Cooling Clues

Investigate how cooling and composition shape igneous rocks.

ESS.4.a "Plan and carry out investigations to explore the processes that form plutonic (intrusive) and volcanic (extrusive) igneous rocks of differing compositions and textures."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline each investigation step, circle each texture or composition clue, and number the two similar-composition pairs. Use your marks to track how the class separates the effects of cooling from the effects of composition.

A Rock Comparison

1. At a road cut, a geologist finds two igneous bodies: a thick mass that hardened underground and a thin layer of lava that hardened at the surface. Magma trapped below ground loses heat slowly, allowing many crystals to grow large. Lava loses heat faster, so its crystals tend to stay small or may not form at all. Cooling place does not by itself tell the whole story. Magmas also differ in composition, including their amounts of silica and iron. To investigate how cooling and composition affect rocks, a class compares four labeled specimens: granite, rhyolite, gabbro, and basalt.

2. First, students use a mineral guide to group granite with rhyolite as generally silica rich, and gabbro with basalt as generally richer in iron and magnesium. The pairs have similar broad compositions, not identical chemistry. Students examine equal-size surfaces with a hand lens, then use a microscope for grains too small to see clearly. They record whether most grains are large, tiny, or absent, and note any gas holes. To keep observations comparable, they inspect three spots on each specimen and use the same size scale. They do not heat rocks or melt them in the classroom.

3. Granite and gabbro commonly show crystals large enough to see with the eye, evidence of slow cooling underground. Rhyolite and basalt usually have much finer grains, consistent with rapid cooling at the surface. A glassy volcanic rock could show no crystals because it cooled so fast that crystals did not grow. Gas holes can form when gas escapes from lava, so holes alone do not measure cooling speed. Students compare rocks within each composition group before comparing the two groups. If a specimen differs from the expected pattern, they recheck its grain sizes and mineral identifications before changing their explanation.

2 ANSWER WITH EVIDENCE

Use the passage

1. Why do the students compare granite with rhyolite and gabbro with basalt before comparing the two groups?

2. What do the students do to make their grain-size observations comparable across specimens?

3. What grain-size result would support underground cooling for granite and surface cooling for rhyolite?

4. A specimen has gas holes. Why are the holes alone not enough to determine its cooling speed, and what should the students check?

3 YOUR TURN

Your own words

A class receives six unlabeled igneous rocks. Write a five- or six-sentence investigation plan using a hand lens, microscope, and mineral guide. Explain how you would compare composition and grain size to infer which rocks cooled underground or at the surface, and state one limit of your inference.

ANSWER KEY

Cooling Clues

HIGH SCHOOL · ESS.4.a

PART 1 · READ AND MARK

Underline each investigation step, circle each texture or composition clue, and number the two similar-composition pairs. Use your marks to track how the class separates the effects of cooling from the effects of composition. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	Why do the students compare granite with rhyolite and gabbro with basalt before comparing the two groups?	**Each pair has a similar broad composition, so comparing rocks within a pair helps students examine the effect of cooling on texture.**
2	What do the students do to make their grain-size observations comparable across specimens?	**They examine equal-size surfaces, inspect three spots on each specimen, and use the same size scale.**
3	What grain-size result would support underground cooling for granite and surface cooling for rhyolite?	**Large crystals in granite and much finer grains in rhyolite would support slow cooling underground for granite and rapid cooling at the surface for rhyolite.**
4	A specimen has gas holes. Why are the holes alone not enough to determine its cooling speed, and what should the students check?	**Holes can form as gas escapes from lava and do not measure cooling speed. Students should check grain size and mineral identifications.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

I would examine three equal-size spots on each rock with a hand lens and a microscope. I would record grain sizes, visible minerals, and any gas holes using the same size scale. A mineral guide would help me sort the rocks into groups with similar likely compositions. Within each group, I would compare grain sizes for evidence of different cooling rates. Larger crystals would support slow cooling underground, while tiny grains or glass would support rapid cooling at the surface. These clues would not prove exact cooling times or chemical compositions without more tests.

Accept plans that compare grain sizes within likely composition groups and use consistent observations across specimens. Students should treat cooling history and composition as inferences, not facts proved by appearance alone.