Las Rocas Nos Cuentan Su Historia worksheet answer key (English).

Study the samples provided by your instructor. Complete each step as explained in the instructions. Answer discussion questions in your groups and be prepared to discuss and present your answers to the class.

Describe each sample in detail. Record descriptions in the table below. Use rulers, balances, hand lenses, and other materials to study and accurately describe the samples.

Individual samples (**Note:** The following samples are organized by number. This exercise does not emphasize naming the rocks; the names are provided here as part of the scientific background.)	**Description and key characteristics**
1. Andesite (A), Basalt (B)	(A) Andesite is typically grayish (e.g., dark gray, reddish gray, greenish gray) rock with some small dark- and light-color mineral crystals (normally amphiboles and plagioclases) that are bigger than the fine-grained material surrounding them and sporadically present throughout the rock. (B) Basalt is typically black or greenish black with a few small crystals distributed throughout the sample and surrounded by fine-grained material. The absence of numerous crystals and its dark color gives the rock a dull luster. (**Note:** Luster is a property typically used to describe minerals.) (**Note:** The crystals described above are called *phenocrysts.* The fine-grained material surrounding phenocrysts is called *groundmass.* The crystals in the groundmass are impossible to see without the aid of a microscope. Some basalts contain abundant phenocrysts [e.g., light color, green, dark color]. The texture of igneous rocks [e.g., aphanitic, phaneritic, porphyritic, pyroclastic, glassy] is based on the size and arrangement of the crystals in a rock.) The texture of the andesite described in this exercise is porphyritic. The texture of basalt, if zero or just a few small phenocrysts are present, is aphanitic. Basalt texture could be porphyritic if a larger number of phenocrysts are present. In extrusive igneous rocks, the amount, size, and shape of the phenocrysts is highly variable, but

	phenocrysts never cover the whole rock in an interlocking fashion (e.g., crystals fused together). Phenocrysts in extrusive rocks appear as spots surrounded by the groundmass.
2. Granite	Crystalline rock that contains multiple light-color (e.g., white, pink, clear) minerals (e.g., potassium feldspar, quartz, muscovite) and fewer dark-color minerals (e.g., mainly biotite) interlocked or fused together throughout the sample. (**Note:** The key characteristic of intrusive igneous rocks is the crystals are easily observable without the aid of a microscope [and, normally, without the aid of a hand lens]. The crystals are interlocked and present throughout the rock [no groundmass, as opposed to extrusive rocks].)
3. Sandstone (S), Conglomerate (C)	(S) Sandstone contains sand-size particles that may include mineral fragments of different composition, size, and shape and occasional fossil fragments (typical of sandstones formed in coastal marine environments). The particles may be sorted (grains of similar size occurring together) and the rock may contain layers. (C) Conglomerate is composed of variable amounts of gravel- to sand-size rock particles with various shapes and composition. (**Note:** Grains in sandstones could have the same composition [e.g., mainly quartz, mainly calcareous grains] or variable [e.g., sand-size mineral fragments of different composition]. Some sandstones contain a few rock fragments that vary from sand- to gravel-size or may be composed of sand-size rock fragments combined with mineral fragments [e.g., volcaniclastic sandstones]. One key characteristic of conglomerates is that coarser-grain particles, which are typically the size of gravel, are usually surrounded by finer-grain material, which is typically the size of sand particles. Sandstone and conglomerate are examples of clastic sedimentary rocks.)
4. Rock salt	An aggregate of salt (typically halite) crystals that are interlocked (i.e., formed when salt water evaporates from a basin). This is an example of a chemical (nonclastic) sedimentary rock.
5. Gneiss	Crystalline rock with alternating bands of light and dark-color material (i.e., minerals). These bands are parallel to each other and usually have variable thickness and are sinuous or folded.

	(**Note:** Gneiss is considered a foliated metamorphic rock. Foliations refer to the bands of different minerals that occur throughout the sample. Foliations cross or penetrate the samples; lines or lineations occur at the surface of the sample.)
6. Marble	Typically light-color rock with noticeable crystals of the same composition (i.e., carbonate minerals, commonly calcite or dolomite) fused together that react with vinegar when they are scratched. (**Note:** Marbles can show sinuous or folded dark-color bands and other structures resembling foliations. Marble is considered a nonfoliated metamorphic rock.)
7. Galena	This mineral is gray, silver gray, or dark gray and exhibits a well-developed cubical shape with surfaces that intersect at 90° angles. When lifted from a table, it is heavier than other minerals because it has a high specific gravity. Its luster is the classical metallic luster in minerals.
8. Calcite	A typically translucent, light-color (e.g., clear, white, yellowish white, light yellow) mineral that exhibits a rhombohedral shape (when broken along cleavage planes) or that of a slightly deformed (e.g., bended) cube. One of its key characteristics is that it reacts with vinegar when scratched. Calcite has nonmetallic luster.

Once you have described all the samples, group them according to similar characteristics. Record a general description for each group of samples in the table below. (**Note:** Ideally, students come up with four groups. Sedimentary chemical [nonclastic] and nonfoliated metamorphic rocks were not included in the descriptions of the groups in the table below.)

Group of samples	Description and key characteristics
Igneous rocks	Rocks with interlocked crystals of various compositions (colors) and crystals surrounded by fine-grain material.
Sedimentary rocks	Rocks with sediments (e.g., rock, mineral, fossil fragments).
Metamorphic rocks	Rocks with bands of different minerals.
Minerals	Samples with homogenous composition and characteristics different from the other groups (e.g., cleavage, specific shapes).

Divide each group of samples into two subgroups based on their unique characteristics. Use the table below to record the descriptions of the newly formed subgroups.

Group	Characteristics of subgroup 1	Characteristics of subgroup 2
	Porphyritic or aphanitic texture, fine-grain groundmass (extrusive)	Phaneritic texture, interlocked crystals (intrusive)

	Fragments present (clastic)	No fragments present, aggregates of minerals of same composition (chemical or nonclastic)
	Foliated	Nonfoliated
	Metallic luster	Nonmetallic luster

Discussion questions

1. What characteristics of the samples in the original groups did you use to form the subgroups?

   Composition (e.g., crystals, sediments), structure of samples (foliations, cleavage), luster
2. What patterns and trends emerge from the data collected and recorded in the above tables?

   Rocks have different characteristics. Groups of rocks can have with similar characteristics; these characteristics are mainly related to composition and structure.
3. Which group (or groups) of samples clearly stands out from the others?

   The minerals
   a. What characteristics make this (these) group(s) stand out?

      These samples do not show evidence of variable composition (heterogeneous). They are composed of the same material. The samples exhibit luster and cleavage, which are not present in the rock samples.
4. Form a hypothesis explaining how the samples in each group formed. Make sure that the evidence collected in this activity supports your hypothesis.

   The answers will vary based on student level and understanding. Ideally, students can hypothesize that

   - sedimentary rocks form from the deposition and lithification of sediments in various environments,
   - minerals form in specific environments with the right condition for having a homogenous composition,
   - igneous rocks form from the accumulation of minerals in specific environments (e.g., precipitation, formation from magma), and
   - metamorphic rocks form from the effects of pressure and heat (the key is the observation of the gneiss and comparing it to igneous rocks).

   High school and college students usually infer that the size of the crystals in igneous rocks is related to the rock's cooling history.

5. Revisit and study all the samples and organize them into two big groups: rocks and minerals.
   a. Define each of these groups using your observations and data.

      Based on the data, you should expect students to define

- rocks as aggregates of minerals, rocks, and fossils that exhibit different structures and composition related to their environments of formation, and
- minerals as solids that exhibit a specific structure (e.g., geometry) and optical properties (e.g., luster, translucency) and are composed of a homogeneous substance.

b. Explain the relationship between rocks and minerals.
Minerals are the building blocks of rocks; rocks are composed of minerals.

Additional activities

6. Explain how the different rock types relate to each other. Prepare a diagram showing these relationships.
   The ideal answer includes a sketch or diagram of the rock cycle. This diagram can take many forms as long as the student relates the rock types with written explanations and arrows.
7. What processes transform one rock type to another? Label and explain these processes in the diagram.
   This is an important exercise. Encourage students to explain (instead of just labeling) how the processes transform one rock type to another, including tectonic processes if it is appropriate to students' level of understanding.
8. In what environments did the rock samples form? (**Hint:** Think about places and conditions ideal for the formation of rocks with characteristics similar to the ones studied in this activity.)
9. Organize your ideas about the environments of rock formation in the table below.

Rock type	**How did the samples form?**	**Where did the samples form? (environments of formation)**	**Key evidence**
Igneous	From volcanic eruptions and solidifying from magma	Volcanic centers, underground in magma chambers	Crystal texture
Sedimentary	From the deposition and lithification of sediments	Coast, river, deep marine, lakes, glaciers	Texture and composition of sediments
Metamorphic	Pressure and heat affected pre-existent rocks	Deep underground, in contact with heat sources, in fault zones	Texture (crystal size, foliations) and composition

A note for teachers.

This answer key is provided as scientific background. Student answers vary and are not expected to be exactly the same as the ones provided in this answer sheet. Students commonly describe the samples by explaining their color, size, shape, hardness, surface roughness, and, occasionally, composition (e.g., spots of various colors, minerals, crystals, rock fragments). Teachers should let students come up with their own descriptions and then assist student groups and individual students in developing scientifically sound descriptions. Ideally, students organize the samples in four groups—one for each rock type and one for minerals. However, students commonly organize samples on the basis of the size, shape, and color.

This exercise may work better by eliminating the chemical (nonclastic) sedimentary and nonfoliated metamorphic rock samples from the set of samples. Chemical (nonclastic) and nonfoliated rocks are commonly put in the same category, but it is difficult for students to understand their differences based solely on physical properties. This level of understanding requires knowledge of Earth processes such as evaporation of water in shallow basins, recrystallization, and metamorphism.