***Lab Handout***

# Lab 13. Characteristics of Minerals: What Are the Identities of the Unknown Minerals?

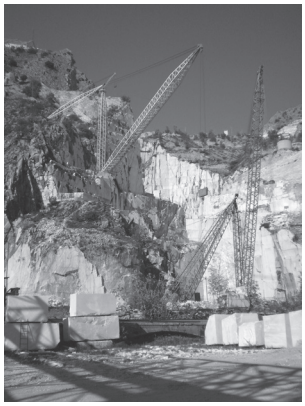
## Introduction

Rocks are made up of different types of minerals or other pieces of rock, which are made of minerals. Granite (Figure L13.1) and marble (Figure L13.2) are examples of different kinds of rock. Earth scientists group rocks into one of three categories:

- *Sedimentary* rocks are formed at the Earth's surface by the accumulation and cementation of fragments of sediments. Sandstone is an example of a sedimentary rock.
- *Igneous* rocks form through the cooling and solidification of magma or lava. Granite is an example of an igneous rock.
- *Metamorphic* rocks are produced when existing rocks are subjected to extreme temperature and pressure. Marble is an example of a metamorphic rock.

**FIGURE L13.1**
**A granite outcrop at Logan Rock, Cornwall, England**

**FIGURE L13.2**
**Marble at a quarry in Carrara, Italy**



Earth scientists use the mineral composition of a rock to classify it. Granite, for example, is made up minerals such as quartz, feldspar, and biotite; marble is made up of minerals called dolomite and calcite. Earth scientists must be able to determine the various types of minerals that are in a rock in order to identify it. Every mineral has a unique chemical composition. Dolomite (see Figure L13.3, p. 322), for example, has the chemical composition of $CaMg(CO_3)_2$, whereas quartz (see Figure L13.4, p. 322) has a chemical composition of $SiO_2$. The unique chemical composition of a mineral gives it a specific combination of

chemical and physical properties. Earth scientists use these chemical and physical properties to identify a mineral.

## FIGURE L13.3

**Dolomite**

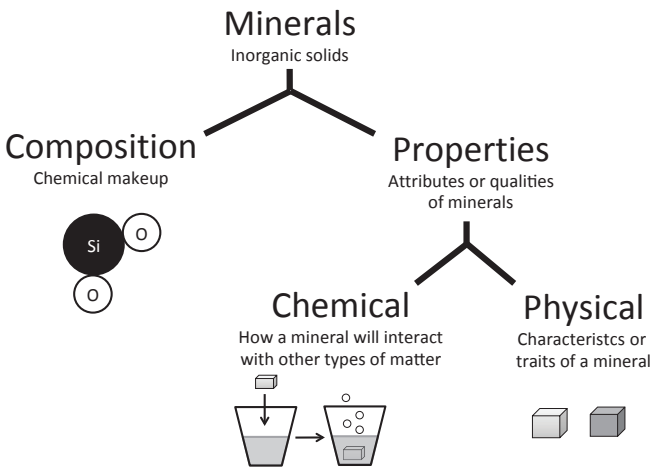
## FIGURE L13.4

**Quartz**

*Chemical properties* (see Figure L13.5) describe how a mineral interacts with other types of matter. Dolomite, for example, reacts with hydrochloric acid but quartz does not. *Physical properties* are descriptive characteristics of a mineral. Examples of physical properties include color, density, streak (whether the mineral streaks on a streak plate and the color of the powder), hardness (whether the mineral can scratch something with a known hardness, like glass or a nail), smell, how the mineral breaks (*cleavage* is when a mineral breaks evenly along a flat surface; *fracture* is when a mineral breaks apart roughly), and luster (whether the material appears metallic or nonmetallic). Some minerals will even attract magnets.

## FIGURE L13.5

**How Earth scientists distinguish between different minerals**




It is often challenging to determine the identity of an unknown mineral based on its chemical and physical properties. For example, if an Earth scientist has only a small amount of a mineral, he or she may not be able to conduct all the different types of tests that are needed because some tests may change the characteristics of the mineral during the process (such as when dolomite is mixed with an acid). It is also difficult to determine

many of the physical properties of the sample, such as its density or its luster, when there is only a small amount of the substance, because taking measurements is harder. To complicate matters further, an unknown mineral may have an irregular shape, which can make it difficult to accurately measure its volume. Without knowing the mass and the volume of a substance, it is impossible to calculate its density. In this investigation, you will have an opportunity to learn about some of the challenges Earth scientists face when they need to identify an unknown mineral based on its chemical and physical properties and why it is important to make accurate measurements inside the laboratory.

## Your Task

You will be given a set of known minerals. You will then document, measure, or calculate at least three different chemical or physical properties for each mineral. When you are done, you will return the known minerals to your teacher, who will then give you a set of unknown minerals. The set of unknowns will include samples of minerals that you tested. Your goal is to use what you know about the physical and chemical properties of matter, proportional relationships, and patterns to design and carry out an investigation that will enable you to collect the data you need to determine the identity of the unknown minerals.

The guiding question of this investigation is, ***What are the identities of the unknown minerals?***

## Materials

You may use any of the following materials during your investigation:

**Consumables**

- Water (in squirt bottles)
- Vinegar
- Set of known minerals
- Set of unknown minerals

**Equipment**

- Safety glasses or goggles (required)
- Chemical-resistant apron (required)
- Gloves (required)
- Electronic or triple beam balance
- Magnifying glass
- Magnet
- Beaker (250 ml)
- Beaker (400 ml)
- Graduated cylinder (100 ml)
- Overflow can
- Pipette
- Ruler
- Streak plate
- Small piece of glass
- Penny
- Nail

## Safety Precautions

Follow all normal lab safety rules. In addition, take the following safety precautions:

- Follow safety precautions noted on safety data sheets for hazardous chemicals.
- Wear sanitized indirectly vented chemical-splash goggles and chemical-resistant, nonlatex aprons and gloves throughout the entire investigation (which includes setup and cleanup).

- Report and clean up any spills on the floor immediately to avoid a slip or fall hazard.
- Handle all glassware with care.
- When using the glass or streak plate, do not pick the plate up with your hands. Place it flat on the table. Otherwise, it may cut your hand.
- Handle nails with care. Nail ends are sharp and can cut or puncture skin.
- Do not place any materials in or around your mouth.
- Handle all glassware with care.
- Wash hands with soap and water when done collecting the data and after completing the lab.

**Investigation Proposal Required?** ☐ Yes ☐ No

## Getting Started

To answer the guiding question, you will need to make several systematic observations of the known and unknown minerals. To accomplish this task, you must determine what type of data you need to collect, how you will collect it, and how you will analyze it.

To determine *what type of data you need to collect,* think about the following questions:

- Which three properties will you focus on as you make your systematic observations? The properties you choose to focus on can be chemical ones (reactions with other substances) or physical ones (e.g., color, density, hardness, streak).
- What information do you need to determine or calculate each of the chemical or physical properties?
- How will you determine if the physical properties of the various objects are the same or different?

To determine *how you will collect the data,* think about the following questions:

- What equipment will you need to collect the data you need?
- How will you make sure that your data are of high quality (i.e., how will you reduce error)?
- How will you keep track of and organize the data you collect?

To determine *how you will analyze the data,* think about the following questions:

- How might the unique chemical composition of a mineral (structure) be related to its unique chemical and physical properties (function)?
- What types of patterns might you look for as you analyze your data?
- What type of calculations will you need to make?

- What type of table or graph could you create to help make sense of your data?

### Connections to the Nature of Scientific Knowledge and Scientific Inquiry

As you work through your investigation, be sure to think about

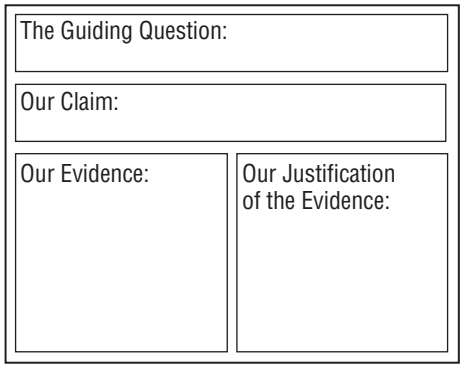
- the difference between data and evidence in science, and
- how scientists use different types of methods to answer different types of questions.

### Initial Argument

Once your group has finished collecting and analyzing your data, your group will need to develop an initial argument. Your initial argument needs to include a claim, evidence to support your claim, and a justification of the evidence. The *claim* is your group's answer to the guiding question. The *evidence* is an analysis and interpretation of your data. Finally, the *justification* of the evidence is why your group thinks the evidence matters. The justification of the evidence is important because scientists can use different kinds of evidence to support their claims. Your group will create your initial argument on a whiteboard. Your whiteboard should include all the information shown in Figure L13.6.

**FIGURE L13.6**

**Argument presentation on a whiteboard**




### Argumentation Session

The argumentation session allows all of the groups to share their arguments. One or two members of each group will stay at the lab station to share that group's argument, while the other members of the group go to the other lab stations to listen to and critique the other arguments. This is similar to what scientists do when they propose, support, evaluate, and refine new ideas during a poster session at a conference. If you are presenting your group's argument, your goal is to share your ideas and answer questions. You should also keep a record of the critiques and suggestions made by your classmates so you can use this feedback to make your initial argument stronger. You can keep track of specific critiques and suggestions for improvement that your classmates mention in the space below.

*Critiques of our initial argument and suggestions for improvement:*

If you are critiquing your classmates' arguments, your goal is to look for mistakes in their arguments and offer suggestions for improvement so these mistakes can be fixed. You should look for ways to make your initial argument stronger by looking for things that the other groups did well. You can keep track of interesting ideas that you see and hear during the argumentation in the space below. You can also use this space to keep track of any questions that you will need to discuss with your team.

*Interesting ideas from other groups or questions to take back to my group:*

Once the argumentation session is complete, you will have a chance to meet with your group and revise your initial argument. Your group might need to gather more data or design a way to test one or more alternative claims as part of this process. Remember, your goal at this stage of the investigation is to develop the best argument possible.

## Report

Once you have completed your research, you will need to prepare an *investigation report* that consists of three sections. Each section should provide an answer for the following questions:

1. What question were you trying to answer and why?
2. What did you do to answer your question and why?
3. What is your argument?

Your report should answer these questions in two pages or less. You should write your report using a word processing application (such as Word, Pages, or Google Docs), if possible, to make it easier for you to edit and revise it later. You should embed any diagrams, figures, or tables into the document. Be sure to write in a persuasive style; you are trying to convince others that your claim is acceptable or valid.