**Activity 2**
**Classification and Soils; Comparison of the Atmospheres of Earth and Mars**

**Objectives:** Students will be introduced to content on planets, atmospheres, soils and classification of objects through a Power Point presentation, a series of demonstrations, a short experiment, and a soils classification activity.

**Terminology:** aquifer, air, asteroid, astrobiologist, atmosphere, clay lens, compost, dirt, erosion, filtrate, fossil, geologist, groundwater, humus, kaolinite, Martian, meteorite, minerals, microorganisms, organic matter, percolation, porosity, soil, soil particle, soil profile, soil texture, topsoil, weathering.

**Grade Level:** $3^{rd}$-$6^{th}$ Grade

**Ideal Class Size:**
24 students divided into six groups of four
One extra adult assistant

**Subject Areas:** Life Science, Earth Science, Math, Inquiry Skills

**Time:**
1 hour introduction and presentations
1 hour classification activity

**Materials:**
1. PowerPoint presentation
2. flip chart or writing board
3. eraseable colored markers
4. Posters:
   - "Methods of Science"
   - "SAFE Rules"
   - "Mars & Earth Atmospheres"
   - "Soil Particle Sizes"
5. Copies (1/student or group):
   - soil classification mats (1 set/group)
   - classification and soils definitions
   - "Group Data Sheet: Classification of Soils"
   - "Mars and Earth" Word Search & "Can You Break the Code" puzzles
6. Demonstration Materials:
   - "Methods of Science" review, with 1 each of the folded airplanes from Activity 1
   - Classification Demo: a large cork board, push pins, and multiple props to classify (such as markers, pencils, erasers, rulers, etc.)
   - Gases in Rocks
     - clear plastic jar
     - water
     - pumice stone
     - three small dense stones
   - Mars and Earth's Atmospheres
     - poster of Mars/Earth atmospheric composition
     - baggies of pre-measured colored beans representing the different gases
     - two clear plastic columns w/caps

- funnel
- meteorite specimen if available

- Where Do Soils Come From?
  - rock specimens, including Igneous (obsidian and granite), Metamorphic (Gneiss), Sedimentary (Sandstone, Shale or Slate, and one good fossil specimen)
  - mineral samples (small vials of colored minerals)
  - silk or plastic hydrangeas – blue and pink
  - sand paintings/colored sand bottle/glazed and unglazed pottery
- Soil Profile/Particle Size
  - clear plastic column/jar mini demo of soil particle settling
    - one container each of pebbles, sand, silt and clay – dry
    - water
  - large soil profiles (3)
  - stop watches (5)
  - water
  - 2 quart water pitcher
  - catch basins (3)
  - large cloth towels (3)

7. <u>Group Activity for Classification of Soils</u>
   - paper towels
   - magnifying glasses (1/student)
   - metric rulers with mm scale (1/student)
   - 6 sets of 12 vials of labeled soils for 24 students (including gravels, sands, and clays in various colors, swamp soil, and a rich loamy potting soil; see chart in next section)
   - classification mats (1 set/group)
   - "Group Data Sheet: Classification of Soils" (1/student)

**Advanced Preparation:**

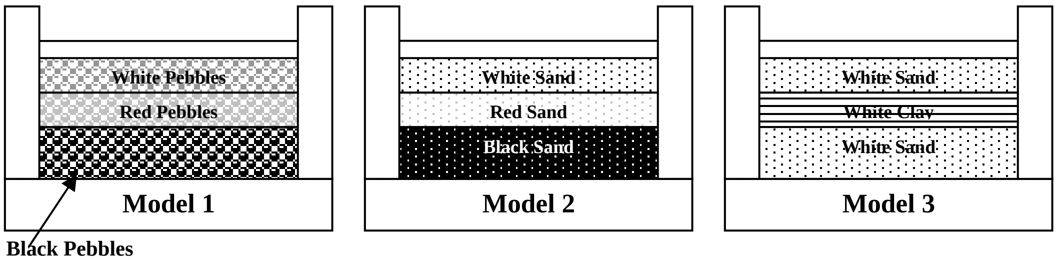
Create appropriate number of copies of data sheets and other documents as listed in the previous Materials section.

Pre-assemble a minimum of 6 sets of small wide-mouthed plastic vials containing 12 labeled soil samples as listed in the key below (make at least three extra sets for back-ups). Label the samples with numbers – the students will be classifying them using various criteria during the group classification exercise.

| ***Soil Sample #*** | ***Soil Type*** |
|---|---|
| 1 | organic soil (compost) |
| 2 | white clay (white terra cotta or porcelain) |
| 3 | red sand |
| 4 | marsh mud |
| 5 | natural sand (sandhills whitish-brown) |
| 6 | red clay (terra cotta) |
| 7 | white gravel |
| 8 | organic soil #2 (mushroom compost) |
| 9 | black gravel |
| 10 | "natural" clay (whitish-brown) |
| 11 | reddish-brown gravel |
| 12 | white sand (builder's sand) |

Copy the “Task List Objectives” (included on page 4 of this lesson plan) onto a classroom writing board or flip chart. This will help you complete all the steps in the scheduled amount of time.

Pre-pack the large soil profiles with appropriate substrate for the “Soil Profile/Particle Size” demo-experiment. Each profile should have three layers of soil with various particle sizes and color combinations. Use the models below as guides.




To create the Mars and Earth atmospheres demo, follow the key below. Spray paint white Navy Beans in the appropriate colors and amounts and store them in separate labeled baggies or containers. The beans can be sorted after each demonstration and reused until they deteriorate. More permanent “beans” such as beads could be substituted. Note: Total atmospheric percentages do not equal 100% because the level of water vapor fluctuates from 1%-4%.

| GAS | COLOR | MARS’ ATMOSPHERE | EARTH’S ATMOSPHERE |
|---|---|---|---|
| Nitrogen | White | 3 beans (3%) | 770 ml (77%) |
| Oxygen | Green | 1 bean (1%) | 210 ml (21%) |
| Argon | Yellow | 2 beans (2%) | 9 ml (0.9%) |
| Carbon Dioxide | Red | 95 beans (95%) | 1 ml = three beans (0.1%) |
| Water Vapor | Blue | 1 bean (1%) | 30 ml (3%) |
| | **TOTAL** | **102 beans (102%)** | **1020 ml (102%)** |

**Background information:**

The search for life on Mars is an ongoing scientific endeavor. By comparing, contrasting, and classifying the soils of Mars and Earth, scientists can gain a better understanding of the conditions that created Martian soils and whether or not the Red Planet has ever sustained life.

Dr. Chris Romanek, a geochemist with SREL, was a member of a scientific team that examined a piece of a meteorite from Mars and concluded that there was evidence for the possibility of life on Mars. How scientists determine the origins of meteorites and what they are composed of will be discussed during a PowerPoint presentation and several demonstrations. Atmospheric compositions, soil structure and function, and the importance of particle size will be discussed.

During the course of the activity students will learn how to recognize different soil compositions, where they can be found, what roles they play in Earth Science and Life Science, and how to classify them.

## Activity 2
## Classification and Soils
## <u>Task List Objectives</u>

**LECTURE AND DEMONSTRATIONS (1 hour)**

**I. Introduction (10 minutes)**

A. Today's topic - Classification and soils
  - Introduce Dr. Chris Romanek, a geochemist and astrobiologist

B. Today's task list

C. Review SAFE Rules

D. Review the Methods of Science and results of Activity #1

**II. Power Point Presentation (15 minutes)**

A. Dr. Chris Romanek

B. Possibility of life on Mars

C. Rocks and soils

D. Particle size of soil as criteria for classification

**III. Demonstrations (35 minutes)**

A. Classification (10 minutes)

B. Atmospheres of Earth and Mars (10 minutes)
  - Gases in rocks
  - Atmospheric composition

C. Where do soils come from? (5 minutes)
  - Rocks, rocks everywhere
  - Minerals in rocks

D. Soil particle size (10 minutes; includes data collection)

**CLASSIFICATION ACTIVITY (1 hour)**

**I. Soil Classification (40 minutes)**

A. Introducing the activity

B. Classify soils

**II. Science Seminar (10 minutes)**

A. Sharing results

III. **Closure (10 minutes)**

A. Wrap-up questions

B. Follow-up activities

## LECTURE AND DEMONSTRATIONS (1 hour)

### I. Introduction (10 minutes)

A. Today's topic

"Classification and Soils," highlights Dr. Chris Romanek, a geochemist who studies soils on Mars and Earth. We'll learn all about how to classify and about rocks and soils on Earth and Mars and why they are important.

B. Today's task list

Remind the students that we will follow a task list to help us keep on track.

C. Review SAFE Rules

D. Review the Methods of Science

What does it mean to be a Junior Scientist? Who remembers what we did last time we were here? *[Relate each step of the Methods of Science to an activity we did during our last visit.]*. Today we are going to watch a PowerPoint Presentation about a really cool scientist who used the Methods of Science to study Mars.

### II. Power Point Presentation (15 minutes)

A. Intro to Power Point Presentation

I want you to think about everything you already know about these science topics: Mars, Earth, Life on planets, and Soils and Atmosphere. I am sure that you have probably studied these topics already in school or in your own independent reading. We are going to explore these topics today in our workshop, so reach way back in your minds and pull out any information that you have stored there. Now hold onto those thoughts and let's get started.

### III. Demonstrations (35 minutes—do only as many as will fit in the time available)

A. Classification (10 minutes)

Before we jump into our experiments we need to talk about a few techniques that will make today's activity easier to understand. You just heard in our Power Point presentation that soil can be "classified" by its particle size. All CLASSIFICATION means is, "the grouping of things according to similar characteristics."

Thousands of years ago, when people began observing nature, they noticed that there where different groups of living things in the world. Some animals had claws and sharp teeth and roamed the land. Others had feathers and beaks and flew in the air. Still others had scales and fins and swam in the water.

People also made observations about plants. Plants varied in shape, size, and color. Some were good to eat while others were poisonous. By observing general characteristics of living things, people developed simple classification systems. They were grouping things according to similar characteristics. Today we call the science of classification TAXONOMY.

Scientists can also classify non-living things like rocks and soils and atmospheres. I'd like you to help me classify some non-living things you might find in the classroom. *[Ask the students to help you classify the objects on the cork board into several different categories by the following characteristics: do they write, do they cut, do they fasten, are they sharp, are they thin, are they* *red are they black. Rearrange the objects on the board into many different groupings and sub-groupings until you are sure the students understand how to classify.]*

B. Atmospheres of Earth and Mars (10 minutes)

One of the non-living things that scientists classify are the atmospheres of planets. Some atmospheres, like Earth's, are good for humans to breath and some might not have enough oxygen for us to survive. Remember in the PowerPoint presentation Dr. Chris had to figure out if the meteorite he was studying came from Mars? He had to make a HYPOTHESIS and then test it. He might have said, "IF this meteorite came from Mars, THEN the gas inside of it will be just like the atmosphere on Mars."

1. Gases in rocks
    - We are getting a little ahead of ourselves here. Did you realize that gases get trapped inside of rocks? Let's do a little demo. *[Ask the students to make a **prediction** based on what they already know about rocks. Ask them what they can **infer** about the behavior of rocks when dropped into water.]*

    - *[Chose an assistant from the class to drop a dense stone into the plastic jar of water. Were the student's predictions correct? Do it a couple more times with dense stones and then ask the assistant to drop the PUMICE stone into the water.* What happened? Why did it float? *Pumice rocks are igneous rocks that are formed when lava cools quickly above ground and the gases in the molten lava don't have a chance to escape.]*

2. Atmospheric composition [colored bean demo]
    - Back to Dr. Chris and how he figured out his meteorite came from Mars. Do you remember during the PowerPoint presentation that we said that the Mars Lander could actually sniff the atmosphere of Mars and tell what gases are there? ATMOSPHERE, or the mixture of gases that surround a planet, is made up of different kinds of chemicals in their gaseous form. Let's take a look at another demo and see just how different the Mars atmosphere is from Earth's atmosphere. We have a couple of clear tubes here. This one will hold a sample of Earth's atmosphere and this one will hold a sample of Mars' atmosphere. *[Display the poster that shows the atmospheric compositions of Earth and Mars.]*

    - What are some of the gases that you breathe when you take a breath here on Earth? OXYGEN. *[Add the proper amount of oxygen beans to the Earth tube and then tell the students that Mars has oxygen too. Add the Mars oxygen beans to the Mars tube. Proceed through all the gases until the atmospheres are complete: NITROGEN, CARBON DIOXIDE, ARGON, and WATER VAPOr. Point out how much $CO_2$ is in Mars' atmosphere and mention that those polar ice caps that they saw earlier during the PowerPoint presentation are made up of $CO_2$, or dry ice, and not $H_2O$ like Earth's polar ice caps.]* Do you notice how thick the Earth's atmosphere is? The Earth's thick atmosphere helps protect us from the Sun's intense heat and radiation. What can you infer about life on Mars by looking at how thin its atmosphere is?

    - So what kind of atmosphere do you think Dr. Chris found in his meteorite? The Martian atmosphere! Since we saw that the scientists found what looks like microscopic fossils of once living bacteria in the meteorite, how might they have gotten there? We can study rocks and soils here on Earth to help answer that question.

C. Where do soils come from? (5 minutes)

Here on Earth there are lots of things that make life possible, like a friendly atmosphere, a nice range of temperatures, water, and good soil. Well, Mars has soil on it, too. How do you suppose it got there?

1. Rocks, rocks everywhere
   - SOIL comes from rocks, so let's look at some rocks. GEOLOGISTS, or scientists who study rocky parts of the Earth, classify rocks into three big groups: IGNEOUS, METAMORPHIC, and SEDIMENTARY.

   - Here are a few examples. IGNEOUS rocks come from lava or magma; the hot liquid material from deep in the Earth. This is a piece of obsidian – or cold lava. Remember the pumice we saw earlier? Obsidian is just like pumice, but without trapped air bubbles inside. Do you think obsidian will float? This is a piece of granite – it became a rock soon after coming to the surface of the Earth and didn't change much after that.

   - Then there are METAMORPHIC rocks like this gneiss that used to be an igneous rock until it got reheated and reshaped over time. *[Point out the stretching effect in the gneiss.]* Last but not least there are SEDIMENTARY rocks. I think these are the neatest rocks because they have fossils in them. Sedimentary rocks started out as Igneous or Metamorphic rocks that got weathered down over thousands of years and turned into soil like sand and silt and clay. Then that soil mixed with water and became mud, and dead plants and animals got covered up by the mud. And then, over thousands or millions of more years, the mud mixture turned to stone and the plants or animals that used to be there were transformed into the fossils we see today. Examples of SEDIMENTARY rocks are sandstone, shale, and slate. Do you remember that Dr. Chris found evidence of nano-bacteria fossils in the Martian meteorite?

2. Minerals in rocks
   - So what are rocks made of? Rocks contain pure minerals like iron, magnesium, calcium, sulfur, and manganese all jumbled, and pressed, and heated together over thousands or millions of years. *[Show the many colors in a sedimentary rock and then show the colored vials of pure minerals.]* The process of weathering and erosion from water and wind helps break mountains of rock down into soils of all different colors and textures and particle sizes. Remember that soil scientists have classified over 20,000 types of soil!!

   - MINERALS are important for a lot of reasons, but one of the most important is that all living things need minerals to grow. You know how commercials are always saying, "You need your vitamins and minerals to grow healthy and strong." Well, it's true, but we can't just go out and pick up a rock and eat it. The minerals in rocks have to be physically and chemically changed before our bodies can use them, and plants and soil microbes do that work for us. Plants can absorb minerals from rocks once they have been broken down into soils. Then we can eat the plants, or the animals that eat the plants, to get our nutrients.

   - Here's a great example of how the hydrangea plant absorbs its nutrients. Have you ever seen this flower around your neighborhood? Sometimes they are blue and sometimes they are pink. Any guesses as to why they are different colors? Same plant, different soil. Botanists and soil scientists discovered that the mineral that affects the color in the flower is ALUMINUM and when the soil is acidic the plant can absorb the aluminum and it turns the flower blue. When the soil is neutral the plant can't absorb the aluminum and the flower is pink.

D. <u>Experimental demo highlighting soil particle size (10 minutes)</u>

- Now that we've talked about minerals in soils, let's talk about particle size. Each individual piece of mineral in this vial is a very small PARTICLE. Soil scientists classify soils by their particle sizes: sand, silt and clay. *[Hang up Particle Size poster.]* All soils are made up of different amounts of these three soils along with some organic matter, microbes, and water. Let's use our four senses and investigate some of them. We won't taste any of them today, although sometimes soil scientists do taste their soil! **SAND** feels like sugar – rough and grainy, **SILT** feels smooth, and **CLAY** particles are so small they feel silky. And who knows what happens to clay when it gets wet? *[May want to pass around some large baggies containing each type of soil so the students can feel them.]*

- Now let's add some of each of these soil types to a clear plastic column and pour some water in. What do you observe? Do you see the air bubbles rising to the surface? Where do you think the air is coming from? From between the soil particles. Now let's shake the column up and see what happens – where do you predict the smallest particles will settle? The largest? Now that you know a little bit about how soil particles of different sizes behave in water, let's do a real experiment.

  *Three soil profiles are used (see page 3 for directions). Students are asked to make verbal predictions based on what they see in the containers – color, particle sizes, etc. Then a pitcher of water is poured into profile #1 and the time it takes for all of the water to drain through is recorded. This was repeated for the next two profiles. The times are written on the board for the students to see and decide if their predictions were correct.*

## CLASSIFICATION ACTIVITY (1 hour)

### I. Soil Classification (40 minutes)

A. <u>Introducing the activity</u>

Are you ready to get your hands into some soil and try out your classifying skills?

*[Pass out the following materials: Classification of soils group data sheets; 12 soil samples to each table – place three samples in front of each student; and one set of classification mats per table. Tell the students not to touch anything until instructed to do so.]*

B. <u>Classifying soils</u>

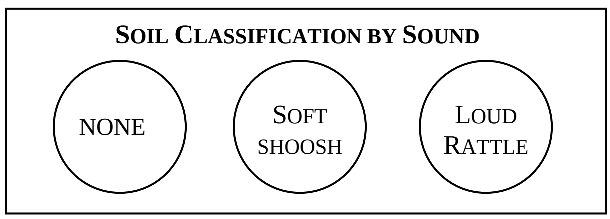
- *[Have the students read along with you while you read from the "Classification of Soils" data sheet.]*

- *[Define the word "investigate" as a way to gather information using the five senses, but explain that they will only be using four of their senses today – sight, hearing, smell, and touch. Even though many soil scientists taste their samples to help them detect different components in the soil, we won't taste any soil samples in this activity. Explain that they will each work with three samples and each sample has a special code number on it. That is the number they write in the column labeled "Sample Soil #". Tell them to begin with any one of their samples, write in the code number, and circle the most appropriate description in each column for their first sample.]*

- *[Remind the students to pay close attention to the instructions in each column: gently shake, look closely, take cap off, and feel it. Encourage them to record at least one "Extra Observation" about their sample in the space provided. They can move through all of their samples on their own at this point. Have them sit quietly when finished with page 1. They will be working as a team during STEP 3 of the exercise.]*

| **SAMPLE SOIL #** | **SOUND** (Gently shake.) | **COLOR** (Look closely.) | **SMELL** (Take cap off.) | **TEXTURE** (Feel it!) |
|---|---|---|---|---|
| | loud rattle none soft shoosh | reddish/orange black white/almost white tan/brown | none "earthy" stinks! | smooth gritty pebbly |
| **EXTRA OBSERVATIONS:** | | | | |

- *[For step 3 of the activity, use the classification mats provided to classify the 12 soil samples using various criteria (SOUND, COLOR, SMELL, TEXTURE). Have students refer to page 1 of their data sheets to place the soil samples on the mat in the appropriate circle. When all 12 soil samples have been classified, students should write the soil sample numbers in the appropriate circles of page 2 of the Classification of Soils Group data sheet.]*




- *[When an entire table has finished classifying all 12 soils samples using all FOUR criteria, have them raise their hands so you can give them page 3 of the data sheet. Instruct them to complete Step 4: Infer. They can work quietly together to answer these questions. Students are asked to choose the types of soils they would use if they were an Artist, a Musician, a Farmer, and a House Builder, and why.]*

## II. Science Seminar (10 minutes)

A. *Once all students have completed their data sheets, go around the room and ask different tables what their choices where for one or two of the occupations: artist, musician, farmer, house builder. When each table has had a chance to offer some input, ask students if they had other ideas or reasons for making the choices they made.*

B. *Summarize the activity by reminding the students of the importance of soils and how they are life sustaining and that is why Dr. Chris studies soils on Mars. Dr. Chris hypothesizes that **if** he finds good soil on Mars, along with some kind of moisture, just the right temperatures, and an hospitable atmosphere **then,** he believes, there might have been, or might be, life on Mars.*

## III. Closure (10 minutes)

A. Wrap-up questions: Take a few minutes to ask students what they feel they've learned during today's class and answer any questions that they might have thought of during the activity.
B. Follow-Up activities: Provide the teacher with copies of the worksheet "Activity 2 – Soil Texture: Follow-up