

# How the RAT Works

Suggested Grade Level: 3-9

## Summary

- Students will examine a simulated Mars rock and will learn how the RAT (rock abrasion tool) on the MER rovers works and why it is a useful tool for geological analysis of rocks on Mars.
- Students will discover how the exterior and interior of a rock can differ.

## Standards

- NM State Science Content Standards: Strand I, Scientific Thinking and Practice
- National Science Education Standards: Standard A, Scientific Inquiry; Standard E, Science and Technology; Standard G: History and Nature of Science

## Background Information

Prior to the MER mission, all of the data about rocks on Mars came from a few analyses of the weathered exterior of rocks. It is particularly important on Mars, with its abundance of wind-blown dust covering the surface and possible weathering of rocks due to past water, that we see through the weathered rind of a rock. The instrument called the Rock Abrasion Tool (RAT) was designed and built by Honeybee Robotics, a small company in Manhattan, and was a new and extremely clever way to mimic the traditional rock hammer of the geologist. The RAT on the Mars rovers was designed to be used to brush or grind, and was equally effective in brushing the surface dust from a rock and in grinding through the weathered surface of a rock. As a grinding wheel, the RAT was able to grind through the surface of the rock a few millimeters deep and expose the unweathered interior of the rock. The MER rovers were then able to use the microscopic imager tool and one or more of the spectrometers to see the minerals within the rock and determine the chemical composition of the rock.

## Materials

- How the RAT Works data sheet, included in this activity
- Mars rocks: one Moon Pie or bite-sized chocolate candy bar or chocolate-covered cookie for each team (it is especially appropriate to choose a variety of cookies that look the same on the outside but may have a different filling or layer on the inside)
- Abrasion tool(s)
- Magnifying glass or hand lens
- Paper plate

## Preparation

1. Print and photocopy the How the RAT Works Data Sheet for each team.
2. Purchase or bake candy or cookies to use as Mars rocks.
3. Create abrasion or grinding tools for each team. Many different possible abrasion or grinding tools can be made using the following: one hex head bolt with washer (the hex-head is the abrasion tool); one round-head bolt with two nuts and a wood insert attached to the end as the abrasion tool; simple screws, bolts, and washers from your local hardware or home improvement store. For younger students, an abrasion tool can be made from an uncooked hollow wide pasta tube.

## Introduction for Students

Show students a rock with a weathered exterior surface that is broken or cut to show a clean interior surface. Ask the questions: Why do geologists use a rock hammer? How does the surface of this rock differ from the interior? How could a robotic field geologist see the interior of rocks lying on the surface of a planet? Each Mars Exploration Rover has a RAT on it. This is a special instrument that can grind away the surface of rocks so geologists can look at the rock beneath the weathered surface. You will work in teams of geological researchers and use your own RAT instrument to explore some very special Mars rocks that have just been collected on Mars and returned to Earth for study.

## Procedure

1. Distribute candy or cookie to each team. Have them unwrap and record observations of the surface including color, texture, composition, etc.
2. Each team should predict what may be found beneath the surface of their “rock.”
3. Have students grind into the surface of their sample with one or more abrasion tools.
4. Students should use the magnifying glass to observe the exposed surface.
5. Students should record their observations of the exposed interior.
6. If many different candy bar or cookie types are used, have students observe and compare their sample with those of other teams.

## Process/Closure

Discuss the differences between the exteriors and the interiors of the students’ specimens. On Mars, thin coatings on the exterior of rocks are believed to result from interaction with water.

Discuss the interior of the students' specimens. Were there layers of any kind? What can you say about these specimens having seen their interiors? What would you have said about them if you could only examine their exteriors?

### Extension/Enrichment

Have each team grind and observe two different types of candy or cookies and compare and contrast them. Older students (grades 6–9) can use a paintbrush to brush off fine sand and then sandpaper to grind the weathered surface of specimens of real sandstone or shale.

### Credits

This activity was adapted by Kathy Jones, Albuquerque Public Schools, and Judy Stanley, LodeStar Astronomy Center, from an activity about core samples entitled *Areology-The Study of Mars in Mars Activities: Teacher Resources and Classroom Activities*.



The rock named Route 66 after “brushing” by the RAT (Spirit, Sol 100)

### **MARS FACTS**

In order to avoid contaminating Mars with Earth microbes, both of the MER mission rovers were sterilized and were worked on in clean rooms on Earth. There is an international agreement about the baseline number of microbes per square centimeter allowable on a spacecraft that lands on another planet. The rovers on this mission had a baseline number several times lower than the requirement

Name(s) \_\_\_\_\_

Date \_\_\_\_\_

### **How the RAT Works**

1. Observe your rock surface closely. Draw/write what you see:

2. Predict what is beneath the surface of your rock. Write/draw your prediction:

3. Use the RAT to scrape away the surface layer(s). Write/draw your observations: