Lab 11: 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.

FIGURE L13.1

A granite outcrop at Logan Rock, Cornwall, England

FIGURE L13.2

Marble at a quarry in Carrara, Italy

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.

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), for example, has the chemical composition of $CaMg(CO_3)_2$, whereas quartz (see Figure L13.4) 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

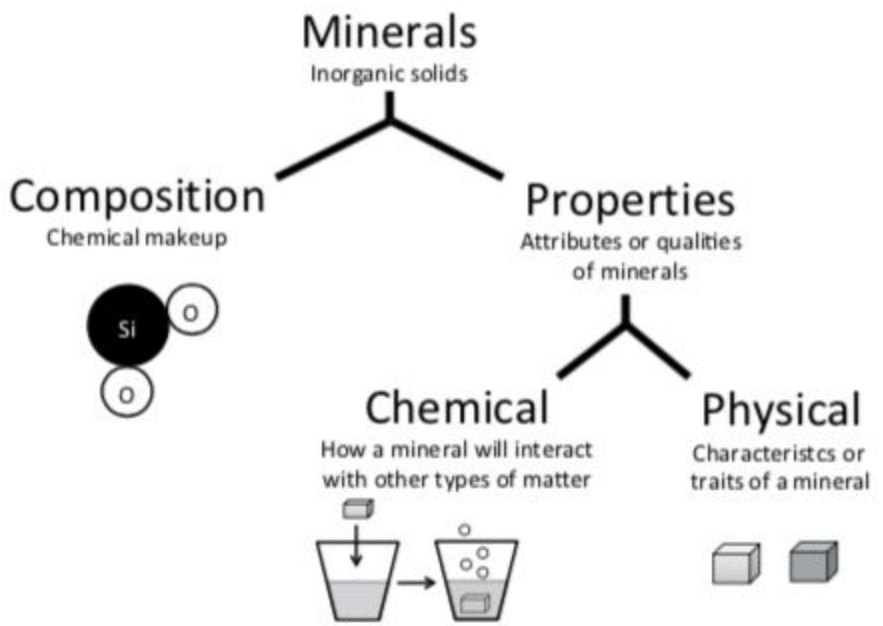
FIGURE L13.4

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:

- Water
- Vinegar
- Set of known minerals
- Set of unknown minerals
- Balance
- Magnifying glass
- Magnet
- Beaker (250 ml)
- Beaker (400 ml)
- Graduated cylinder (100mL)
- Overflow container
- Pipette
- Ruler
- Streak plate
- Small piece of glass
- Penny
- Nail

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 your 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 your 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?

Report

Once you have completed your research, you will need to prepare an investigation report that consists of four sections (be sure to have section headings):

1. Introduction: Give some background information on the topic. Explain what question were you trying to answer and include a hypothesis. (Background info, research question and hypothesis)
2. Procedure: What did you do during your investigation and why did you conduct your investigation in this way? (How you collected and analyzed data)
3. Data: Include a data table and/or graph to show your results. Be sure to include a title for your table or graph with labels for the variables.
4. Conclusion: What is your argument? (Claim - Evidence - Reasoning) Include your conceptual model.

Your report should answer these questions in two pages or less. The report must be typed, and any diagrams, figures, or tables should be embedded into the document. Type your report on Google Docs (12 point font, double-spaced) and share it with your teacher. Your report will be graded based on the rubric in the class syllabus.