



The Rock Cycle

Chapter 17 of 29 • Processes that Shape Earth

Lesson 17: How do Earth's materials move and change, and what supplies the energy?

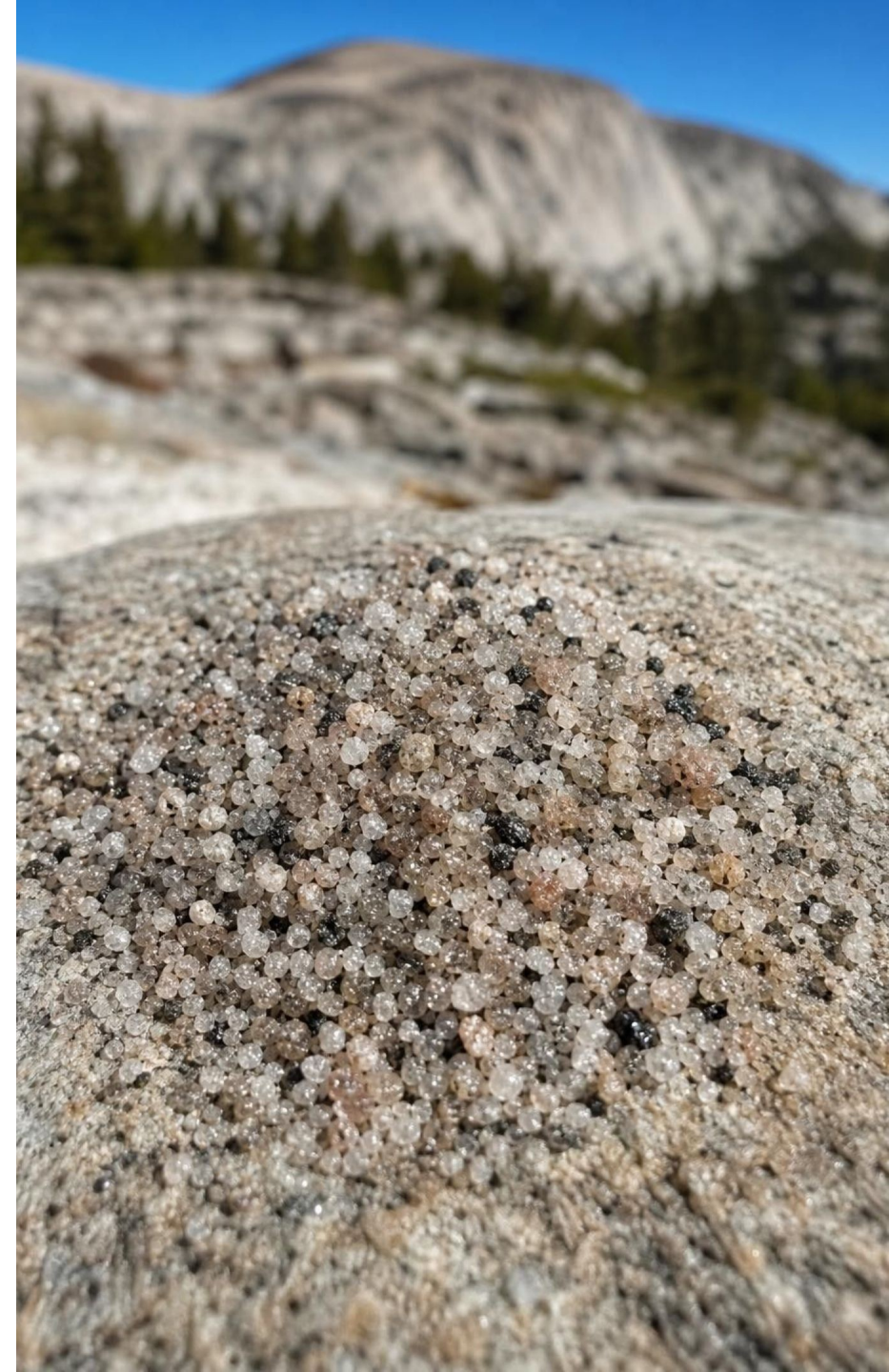
Angela's Wand • Bring Science Alive! 7th Grade Integrated

PHENOMENON

The sand at the foot of the dome matches the dome

A hiker at the base of a bare granite dome in the Sierra Nevada scoops up gritty sand. Under a lens the grains are pink, white, gray and glittering black, the same colors as the specks in the rock overhead. This granite hardened kilometers underground about 100 million years ago and never erupted. How is it in the open air, why is it turning into sand, and what happens to the sand next?

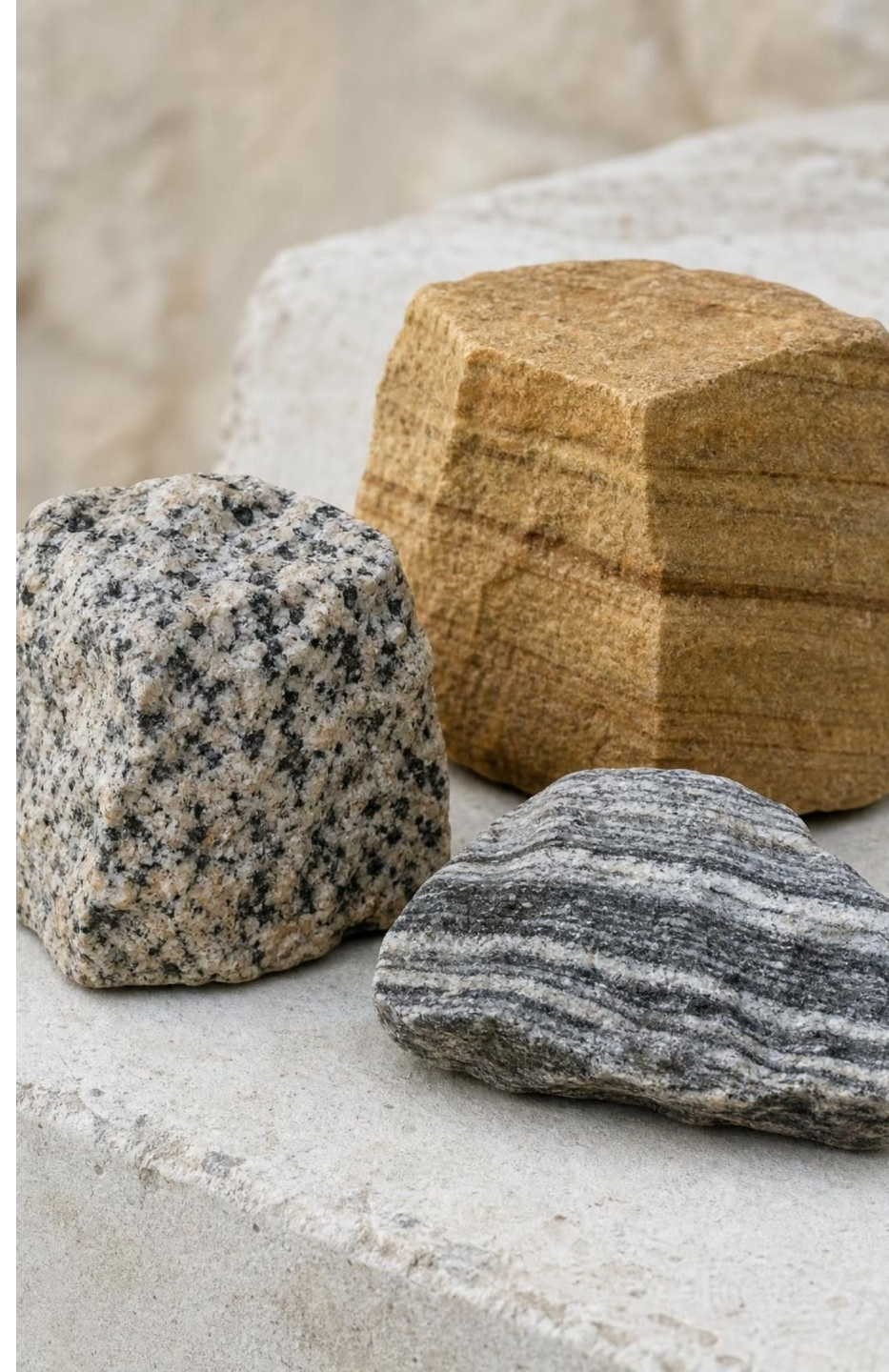
- Notice: what do the sand grains and the rock specks have in common?
- Wonder: what had to happen to the rock that once lay on top of this granite?
- Predict: where will this sand be in a thousand years? In a million?



LEARNING TARGETS

What you will be able to do

- Use a rock's grain size and arrangement as clues to how it formed.
- Explain why cooling speed sets crystal size, and tell intrusive from extrusive rock.
- Describe how weathering, erosion, deposition and burial make sedimentary rock.
- Explain how heat and pressure change solid rock without melting it.
- Build a rock-cycle model with many routes and name the energy behind each one.
- Tell a rock's story from evidence, keeping observations and inferences apart.





What is a rock made of? Building blocks inside building blocks

- When atoms lock into a pattern that repeats over and over, they form a crystal.
- A mineral is a naturally formed solid with a set makeup and its own crystal pattern.
- Most rocks are built from one or more minerals; granite has four main ones.
- A few rocks are mostly natural glass, with no repeating pattern at all.
- Two clues tell how a rock formed: composition (what it is made of) and texture (grain size and arrangement).

Three words for reading a rock



mineral

A naturally formed solid with a set chemical makeup and atoms in a repeating pattern.
The glittering black flakes in granite are one mineral; the pink chunks are another.

composition

What a rock is made of: which minerals, and so which elements, it contains.
Granite's composition is rich in silica, so it is light colored and less dense than dark lava rock.

texture

How big a rock's grains or crystals are, their shape, and how they fit together.
Sand-sized grains in flat layers are a texture; interlocking crystals are a different texture.

Three families, three processes, three textures

Model: How to tell the rock families apart



Igneous: melted rock cooled and hardened

Interlocking crystals, large or tiny; sometimes glassy, sometimes full of gas holes. No layers of loose grains.



Sedimentary: pieces settled, were buried and cemented

Separate grains, pebbles or shell bits stuck together, often in flat layers; grains may rub off.



Metamorphic: solid rock changed by heat and pressure

Crystals flattened and lined up, sometimes in light and dark bands, or regrown into a fused, sugary mass.

The family name tells you the process; the texture is the evidence for it.

Quick check: read the texture

CHECK FOR UNDERSTANDING

A rock has rounded sand-sized grains in thin flat layers, and grains come off when you rub it. Which family, and what is the evidence?

A. Igneous: the grains are crystals that grew from magma

B. Sedimentary: loose grains were deposited in layers and cemented

C. Metamorphic: the layers are bands made by pressure

D. Cannot tell without knowing the minerals





Igneous rock: cooling time sets crystal size

- Magma is melted rock underground; lava is melted rock that reached the surface.
- As melt cools, crystals start tiny and keep growing as long as the rock stays molten.
- Slow cooling underground: large crystals you can see. This is intrusive rock, like granite.
- Fast cooling at the surface: tiny crystals or glass. This is extrusive rock, like basalt.
- Intrusive rock reaches the surface only after uplift and erosion strip away the rock above.

MODEL

Intrusive versus extrusive: same melt, different clock

Model: Two fates for the same magma

Intrusive (cools below the surface)	Extrusive (cools at the surface)
Insulated by surrounding warm rock	Loses heat quickly to air or water
Thousands to millions of years to harden	Hours to years to harden
Large interlocking crystals, coarse texture	Tiny crystals or glass; may hold gas holes
Examples: granite (light), gabbro (dark, denser)	Examples: basalt (lava flow), pumice and obsidian (glassy)
Seen at the surface only after uplift and erosion	Forms lava flows and volcanic layers at the surface

Gabbro and basalt can be made from the same ingredients; the difference is where and how fast they cooled.



Words for melted rock and what it becomes

igneous rock

Rock that forms when magma or lava cools and hardens. *A black lava flow hardening on a volcano's flank is becoming igneous rock.*

intrusive rock

Igneous rock that hardened slowly below the surface, so its crystals are large. *The granite of the dome is intrusive; its specks are crystals the size of rice grains.*

extrusive rock

Igneous rock that hardened quickly at the surface, so its crystals are tiny or it is glassy. *Basalt and pumice are extrusive; you need a lens to see any crystals in basalt.*





CHECK FOR UNDERSTANDING

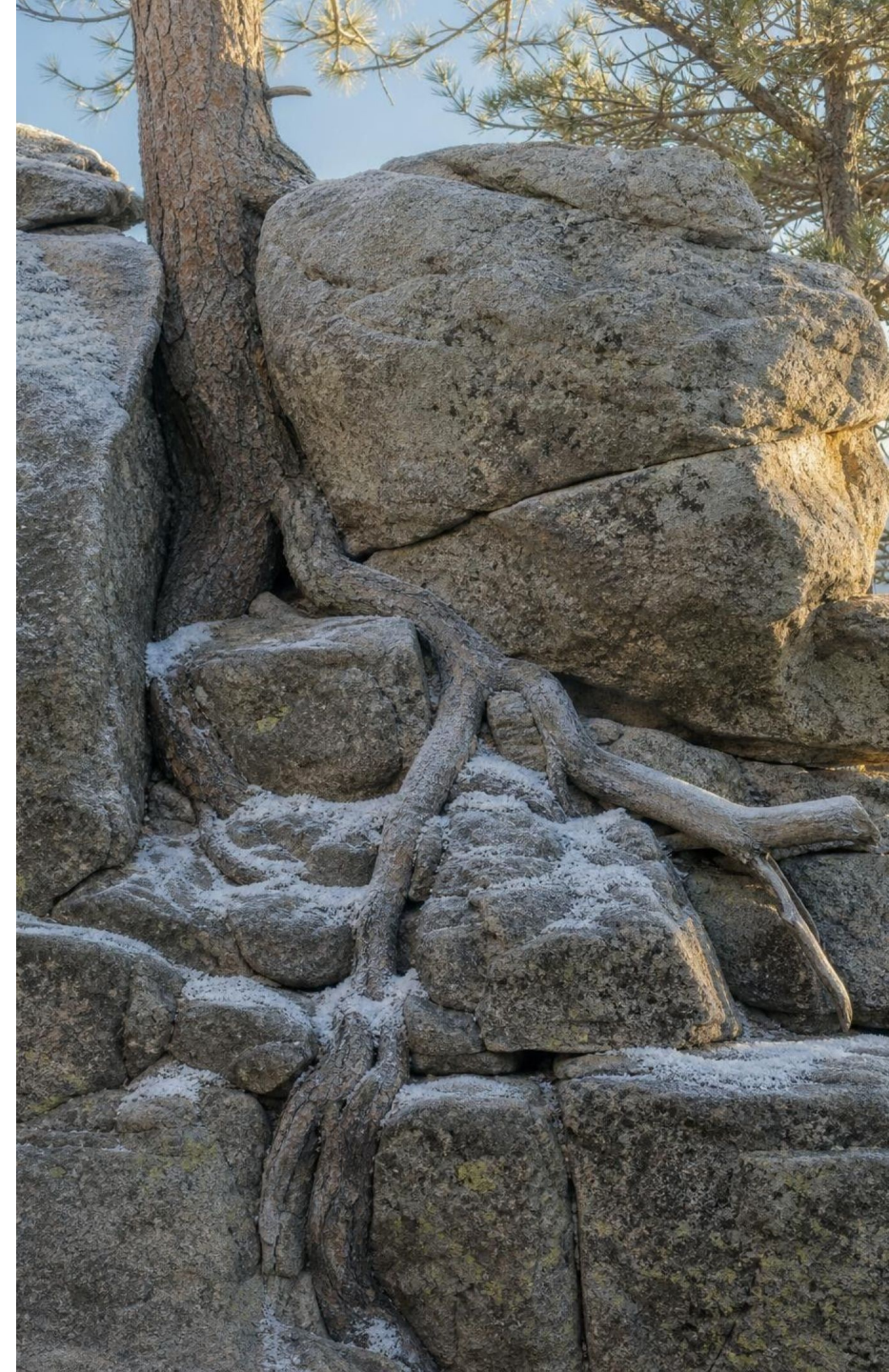
Quick check: where did it cool?

Two rocks have the same ingredients. One has crystals you can see; the other is dark with crystals too small to see without a lens. What is the best explanation?

- A. The coarse rock cooled slowly underground; the fine one cooled fast at the surface
- B. The coarse rock is older, so its crystals had more time to grow after hardening
- C. The fine rock lost most of its minerals while erupting
- D. The two rocks must have different compositions after all

Sedimentary rock begins with breakdown at the surface

- Physical weathering: ice, heat and cold, roots and wind crack rock into fragments called sediment.
- Chemical weathering: water and air react with minerals, changing or dissolving them.
- Erosion: wind, water, ice and gravity carry the sediment away.
- Deposition: when the carrier slows and loses energy, it drops its load, biggest pieces first.
- Burial: new layers press the grains together (compaction); minerals glue them (cementation).



From the dome to a sandstone: one sedimentary route

Model: Granite grains on their way to becoming rock again

1	2	3	4	5	6
Granite dome weathers; grains loosen → (weathering)	Rain and gravity carry grains into a stream → (erosion)	Stream enters a lake, slows, drops the sand → (deposition)	Layer after layer buries the sand → (burial)	Weight compacts; mineral cement glues grains → (compaction and cementation)	Sandstone: layered rock of the old granite's grains



Sun-driven weather and gravity power every step until burial; the weight of the layers does the rest.



The dissolved route: shells and salt

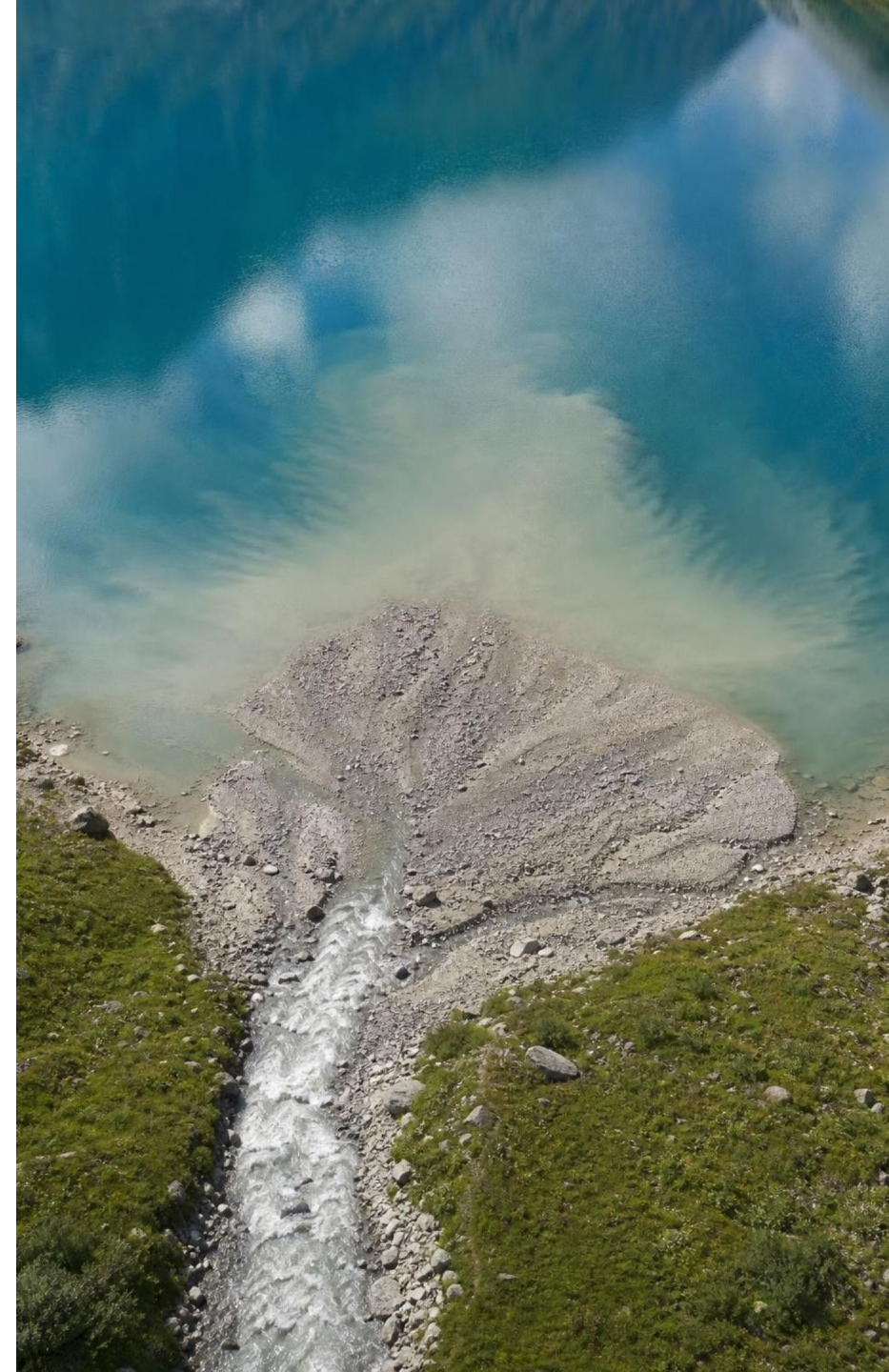
Chemical weathering sends dissolved material down rivers to lakes and the sea. Two things can happen to it. Sea creatures pull it from the water to build shells; the shells pile up on the seafloor and become limestone. Or the water evaporates, the minerals grow too concentrated to stay dissolved, and they crystallize out as rock such as halite (rock salt). Both are sedimentary rock with no sand grains at all.

THINK, PAIR, SHARE

Discuss: where does the river drop its load?

- Think about what keeps a pebble moving versus what keeps a mud particle moving.
- Where does the water lose most of its energy?
- Which rock would form near the mouth, and which far out in the lake?

A fast mountain stream carrying pebbles, sand and mud enters a calm lake. Predict the order in which the pieces settle, from the stream mouth outward, and explain using energy.





Metamorphic rock: changed while still solid

- Deep burial or plate collisions put solid rock under great heat and pressure.
- The rock never melts. Its crystals flatten, line up, and regrow into new or larger crystals.
- Squeezing over wide areas lines crystals up in sheets or bands: schist and gneiss.
- Heat from nearby magma regrows crystals in the rock it touches: limestone to marble.
- Rock closest to the heat changes most; rock farther away changes less.

Words for change without melting



metamorphic rock

Older rock whose texture or minerals were changed by heat, pressure or hot fluids while it stayed solid.

The wavy banded rock on the island was once ordinary rock squeezed between colliding plates.

deformation

Slow bending and squeezing of solid rock that flattens its crystals and lines them up, often in bands.

Deformation gives schist its flaky sheets and gneiss its light and dark bands.

recrystallization

Regrowth of a rock's crystals into new or larger crystals while the rock is solid.

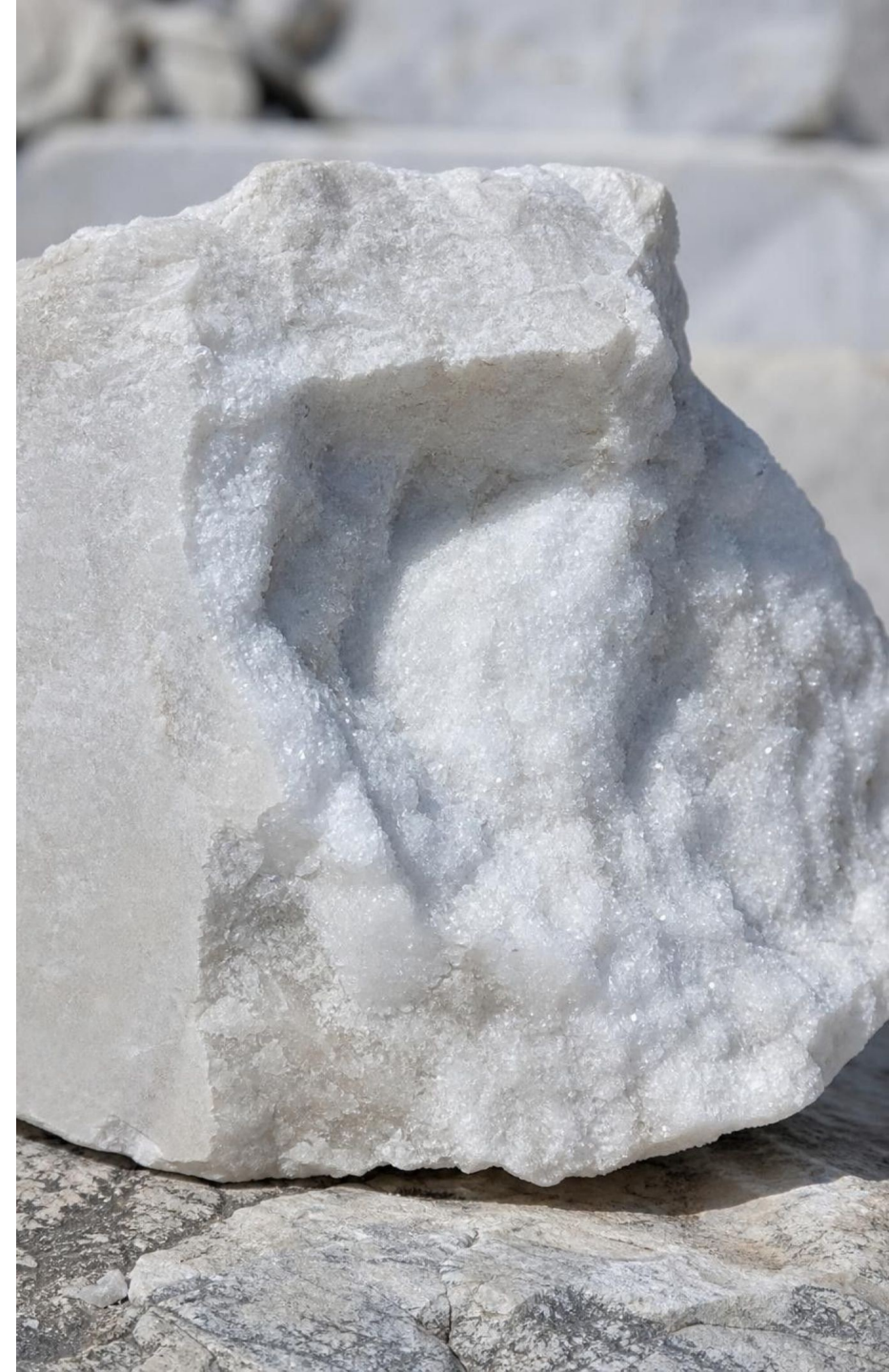
Recrystallization beside a magma body turns limestone into sugary-looking marble.

CHECK FOR UNDERSTANDING

Quick check: does it have to melt?

A student says marble forms when limestone gets hot enough to melt and then hardens again. What is wrong with this, and what actually happens?

- A. Nothing is wrong; marble is melted limestone
- B. Limestone cannot change at all; marble forms from magma
- C. Heat regrows the limestone's crystals while the rock stays solid; melting would make igneous rock
- D. Marble forms only from pressure, never from heat



The rock cycle: a web of routes, not a loop

Model: Five stations and the processes that move material between them

Magma → (cooling and crystallization)

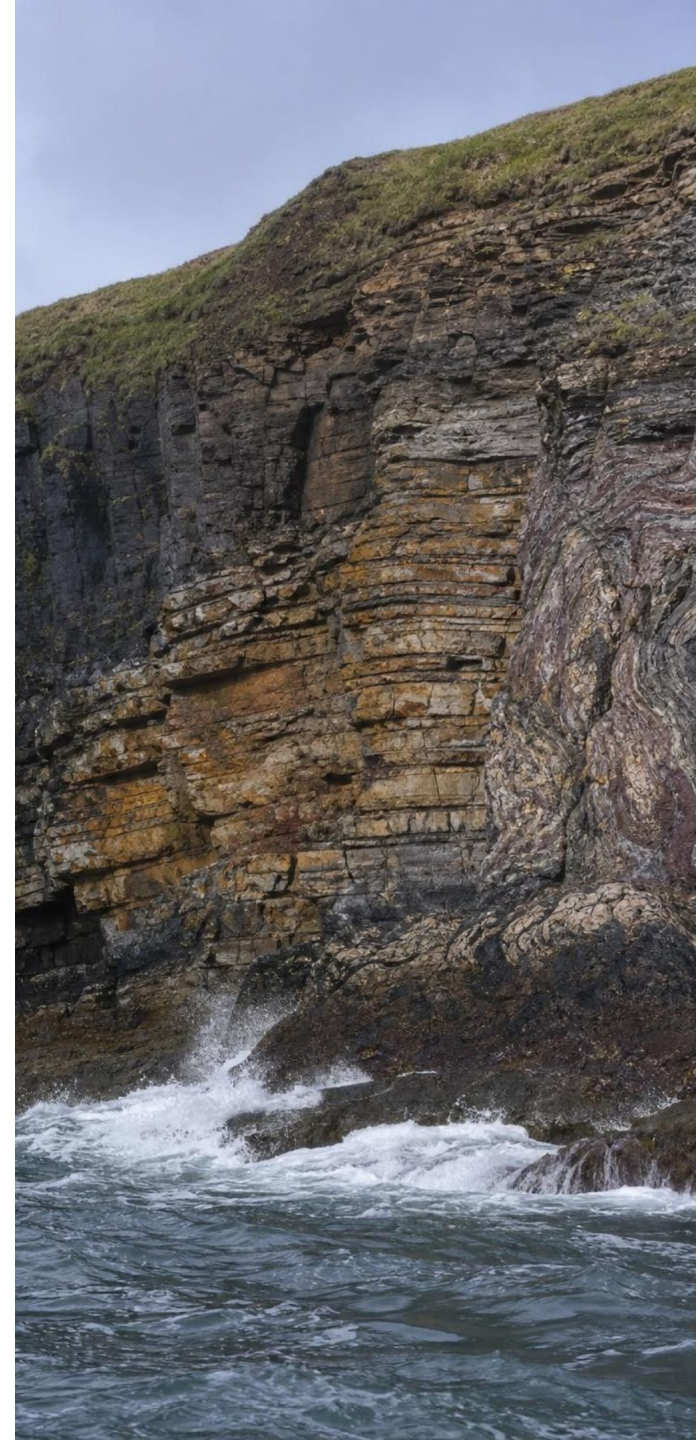
Igneous rock → (weathering and erosion)

Sediment → (deposition, burial, compaction, cementation)

Sedimentary rock → (heat and pressure (no melting))

Metamorphic rock → (melting) (back to the start)

Shortcuts exist everywhere: any rock can weather, any rock can be metamorphosed, any rock can melt, and metamorphic rock can be changed again.



MODEL

Who pays for each change? Two energy budgets

Model: The energy behind the arrows

Sun and gravity: surface processes	Earth's hot interior: deep processes
Weather, rain, wind and freeze-thaw weather rock	Melts rock into magma
Rivers, glaciers and wind erode and carry sediment	Drives plate motion that collides, buries and squeezes rock
Gravity pulls sediment downhill and into low basins	Supplies the heat that recrystallizes and deforms rock
Evaporation leaves dissolved minerals as salt crusts	Pushes magma upward; lifts deep rock toward the surface
Weight of buried layers compacts sediment	Heat flowing out of magma lets it crystallize

Every arrow in the cycle has a bill, and the Sun or Earth's interior pays it.



THINK, PAIR, SHARE

Discuss: a route that never melts

Describe a route that takes the dome's granite to a metamorphic rock without the material ever melting. Then describe a route that takes it to a new igneous rock. Which route needs the Sun, and where?





REAL-WORLD CONNECTION

California connection: the whole cycle within a day's drive

Yosemite's domes are granite that cooled kilometers underground about 100 million years ago; uplift and erosion exposed them. East of the Sierra, the Mono Craters are young obsidian and pumice domes that cooled too fast for many crystals to grow. At Badwater Basin in Death Valley, a crust of mostly halite marks where a lake dried up. In the Sierra foothills, burial and squeezing turned old sea-floor rock into marble.

Task: trace each sample's route and its energy

For each sample, name the family, the process that made it, the energy source, and one earlier form the material could have had. Then draw the samples' routes on your cycle model.

Sample	Texture observed	Setting where it was found
1	Interlocking crystals the size of rice grains, pink, white, gray and black	Core of a mountain range, under a slope of matching sand
2	Rounded sand grains in flat layers; grains rub off; a few pink grains	Canyon wall 200 km from the mountains
3	Sand grains fused so none rub off; breaks across the grains	Deep road cut where the canyon rock was buried and squeezed
4	Dark, dull, crystals too small to see; small round holes	Top of a layered volcanic hill
5	White crust of cube-shaped crystals	Floor of a dry desert lake



CHECK FOR UNDERSTANDING

Quick check: name the energy source

- A glacier grinds a valley floor into rock flour.
- Magma rises beneath a volcano.
- Limestone beside an intrusion recrystallizes into marble.
- A dry lake's water evaporates and leaves a salt crust.
- Two plates collide and squeeze sandstone into quartzite.
- Buried sand is compacted by the weight of the layers above it.

Hold up S for Sun and gravity, or I for Earth's interior, as each process is read aloud.





How geologists read a rock's story

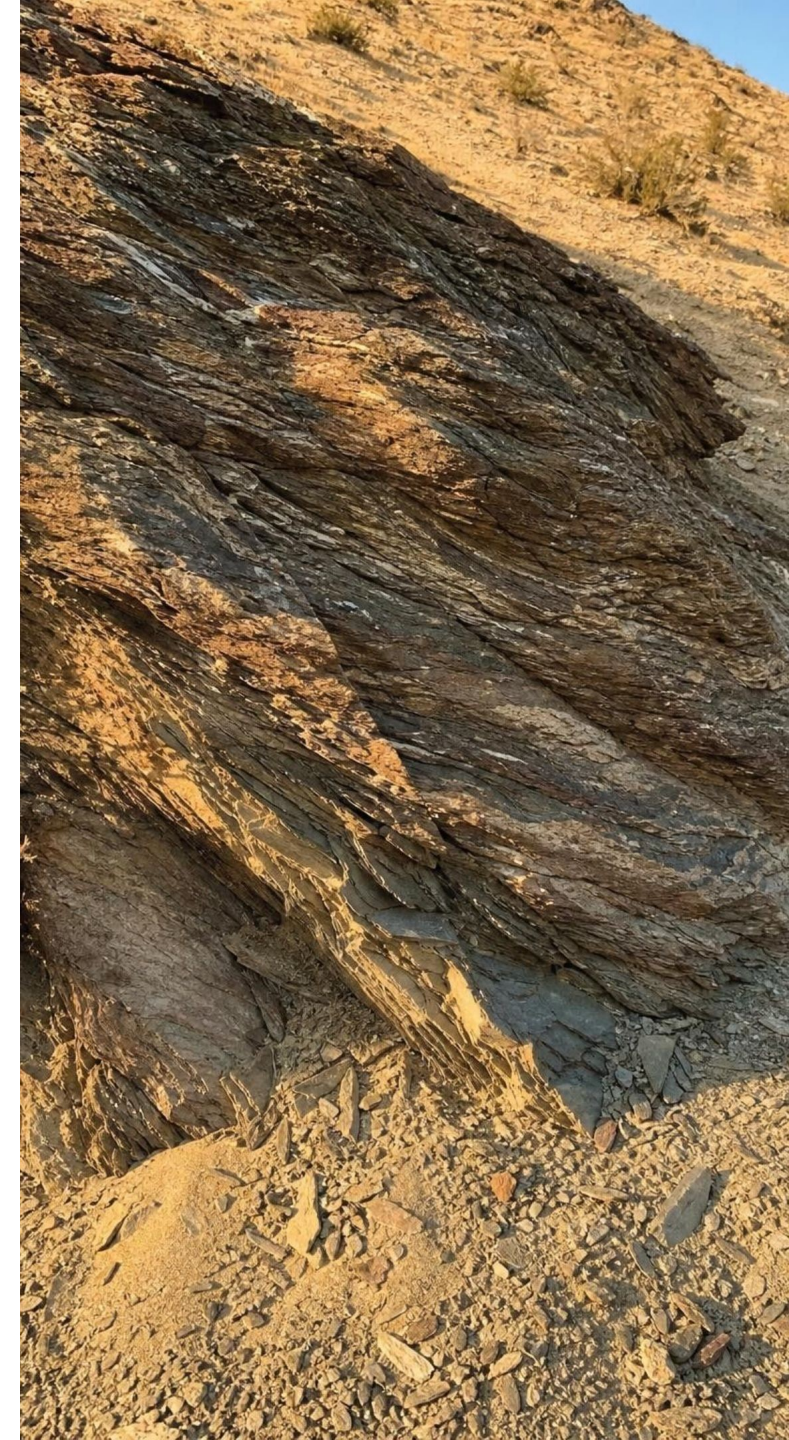
- In the field: a hand lens for texture, a hammer for a fresh surface, a map of how formations sit together.
- In the lab: microscopes and instruments that measure composition and crystal size.
- Observation: 'the grains are sand-sized and rounded.' Inference: 'water carried them a long way.'
- One clue is a hint; several clues that agree make a strong explanation.
- Most changes are too slow, too deep or too small to watch, so the evidence is the rock itself.

MISCONCEPTION CHECK

True or false? The cycle has a fixed order

"Every rock follows the same path: igneous rock weathers into sediment, the sediment becomes sedimentary rock, that rock is squeezed into metamorphic rock, and the metamorphic rock melts back into magma. A rock cannot skip a step."

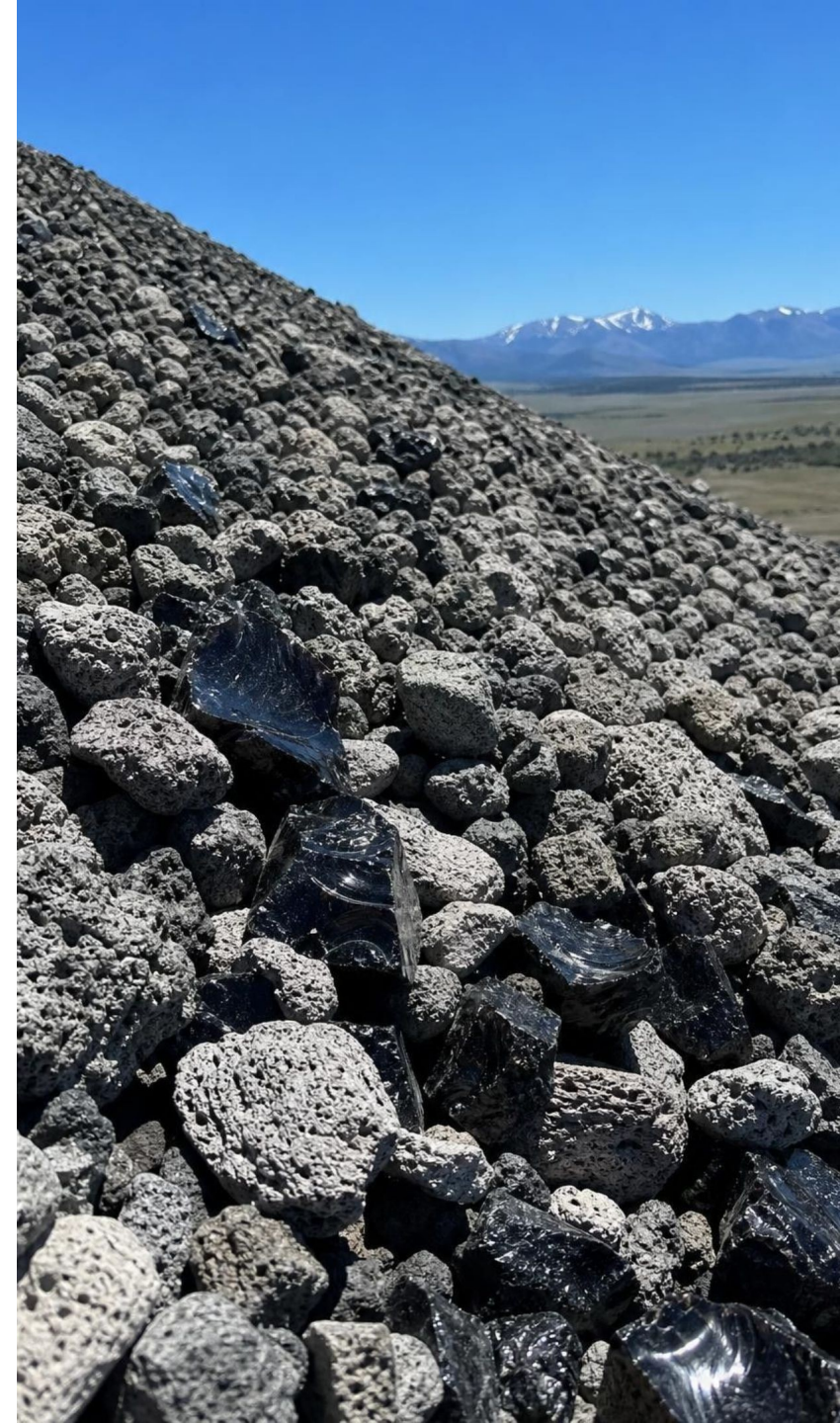
True or false? Explain your reasoning.



PUTTING IT TOGETHER

Putting it together

- Texture records process: interlocking crystals, layered grains, or flattened and banded crystals.
- Igneous: melt cools; slow underground means big crystals, fast at the surface means tiny or glass.
- Sedimentary: weathering, erosion, deposition, burial, cementation, or minerals left by shells and evaporation.
- Metamorphic: heat and pressure change solid rock; nothing melts.
- The rock cycle is a web; any rock can become any other, with no required order.
- Sun and gravity power the surface; Earth's interior powers melting, uplift and squeezing.





Exit ticket

Exit ticket

- A rock has flattened crystals lined up in wavy bands. Name the family and the two conditions that made it.
- Write a two-step route from basalt to sandstone, naming the process and the energy source for each step.
- Explain in one sentence why granite found on a mountain top is evidence that rock above it was removed.
- A classmate says marble is melted limestone. Correct the sentence.