmania
    - Scroll mouse to zoom/ click zoom slider;
    - Click on the map to select a specific location (e.g., location your school or home), noting specific details of that area in the call-out box. "**URL link"** (click this) will take you to a specific profile report of geology, soil type (e.g., clay), plus plants and other features of the site. Use these to guide the questions of how rocks affect the soils, which affects the land use etc.
- **Exploring CSIRO's Soil & Landscape Grid of Australia**
    - Overview: https://esoil.io/TERNLandscapes/Public/Pages/SLGA/ProductDetails-SoilAttributes.html
    - Encourage students to explore Australia, and specifically Tasmania's maps
    - Link place to geology features
    - For example: can "Quick View" the maps (see top menu list), and in the 'select product type to view' select Tasmania (or other maps of choice – see a variety across Australia).
    - Scroll down the page to view different attributes of the rock and soil features

		• Could include whole/ small class group discussions going through each map, asking why they think these results are seen (e.g., high acidity of the soil water content in West, SW & NE Tasmania), and what impacts this might have. Make note of questions that they have, and encourage seeking answers from reputable sources (e.g., digital inquiry; industry/ research engagement opportunity). Local soils: Pasture science, sampling soils & pH test practical • **Practical and theory lessons (prepared by TIA):** 1-2 lessons across the packages • **Video resource from TIA** showcasing this practical application & demonstration on a school (urban or school farm setting). This resource can be viewed by both educators and students alike: https://youtu.be/uFmrq9EI1ZM, as part of the **Pastures in Schools Program**. • **Resources:** lessons developed for this program can be found within the TIA lesson package in the TIA Professional Development Workbook: Engaging Students in STEM Using Agriculture **(latest: version 3, 2020).** This includes practical and theory guides. • **Specific lessons in TIA resource workbook:** 31 & 32 (page 90 – hands-on soil texture and pH testing). • **Equipment requirements:** pH test kit (standard commercial kit), optional digital devices for mapping element (if chosen to capture the data this way). • Nature Knowledge Library resource: *Often referred to as the master variable of soil, pH controls a wide range of physical, chemical, and biological processes and properties that affect soil fertility and plant growth.* • *Soil pH reflects the acidity level in soil & significantly influences the availability of plant nutrients, microbial activity, and even the stability of soil aggregates. At low pH, essential plant macronutrients (i.e., N, P, K, Ca, Mg, and S) are less bioavailable than at higher pH values near 7, and certain micronutrients (i.e., Fe, Mn, Zn) tend to become more soluble and potentially toxic to plants at low pH values (5–6) (Brady & Weil 2008)* • **pH test kit**: Commercial kits (e.g., hardware shop test kits are fine), or existing resources within schools. • **Risk assessment** – follow general instructions from the commercial pack. Main concerns are irritation from chemicals, spillage (ensure gloves or eye safety PPE is worn if appropriate). Disposal of samples correctly according to the kit/ laboratory technician guidance.	

		• **Soil sampling note:** either teacher/lab technician to collect samples prior, or students collect at home or supervised in class time, then return to laboratory/classroom). Students could bring their own from home. When collecting, include details of sample such as: location, moisture, depth of collection etc. • **Prior to test:** Can discuss properties of the soils – pH level (refresher of what this is), particle size (qualitative – describe this, hand soils), composition of the soil, approx. depth of the soil collected. What does all this mean? Why might we need to know what the soil make-up is? • **Encourage students to think about & discuss its impacts:** areas might include – general environment surroundings, drainage, aspect, what may agricultural crops or horticulture may grow there, building/ development considerations, waste, sports fields. Might this change over the seasons? Why? Why Not? Draw upon your knowledge & observations of the surroundings to inform. Soil Compaction – The What, Why & How? • **Initial discussions** – guiding questions & applications: What is soil compaction? Soil is like a sponge – solid material but also filled with pores for air and moisture to travel through. Important for drainage, microbial life in soil & plant health. • What might someone mean by **resilience** of a crop or pasture? • Why is soil compaction important? • Why measure soil compaction? (include: air is important for soil health – microbes, roots, other soil organisms), water flow, ability for plants to send roots into the soil. • **Examples:** Links to sports field horticulture/ landscape maintenance (e.g., MCG spots field maintenance utilises specialised measurement equipment (Clegg Hammer) to measure the turf and cricket pitch soil compaction). • Examples: Links to agriculture pasture – dairy pasture, rotation of herds in paddocks. Resilience of grass to recover from grazing from hooved animals (e.g., cows, sheep). • Introduce 2 x methods for measuring soil compaction: • Methods comparison: Penetrometer method (e.g., https://www.youtube.com/watch?v=UmGe6lAxzb0) and Clegg Hammer	

		(https://vimeo.com/203325297) – compare and contrast methods (purely based on visual observations of the videos, and other resources if required online/ in person). • Similar approaches that may be used as a simple proxy for a **penetrometer** that could be used in schools: pencil-in-soil example (qualitative, descriptive) can be used in soil/grass sites around school. Depth that the pencil will penetrate with similar pressure – measure the depth (cm/mm) that it reaches across different sites. Could replicate multiple samples in a specific location, then average the depths. • **Clegg hammer:** if have access to this, use. Similar experiment in schools that may be used to replicate the measurement of a Clegg hammer (aka. Hoof on ground) – get students to brainstorm if there is a creative approach. Think outside the box! • Encourage students to compare the two (or more!) methods of soil compaction. This links with the following curriculum content descriptor: o Curriculum alignment (Methods and scientific processes): *They analyse the impact of assumptions and sources of error in methods and evaluate the validity of conclusions and claims* (Science Inquiry: Evaluating (AC9S9I06) Lesson: Soil Careers Spotlight • Various career spotlights, via video resources, or can be via in-person engagement in class with a local soil scientist or agronomist for example (reach out if you need assistance connecting). Careers in soil science & agronomy • Aim: explore and showcase different careers and pathways that link rocks, soils and sustainability. • **Soil Science Australia** has a **careers in soil science** package of learning prepared. This includes discussion prompts, videos and case study examples. • **Locally**: could involve industry visits (in-class/field), or virtual interviews (e.g., with local Tasmanian agronomists/ soil scientists). • **Soil Science Australia** have prepared a ***Soil Science Careers* Teacher Guide** (2020) – Resource: https://www.soilscienceaustralia.org.au/wp-content/uploads/2021/09/Soil-science-careers-teacher-guide-2020_updated.pdf Provides a range of career pathway options in soils science, and highlights the interdisciplinary nature of soils and agriculture. • **Video resources** examples for additional career spotlights:	

		• Soil Science Australia Video – *Soils: what lies beneath your feet?* Passionate people discussing their careers in soils & agriculture https://www.youtube.com/watch?v=S7I-yEUZ1j4 • ABC resource: *Who Loves Soil? Tim does!* (2:37 min video) - https://www.abc.net.au/education/abc-open-who-loves-soil-tim-does/13980958	