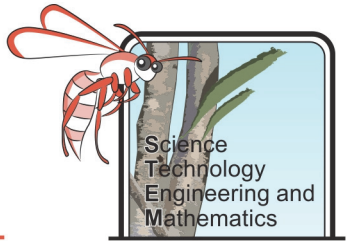


Intended Use of Resources

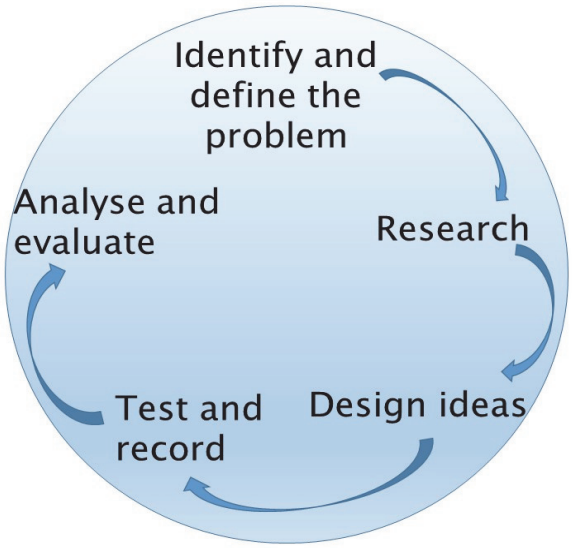
This project has been designed so that teachers from different STEM areas can pick and choose sections relevant to their subject area to work on. All activities in this package do not need to be completed to get value from the package – each activity can be completed as a stand-alone or can be approached, as a team, as a larger project. The package has potential to be extended into a much longer project to include curriculum points from different STEM subjects.

There are three **student workbooks - Open, Guided and Scaffolded,** that go along side this resource. All have the same suggestions for activities, however they have been written and edited to provide differentiated learning options to support good teaching practice**.** Teachers may pick and choose which versions they give which students and may wish to edit them further to address their learning needs. Due to the differentiation of the workbooks, the **Open** activities will enable more syllabus links to be addressed, which is why each activity has its own syllabus links key. However, if you wish to give a truly open-ended investigation then you could just give the students the challenge and background information section of the Student Workbook.

The Woodside Australia STEM Project aims to be accessible and supportive for teachers and students, please contact us if you have questions, require assistance or would like to arrange an incursion or a professional development workshop - www.wasp.edu.au

The Challenge

Have you ever wondered why the Moon is covered in craters and the Earth's surface is relatively crater free? What leads to these two neighbours being so different? Your challenge is to investigate how natural activity changes the Earth's surface over time.



Background Information

You may have heard the phrase 'Dynamic Earth', but what does that mean? Dynamic means constantly changing. There are many natural systems and processes on Earth that lead to it being a planet of change.

Water is a major instrument for change on the Earth's surface. Seas can erode cliffs and shorelines; they can move sand and change where beaches are. Rivers can cut down hillsides and create gullies. Glaciers can creep over the land, scouring out chunks and creating wide U-shaped valleys. Rain and snow can enter cracks in rocks and slowly break them apart.

Even the wind is powerful enough to cause changes to the Earth's surface. The wind can carry sand and sediment particles which can erode rocks and landscapes. Wind can move sand dunes and change deserts.

Plants and animals can also change landscapes. Tree roots help to hold soil in place. When trees are removed from an area then we can get landslides, or removal of topsoil by wind and water. Animals can burrow into the ground or produce tracks on the surface.

Furthermore, what is going on inside the Earth can also affect how it looks on the outside. The Earth is made up of layers and the deeper you go in the Earth, the hotter it gets. Sometimes hot material is brought up from below the Earth's surface and can erupt out at volcanoes. The lava can spread over the Earth and create new land. Volcanoes can get very big and form mountains.

Activities

This booklet contains extra information on each activity, including syllabus links the overall activity objective, suggestions for recommended equipment or alternative ways to run investigations as well as useful resources and website links. Please note that any reference websites provided in the entirety of our resource documents were current at the time of publication. Please advise if links are no longer accessible.

The syllabus links have been colour coded – please see the colour key below:

Covered in Scaffolded, Guided and Open student workbook
Covered in Guided and Open Student workbook
Covered in Open student workbook

List of activities

Background Research

Objective

In this activity, students will gain more understanding about what erosion is and consider what natural processes might cause it. They are than asked to consider the surfaces of other planetary bodies in our solar system and why they may appear so different.

The Moon and Mercury have heavily cratered surfaces due to the lack of atmosphere, and therefore weather to erode them. They also have no evidence of current tectonic processes, or volcanism. Mars has some impact craters visible as well, although Mars does have a very thin atmosphere (about 1% that of Earth's). This means it does have some weather – including huge dust storms, which can erode the surface and smooth out craters. Mars also has the largest volcano in the Solar System (Olympus Mons) and channel like features which may have been caused by flowing liquid at some point. We know very little about the surface of Venus as its atmosphere is so thick and hot that it is difficult to capture any images.

In the Scaffolded and Guided booklet, students are given suggested websites to use for their research. In the Open booklet, students are asked to reference any sources they use.

Subject area	Australian syllabus links
Science	ACSSU075 Earth's surface changes over time as a result of natural processes and human activity
Technologies	ACTDIP009 Collect and present different types of data for a specific purpose using software

Useful website:

- NASA website with information about The Moon
  https://spaceplace.nasa.gov/all-about-the-moon/en/
- Explanation of why the Moon has lots of craters, as opposed to Earth
  https://astronomy.swin.edu.au/~smaddiso/astro/moon/craters.html
- Definitions and examples of erosion
  https://www.nationalgeographic.org/encyclopedia/erosion/
- Information about Mars and its atmosphere
  https://spaceplace.nasa.gov/all-about-mars/en/

Deep Valley

Objective

In this activity, students will investigate the changes in river features from source to mouth. They will use equipment to take measurements of the depth and width of valleys created from rivers flowing down them. Students given the Open booklet will use their results to interpret pictures and decide if they are at the river mouth or near the source. This activity shows how rivers can change the surface of the Earth creating deep valleys and moving sediments.

This activity focuses on investigation skills and data collection, management, and analysis. Students can use Microsoft Excel or similar software to create a table and draw a graph of their results. Students are prompted to evaluate the experiments – this can be a good introduction to fair testing and consideration of the scientific method.

This investigation can be completed by individuals or groups. Students can compare results with other groups to discuss similarities and differences.

In the Scaffolded booklet, students are given a full equipment list and method, whereas in the Guided book they are given a less detailed method and asked to make improvements. Students with the Open book are asked to design their own investigation and come up with an equipment list themselves.

Subject area	Australian syllabus links
Science	ACSSU075 Earth's surface changes over time as a result of natural processes and human activity ACSSU076 Forces can be exerted by one object on another through direct contact or from a distance ACSHE061 Science involves making predictions and describing patterns and relationships ACSIS064 With guidance, identify questions in familiar contexts that can be investigated scientifically and make predictions based on prior knowledge ACSIS065 With guidance, plan and conduct scientific investigations to find answers to questions, considering the safe use of appropriate materials and equipment

	ACSIS066 Consider the elements of fair tests and use formal measurements and digital technologies as appropriate, to make and record observations accurately ACSIS068 Use a range of methods including tables and simple column graphs to represent data and to identify patterns and trends ACSIS216 Compare results with predictions, suggesting possible reasons for findings ACSIS069 Reflect on investigations, including whether a test was fair or not ACSIS071 Represent and communicate observations, ideas and findings using formal and informal representations
Technologies	WATPPS21 Define a sequence of steps to design a solution for a given task WATPPS22 Identify and choose the appropriate resources from a given set WATPPS23 Develop and communicate design ideas and decisions using annotated drawings and appropriate technical terms WATPPS24 Select, and safely use, appropriate components and equipment to make solutions WATPPS26 Work independently, or collaboratively when required, to plan, safely create and communicate ideas and information for solutions. ACTDIP009 Collect and present different types of data for a specific purpose using software
Mathematics	ACMMG084 Use scaled instruments to measure and compare lengths, masses, capacities and temperatures ACMSP096 Construct suitable data displays, with and without the use of digital technologies, from given or collected data. Include tables, column graphs and picture graphs where one picture can represent many data values

Useful website:

- BBC bitesize introduction to river landforms and terminology https://www.bbc.co.uk/bitesize/topics/zs92tfr
- Simple information on energy transfers which discuss gravitational potential energy – could be useful for more advanced students who may want to research what causes the depth of the valley to change. https://www.bbc.co.uk/bitesize/guides/z8hsrwx/revision/2

Size of Sediment

Objective

Students will investigate how far different sediment types will be transported from the source, using a model river on a hillside. They should find that larger sediments travel less (as they require more energy), whereas finer sediments will travel the furthest, as they are more easily carried by water. Flooding or high energy events will lead to a river having more energy and carrying capacity. If students use a lot of water to create their "river", their large sediments and clasts will travel further than when less water is added.

This activity focuses on investigations skills. Student with the Open booklet will plan their own investigation. Guided students will improve a method and focus on fair testing about how to collect, present and analyse results. Scaffolded students will follow a method to safely investigate. All students will evaluate their experiment.

Students can collect more quantitative data by collecting sediment samples at different points from the source (measuring the distance from the source) and passing the sediments through sieves to determine the grain size distribution. Instead of trying to determine a percentage, they may be able to weigh the fine, medium and course grained sediment collected at each point to find out how much they have of each. For advanced students, they could plot these as pie charts, using a spreadsheet.

Students will consider what happens during flooding events. They will also discuss how this experiment shows how rivers can change the surface of the Earth.

Subject area	Australian syllabus links
Science	ACSSU075 Earth's surface changes over time as a result of natural processes and human activity ACSSU076 Forces can be exerted by one object on another through direct contact or from a distance ACSHE061 Science involves making predictions and describing patterns and relationships ACSIS064 With guidance, identify questions in familiar contexts that can be investigated scientifically and make predictions based on prior knowledge ACSIS065 With guidance, plan and conduct scientific investigations to find answers to questions, considering the safe use of appropriate materials and equipment

	ACSIS066 Consider the elements of fair tests and use formal measurements and digital technologies as appropriate, to make and record observations accurately ACSIS068 Use a range of methods including tables and simple column graphs to represent data and to identify patterns and trends ACSIS216 Compare results with predictions, suggesting possible reasons for findings ACSIS069 Reflect on investigations, including whether a test was fair or not ACSIS071 Represent and communicate observations, ideas and findings using formal and informal representations
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Mathematics	ACMSP096 Construct suitable data displays, with and without the use of digital technologies, from given or collected data. Include tables, column graphs and picture graphs where one picture can represent many data values ACMMG084 Use scaled instruments to measure and compare lengths, masses, capacities and temperatures

Useful websites:

- Sorting by Movement – Teachers Notes give some more explanation on sediment sorting as well as another suggested activity.
  https://www.wasp.edu.au/course/view.php?id=35#section-0
- This BBC website describes how different sediment types are transported in a river and discusses deposition of sediment
  https://www.bbc.co.uk/bitesize/guides/zq2b9qt/revision/3

Gravity Movement

Objective

Students carry out an investigation to find out how increasing the steepness of a slope would affect how fast a boulder (or object) will roll down it. This is an introduction to gravitational forces.

For the Scaffolded and Guided students, they are given a list of equipment and a method. The Open students must design their own investigation, this includes coming up with their own equipment list. All students will evaluate their investigation.

Students will record how long it takes a ball to roll down a slope as the angle is increased. Students are asked to present their data in tables (this has been given for students in the Scaffolded and Guided booklet). These results can also be plotted and presented in graphs, hand drawn or created on the computer. It is recommended that students conduct numerous trials. This can lead on to a discussion of errors (such as not pressing the stopwatch on time, not placing the ball in the exact same spot each trial etc.). If they are strong Mathematics students you may wish to introduce calculating averages or using Excel functions.

If students are confident using protractors, they could measure angles rather than measuring the height of the raised end of guttering.

You could introduce the idea of frictional forces, which will act to slow the ball down.

Subject area	Australian syllabus links
Science	ACSSU075 Earth's surface changes over time as a result of natural processes and human activity ACSSU076 Forces can be exerted by one object on another through direct contact or from a distance ACSHE061 Science involves making predictions and describing patterns and relationships ACSIS064 With guidance, identify questions in familiar contexts that can be investigated scientifically and make predictions based on prior knowledge ACSIS065 With guidance, plan and conduct scientific investigations to find answers to questions, considering the safe use of appropriate materials and equipment

	ACSIS066 Consider the elements of fair tests and use formal measurements and digital technologies as appropriate, to make and record observations accurately ACSIS068 Use a range of methods including tables and simple column graphs to represent data and to identify patterns and trends ACSIS216 Compare results with predictions, suggesting possible reasons for findings ACSIS069 Reflect on investigations, including whether a test was fair or not ACSIS071 Represent and communicate observations, ideas and findings using formal and informal representations
Technologies	WATPPS21 Define a sequence of steps to design a solution for a given task WATPPS22 Identify and choose the appropriate resources from a given set WATPPS23 Develop and communicate design ideas and decisions using annotated drawings and appropriate technical terms WATPPS24 Select, and safely use, appropriate components and equipment to make solutions WATPPS26 Work independently, or collaboratively when required, to plan, safely create and communicate ideas and information for solutions. ACTDIP009 Collect and present different types of data for a specific purpose using software
Mathematics	ACMSP096 Construct suitable data displays, with and without the use of digital technologies, from given or collected data. Include tables, column graphs and picture graphs where one picture can represent many data values ACMMG084 Use scaled instruments to measure and compare lengths, masses, capacities and temperatures ACMSP095 Select and trial methods for data collection, including survey questions and recording sheets

Useful websites:

- YouTube video of a highly energetic geologist explaining landslides and mass wasting https://www.youtube.com/watch?v=F0FeDYuLIoQ&t=372s

Soils on Slopes

Objective

Students research what soil creep is and investigate if the soil type on a hillside will affect how quickly it creeps downhill.

When dry, the shape of sediment will be the most important factor determining how much the soil creeps. If there are lots of spherical, well rounded grains, they will roll over each other more easily than if there are lots of angular grains. You may wish students to investigate soils using magnifying glasses/hand lenses before they conduct the investigations as this may help them to make predictions.

The moisture content of the soils will also greatly affect the amount of creep. When the soils are slightly damp, they will be more cohesive, however when they become saturated then the sediments will slide past each other.

This investigation focuses on the scientific method and encouraging students to think about fair testing and how to take accurate measurements. Students using the Scaffolded booklet are given a clear method and equipment list as well as a results table. Students using the guided booklet are asked to make improvements to the method they have been given to ensure that it is a fair test and they are making accurate measurements. Students using the Open booklet will design their own investigation. Students can present their results in tables and graphs either hand drawn or created on the computer. All students are asked to evaluate the investigation and consider how to improve it.

Subject area	Australian syllabus links
Science	ACSSU075 Earth's surface changes over time as a result of natural processes and human activity ACSSU076 Forces can be exerted by one object on another through direct contact or from a distance ACSHE061 Science involves making predictions and describing patterns and relationships ACSIS064 With guidance, identify questions in familiar contexts that can be investigated scientifically and make predictions based on prior knowledge ACSIS066 Consider the elements of fair tests and use formal measurements and digital technologies as appropriate, to make and record observations accurately ACSIS068

	Use a range of methods including tables and simple column graphs to represent data and to identify patterns and trends ACSIS071 Represent and communicate observations, ideas and findings using formal and informal representations
Technologies	WATPPS21 Define a sequence of steps to design a solution for a given task WATPPS22 Identify and choose the appropriate resources from a given set WATPPS23 Develop and communicate design ideas and decisions using annotated drawings and appropriate technical terms WATPPS24 Select, and safely use, appropriate components and equipment to make solutions WATPPS26 Work independently, or collaboratively when required, to plan, safely create and communicate ideas and information for solutions. ACTDIP009 Collect and present different types of data for a specific purpose using software ACTDIP009 Collect and present different types of data for a specific purpose using software
Mathematics	ACMSP096 Construct suitable data displays, with and without the use of digital technologies, from given or collected data. Include tables, column graphs and picture graphs where one picture can represent many data values ACMMG084 Use scaled instruments to measure and compare lengths, masses, capacities and temperatures ACMSP095 Select and trial methods for data collection, including survey questions and recording sheets

Useful websites

- Possible extension activities looking at slope stability from the AusEarthEd YouTube channel
  https://www.youtube.com/watch?v=5ymdlrXhHSw
  https://www.youtube.com/watch?v=Eksy8FkrYmc
- Blog post explaining some factors which effect slope stability

https://ausearthed.blogspot.com/2020/06/slope-stability-i.html

- Blog post looking at how water affects slope stability
  https://ausearthed.blogspot.com/2020/06/slope-stability-ii.html

Acid Rain

Objective

In this activity, students investigate which rock types will be most affected by acid rain and consider how natural events, such as volcanic eruptions, can lead to acid rain.

It is recommended that the rock samples the students use are first soaked in water and they are weighed wet as some of the rocks will be very porous and the water will fill in the pores. If they were weighed when dry and then put in vinegar their weight may appear to increase, even though they have dissolved slightly so their mass should have decreased.

Vinegar is a strong enough acid to dissolve limestone, which should break down the most. Limestone is made of calcium carbonate, which reacts with the acid to give off carbon dioxide; you may see bubbles being produced. Some sandstones may also break down a little; depending on what the sediment has been cemented together with. There should be little to no change with any igneous or metamorphic rock (except marble, which is metamorphosed limestone, so will also dissolve).

For the Scaffolded and Guided students, they are given a list of equipment and a method. The Guided students are asked to improve the method they are given. They should consider how they will get data from the investigation, including possibly taking photos and making visual observations as well as taking qualitative data, such as weighing the rocks. The Open students must design their own investigation this includes coming up with their own equipment list. Again, they should be encouraged to consider what data they will collect to enable them to answer the investigation question. All students will evaluate their investigation and consider how it could be improved and extended.

Students can present their data using graphs and tables, either hand drawn or created on a computer.

Subject area	Australian syllabus links
Science	ACSSU075 Earth's surface changes over time as a result of natural processes and human activity ACSHE061 Science involves making predictions and describing patterns and relationships ACSIS064 With guidance, identify questions in familiar contexts that can be investigated scientifically and make predictions based on prior knowledge ACSIS065

	With guidance, plan and conduct scientific investigations to find answers to questions, considering the safe use of appropriate materials and equipment ACSIS066 Consider the elements of fair tests and use formal measurements and digital technologies as appropriate, to make and record observations accurately ACSIS068 Use a range of methods including tables and simple column graphs to represent data and to identify patterns and trends ACSIS216 Compare results with predictions, suggesting possible reasons for findings ACSIS069 Reflect on investigations, including whether a test was fair or not ACSIS071 Represent and communicate observations, ideas and findings using formal and informal representations
Technologies	WATPPS21 Define a sequence of steps to design a solution for a given task WATPPS22 Identify and choose the appropriate resources from a given set WATPPS23 Develop and communicate design ideas and decisions using annotated drawings and appropriate technical terms WATPPS24 Select, and safely use, appropriate components and equipment to make solutions WATPPS26 Work independently, or collaboratively when required, to plan, safely create and communicate ideas and information for solutions. ACTDIP009 Collect and present different types of data for a specific purpose using software
Mathematics	ACMSP096 Construct suitable data displays, with and without the use of digital technologies, from given or collected data. Include tables, column graphs and picture graphs where one picture can represent many data values ACMMG084 Use scaled instruments to measure and compare lengths, masses, capacities and temperatures ACMMG290 Compare objects using familiar metric units of area and volume

	ACMSP095 Select and trial methods for data collection, including survey questions and recording sheets

Useful websites

- AusEarthEd YouTube video explaining more on Chemical Weathering https://www.youtube.com/watch?v=JpRS9N-NWsY&t=3s
- WASP Year 4 Acid Rain – Teacher Notes explaining chemical weathering and acid rain. https://www.wasp.edu.au/mod/resource/view.php?id=493

Land Rebound

Objective

In this activity students investigate isostasy (crustal rebound after mass has been removed). They will find out what can happen to the land post-glacial periods and see that when mass is removed that the crust can rise upwards as it lies on the semi-solid mantle below. They can consider how the land rising may affect apparent sea level.

Students can collect both quantitative and qualitative data. They may wish to take photos or record this experiment to show visually what happens to the land as mass is removed.

For the Scaffolded and Guided students, they are given a list of equipment and a method. The Guided students are asked to improve the method they are given. They should consider how they will get data from the investigation, including possibly taking photos and making visual observations as well as collecting qualitative data. The Open students must design their own investigation this includes coming up with their own equipment list, again they should be encouraged to consider what data they will collect to enable them to answer the investigation question. All students will evaluate their investigation and consider how it could be improved and extended.

Students can present their data using graphs and tables, either hand drawn or created on a computer.

Subject area	Australian syllabus links
Science	ACSSU075 Earth's surface changes over time as a result of natural processes and human activity ACSSU076 Forces can be exerted by one object on another through direct contact or from a distance ACSHE061 Science involves making predictions and describing patterns and relationships ACSIS064 With guidance, identify questions in familiar contexts that can be investigated scientifically and make predictions based on prior knowledge ACSIS065 With guidance, plan and conduct scientific investigations to find answers to questions, considering the safe use of appropriate materials and equipment

	ACSIS066 Consider the elements of fair tests and use formal measurements and digital technologies as appropriate, to make and record observations accurately ACSIS068 Use a range of methods including tables and simple column graphs to represent data and to identify patterns and trends ACSIS216 Compare results with predictions, suggesting possible reasons for findings ACSIS069 Reflect on investigations, including whether a test was fair or not ACSIS071 Represent and communicate observations, ideas and findings using formal and informal representations
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Mathematics	ACMSP096 Construct suitable data displays, with and without the use of digital technologies, from given or collected data. Include tables, column graphs and picture graphs where one picture can represent many data values ACMMG084 Use scaled instruments to measure and compare lengths, masses, capacities and temperatures ACMMG290 Compare objects using familiar metric units of area and volume ACMSP095 Select and trial methods for data collection, including survey questions and recording sheets

Useful websites

- Professor John Wheeler from the University of Liverpool talks about isostasy using an analogue model.
  https://www.youtube.com/watch?v=t2CFSuvm1A4
- Britanica Article explaining the theory of Isostasy
  https://www.britannica.com/science/isostasy-geology
- Wikipedia article explaining post-glacial rebound
  https://en.wikipedia.org/wiki/Post-glacial_rebound

Mapping Change

Objective

In this activity students will create a poster or field guide which will show evidence of surface changes caused by natural events in their local area.

Students are encouraged to first think about what sort of evidence they might be looking for and what it might look like, e.g. weathering of rocks (Scaffolded and Guided booklets give them suggestions whereas Open students have to think about this themselves). They can plot out a (safe) route where they will look for and record evidence of changes. Scaffolded students are encouraged to take photos and/or create labelled diagrams. Guided students are encouraged to write additional notes and add these to their poster/field guide. Open students first research what information is usually in a field guide and use this to decide what information they will collect and how they will collect and present it.

You may want to show them other field guides first so that they have an idea what a field guide is, as many will never have seen one before.

As these are for the purpose of others to use it is important that students give very clear directional language as to where the locations are and how to find them. You may want to introduce using a compass. If the students have iPads/ tablets you may be able to download some free apps which will give exact co-ordinates, or that has a distance measurement tool/ step counter so students could write the distance between locations.

Subject area	Australian syllabus links
Science	ACSSU075 Earth's surface changes over time as a result of natural processes and human activity ACSIS071 Represent and communicate observations, ideas and findings using formal and informal representations
Technologies	WATPPS21 Define a sequence of steps to design a solution for a given task WATPPS22 Identify and choose the appropriate resources from a given set WATPPS23 Develop and communicate design ideas and decisions using annotated drawings and appropriate technical terms WATPPS24 Select, and safely use, appropriate components and equipment to make solutions

	WATPPS26 Work independently, or collaboratively when required, to plan, safely create and communicate ideas and information for solutions. ACTDIP009 Collect and present different types of data for a specific purpose using software
Mathematics	ACMSP095 Select and trial methods for data collection, including survey questions and recording sheets

Useful websites:

- Downloadable PDF explanation on how to create a field guide https://cpw.state.co.us/Documents/Family/FieldGuide.pdf
- Step by step guide "How to create a field guide when you are a young naturalist" https://www.wikihow.com/Write-a-Field-Guide-When-You-Are-a-Young-Naturalist
- Short blog on what to include in a field guide – this has useful tips on how to catalogue data and ensure you record locations for sightings. https://blog.nwf.org/2010/06/make-a-field-guide-to-your-yard/