



Earth & Space Science Curriculum Link:

Describe the key processes of the rock cycle and examine how properties of rocks reflect their formation and influence their use.

Geomechanics Focus:

Applying rock cycle knowledge to construction: Linking rock properties to engineering applications.

Background Information

Igneous rocks (granite, basalt) are generally hard and dense due to cooling from magma. Sedimentary rocks (limestone, sandstone) are softer and more porous, formed from compacted sediments. These properties influence their suitability for road base, concrete, and landscaping.

You can watch the demonstration video [here](#).

A teacher presentation for the following activity is provided in this teaching package.

Aim

Test and compare hardness, density, porosity and strength of different rocks to determine their suitability for engineering uses

Materials

Per small group (figure 1)

- Hand lens/magnifying glass/microscope
- Nail, steel file or screwdriver
- Scale
- Graduated cylinder or beaker with water
- Hammer (teacher demo only).
- PPE (gloves, safety glasses)
- Rock samples: granite, basalt, limestone, sandstone (figure 2-5)

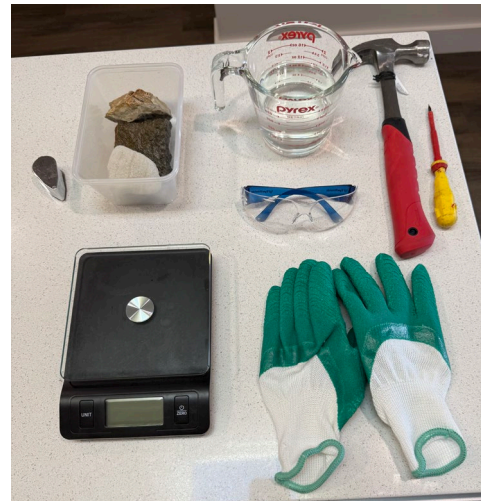


Figure 1: Materials

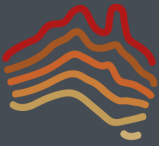


Figure 2: Granite (light in colour, coarse-grained, interlocking crystals)



Figure 3: Basalt (dark in colour, fine-grained, interlocking crystals)



Figure 4: Limestone (range of appearances but usually beige to grey in colour, contains calcium carbonate – use acid test to confirm)



Figure 5: Sandstone: Sand-sized grains in a cement

Safety Notes

Students must wear goggles during tests and wash their hands after tests. Hammer impact test is teacher-only. Perform hammer demo in a tray or box to contain fragments. Ensure stable surface and light taps only.

Method

1. Run through the PowerPoint presentation provided in the teaching package.
2. Observe rock samples with hand lenses (figure 6), magnifying glasses or microscopes. Write down observations.
3. Hardness test: Scratch each rock with a nail, steel file or screwdriver (figure 7). Record which resist scratching.

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Important: this test is a comparative rock scratch test, not a true Mohs hardness test.

- The Mohs scale measures the hardness of individual minerals, not whole rocks.
 - Our scratch test will help students compare relative resistance to scratching among rock samples, but it does not assign Mohs numbers to rocks.
4. Density test: Measure mass and volume (water displacement; figure 8). Calculate density:

$$\text{Density (g/ml)} = \frac{\text{Mass}}{\text{Volume}}$$

Watch the Determining Densities video on our Youtube (AusEarthEd).

5. Porosity test: Weigh dry rock (figure 9), submerge for 10 min (figure 10), re-weigh, calculate water absorbed and porosity:

Calculate water absorbed:

$$\text{Water Absorbed (g)} = \text{Wet Mass} - \text{Dry Mass}$$

Estimate porosity:



Figure 6: Observing with a hand lens



Figure 7: Scratch test



Figure 8: Measuring water displacement



Figure 9: Measuring the dry mass



Figure 10: Submerging for 10 mins



Figure 11: Strength test

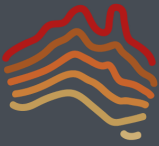
$$\text{Porosity (\%)} = \frac{\text{Water Absorbed}}{\text{Dry Mass}} \times 100$$

6. Strength Demo (Teacher Only): Wearing PPE, lightly tap each rock with a hammer in a tray or

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outside on a hard surface (figure 11). Observe if it fractures or crumbles.

7. Rank Suitability: Based on results, rank rocks for road base, concrete aggregate, and landscaping.

Guidance: Ideal properties by engineering use

- 1) Road base: a compacted, multi-sized crushed rock material used as a stable foundation



Figure 8: Road base (source: <https://www.bracingsystems.com/what-is-road-base-and-why-does-it-matter>)

for driveways, paths, and under slabs, providing strength and support before a final surface is applied

Ideal properties:

- **Hardness:** Moderate to high (to resist wear)
- **Density:** High (for stability and load-bearing)
- **Porosity:** Low (to prevent water infiltration and weakening)
- **Strength:** High compressive strength (to withstand traffic loads)

- 2) Concrete aggregate: granular materials (like sand, gravel, crushed stone, or recycled concrete) that form the bulk of concrete (made from limestone), providing strength and volume, with cement acting as the binder

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Figure 9: Concrete aggregate

Ideal properties:

- **Hardness:** High (to ensure durability of concrete)
- **Density:** High (for strong concrete mix)
- **Porosity:** Low (to avoid water absorption and weakening)
- **Strength:** High (to maintain structural integrity)

3) Landscaping (pavers, decorative stone, facing): rock materials selected for outdoor surfaces and aesthetic features, including pavers, stepping stones, wall facing, and garden rock.

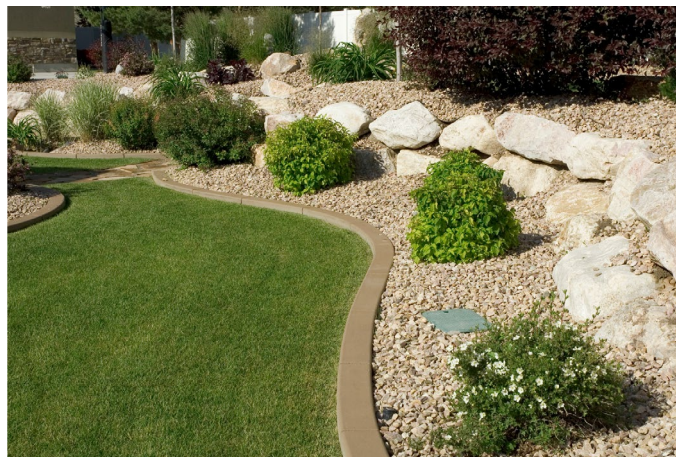


Figure 10: Landscaping

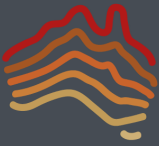
Ideal properties:

- **Hardness:** Can be moderate (ease of shaping)
- **Density:** Moderate (lighter rocks easier to handle)

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- **Porosity:** Can be higher (for aesthetic and drainage purposes)
- **Strength:** Not as critical as structural uses, but should resist weathering

Results

Rock Sample	Observations	Hardness	Density (g/ml)	Porosity (%)	Strength Notes	Suitability
Granite	<i>Visible crystals that interlock tightly. Hard, shiny mineral grains.</i>	<i>Very hard (most minerals resist scratching)</i>	<i>High (~2.6–2.7)</i>	<i>Low (<1%)</i>	<i>Does not fracture under light hammer tap</i>	<i>Excellent for road base & concrete</i>
Basalt	<i>Fine-grained texture. Dark colour. May see small holes from gas bubbles.</i>	<i>Hard (resists scratching)</i>	<i>High (~2.7–3.0)</i>	<i>Low (<1%)</i>	<i>Very strong, minimal chipping</i>	<i>Excellent for road base & concrete</i>
Limestone	<i>Uniform, light colour. May see tiny fossil fragments or shell pieces.</i>	<i>Soft (scratches easily)</i>	<i>Low (~2.3–2.7)</i>	<i>Moderate (5–10%)</i>	<i>May chip, fracture or crumble under hammer</i>	<i>Good for landscaping, essential for concrete but not as aggregate</i>
Sandstone	<i>Individual sand grains visible. Grains loosely cemented</i>	<i>Soft (scratches easily)</i>	<i>Low (~2.2–2.4)</i>	<i>High (>10%)</i>	<i>Crumbles easily under hammer but does not often fracture</i>	<i>Poor for road base, good for landscaping</i>

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Note: Values and properties can vary depending on the sample.

Discussion

1. How do these properties relate to their formation?
Igneous rocks form under heat/pressure -> dense & hard; sedimentary rocks from Sediments, which don't fit together well, allowing air or water to fill voids -> softer & porous.
2. Which rock would be best for a tunnel lining? Why?
Granite or basalt – strong and low porosity
3. Why might sandstone be less suitable for road base?
High porosity and low strength -> absorbs water and breaks down under load.
4. For density and porosity measurements, what sources of uncertainty or error might there be?
Answers will vary but may include:

Instrument precision:

*Scales may not show enough decimal places, leading to rounding errors in mass.
Measuring jugs or cylinders may have coarse graduations, making volume estimates less accurate.*

Measurement errors:

Spillage or incomplete submersion.

Human factors:

Misreading measurements or rounding errors in calculations.

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Teacher Note: Real-World Geomechanics Connection



Figure 11: Drill core samples from a geotechnical investigation showing the effect of weathering on rock strength: (A) fresh sandstone core (high strength, intact) and (B) highly weathered siltstone core (very low strength, fragmented). Image: Ali Parsa, JK Geotechnics.

These drill core images from a geotechnical investigation provide a real-world example of how rock properties influence engineering decisions.

- The fresh sandstone core is intact and competent, indicating high strength and low weathering.
- The highly weathered siltstone core is fragmented and weak, showing significant strength loss due to weathering.

This example reinforces a key concept for students: Rock type alone does not determine suitability for engineering — **rock condition (especially weathering) is critical.**

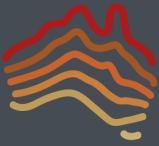
Teachers can use these images to:

- Highlight that rocks of similar origin (both sedimentary) can behave very differently
- Connect classroom tests (hardness, porosity, strength) to real engineering assessments
- Introduce how engineers use drill cores to evaluate subsurface conditions before

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construction

Extension

Research how engineers modify or treat rocks (e.g., crushing, chemical treatments) to improve suitability for construction.

For more activities like this, why not try our Year 8 STEM Chopping on Rock Project?

Possible sources:

TFS Soils. (n.d.). Soil modification: Basics and importance. Retrieved January 6, 2026, from <https://www.tfsoils.com/soil-modification-basics-and-importance>

What Geomechanics Is and Why It Matters

Geomechanics is the study of how soil, rock, and Earth materials behave, forming a critical foundation for the design and performance of modern infrastructure. It enables engineers and planners to develop safe, efficient, and sustainable structures, such as buildings, tunnels, roads, and dams, by providing accurate ground models and an understanding of how the ground responds to natural and human-induced changes. Geomechanics also contributes to public safety by helping identify and manage geohazards such as landslides, sinkholes, and ground instability, supporting climate resilience, sustainable development, and the global energy transition. Through proactive ground assessment and risk evaluation, geomechanics helps prevent infrastructure failures, reduce project delays, and lower financial and social costs. Careers in geomechanics span a wide range of roles, including field investigations, laboratory testing, data analysis, and engineering design, with entry pathways commonly through geology, civil engineering, and environmental science. Alternative routes, such as experience in construction, surveying, or environmental monitoring, also provide effective foundations for moving into the field. Professionals develop skills in technical analysis, communication, critical thinking, and multidisciplinary collaboration, supporting informed decision making across infrastructure and environmental projects.

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Aim

Test and compare hardness, density, porosity and strength of different rocks to determine their suitability for engineering uses



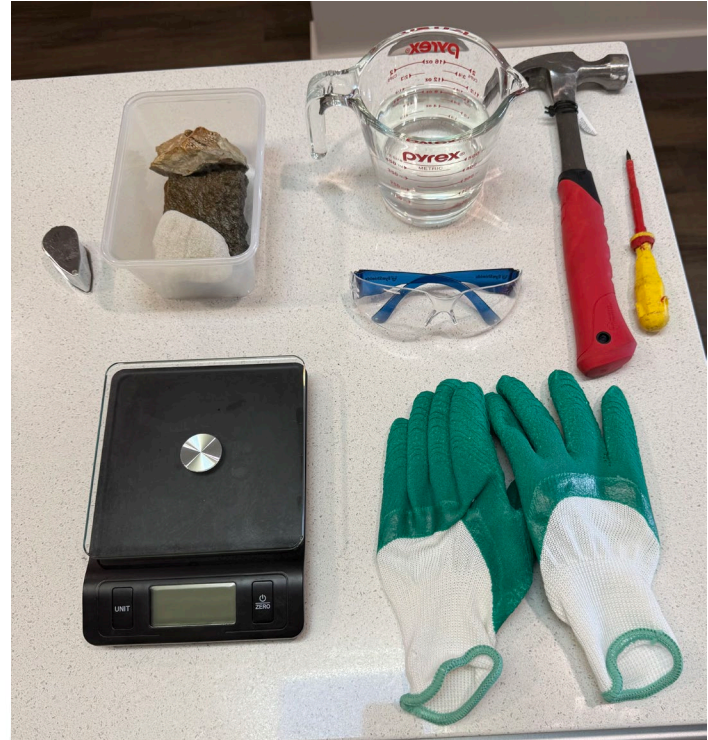
Materials

Per small group:

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- Graduated cylinder or beaker with water

For teacher demonstration:

- Hammer
- PPE (gloves, safety glasses)



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Granite						
Basalt						
Limestone						
Sandstone						



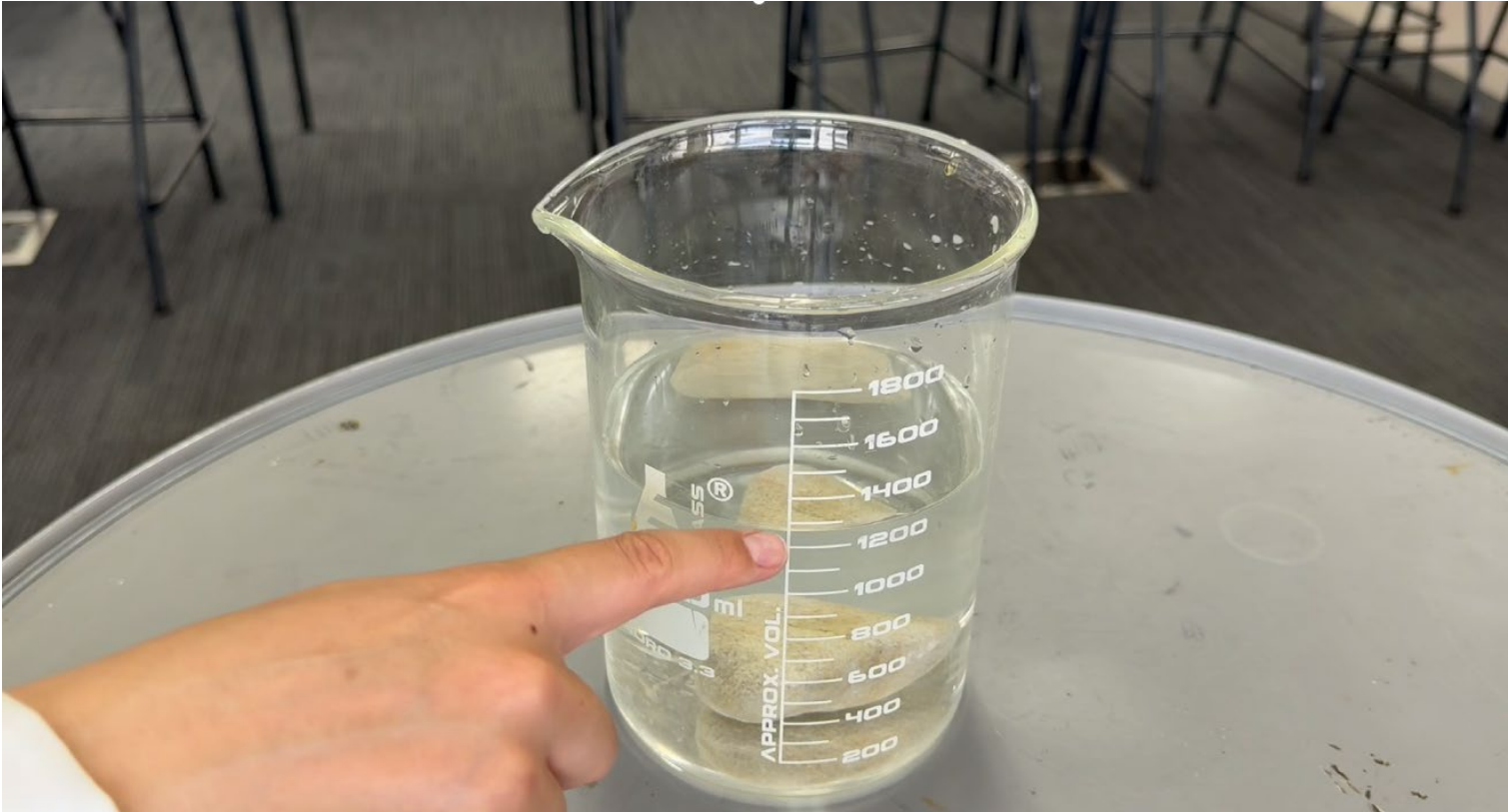
Observe rock samples with hand lenses, magnifying glasses or microscopes.
Write down observations



Hardness Test: Scratch each rock with a nail or steel file.
Record which resist scratching.



Density Test: First, measure mass and volume (water displacement).



$$\text{Density (g/ml)} = \frac{\text{Mass}}{\text{Volume}}$$

e.g.,:

$$\text{Density (g/ml)} = \frac{150\text{g}}{65\text{ml}} = 2.3 \text{ g/ml (also g/cm}^3\text{)}$$



Porosity Test: First, weigh dry rock, submerge for 10 min, re-weigh



Water Absorbed (g) = Wet Mass – Dry Mass

$$\text{Porosity (\%)} = \frac{\text{Water Absorbed}}{\text{Dry Mass}} \times 100$$

e.g.,:

$$\text{Porosity (\%)} = \frac{4g}{185g} \times 100 = 2\%$$



Strength Demo (Teacher Only): Wearing PPE, lightly tap each rock with a hammer in a tray or outside on a hard surface. Observe if it fractures or crumbles.



Rank Suitability: Based on results, rank rocks for:

Rock Sample	Observations	Hardness	Density (g/ml)	Porosity (%)	Strength Notes	Suitability
Granite						
Basalt						
Limestone						
Sandstone						



Road base



Concrete aggregate



Landscaping



Discussion





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