Satellite Imagery and Mapping
Teacher Guide

Desert Research and Technology Studies (RATS)
Desert RATS Education

GRADE LEVELS
4th – 9th

CONNECTION TO CURRICULUM
Science, Geography, Mathematics

TEACHER PREPARATION TIME
1 hour

LESSON TIME NEEDED
1 hour

Complexity
Moderate

ACTIVITY OVERVIEW
In this activity, students will observe satellite or aerial images to classify features they see and create thematic unit maps.

To allow a familiar start to making maps, in Part 1 students will first work with an aerial image of a school property. In Part 2 they will use their new map making skills to develop a unit map of an area in northern AZ.

OBJECTIVES
Students will:
- Develop an understanding of the use of maps in the scientific process.
- Create a unit map of a school area in order to gain general unit map skills.
- Create a geologic features unit map of an area in northern AZ
- Interpret the geologic history of an area.

MATERIALS
- Image for base information of School Campus (see Slide Show) or create your own - see pg. 4
- Image for base information of SP Crater, AZ (see Slide Show)
- Satellite Imagery and Mapping Slide Show
- Tracing paper
- Colored pencils
- Tape or paper clips
- Optional – plastic sleeves or laminating film allows for multiple class use
- Optional – Satellite Imagery and Mapping Slide Show
- Optional – computers with Google Earth

NATIONAL STANDARDS
National Science Education Standards (NSTA)
Science as Inquiry
- Skills necessary to become independent inquirers about the natural world
- Understanding of scientific concepts
- An appreciation of ‘how we know’ what we know in science
- Understanding of the nature of science
- The dispositions to use the skills, abilities, and attitudes associated with science

Earth and Space Science Standards
- Structure of the earth system
- Earth’s history
- Earth in the solar system

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Science and Technology Standards

- Understanding about science and technology
- Abilities to distinguish between natural objects and objects made by humans

Science in Personal and Social Perspectives

- Natural hazards

History and Nature of Science Standards

- Science as a human endeavor
- Nature of science
- History of science

National Mathematics Standards

Ratios and Proportional Relationships

- Analyze proportional relationships and use them to solve real-world and mathematical problems

National Geography Standards

The World in Spatial Terms

- How to use maps and other geographic representations, tools, and technologies to acquire, process, and report information from a spatial perspective
- How to analyze the spatial organization of people, places, and environments on the Earth's surface

The information below provides background information and a suggested set of procedures to use for the two activities.

BACKGROUND

Using maps and imagery to investigate areas of the Earth's surface and other planetary bodies are key skills for geologists, planetary scientists, geographers, engineers, plus many other Earth and space science professionals. Maps and imagery assist in urban planning, civil engineering projects, and scientific studies. These tools can help provide a spatial representation of an area to investigate scientific, environmental, or even cultural aspects of a region.

There are several different types of maps and imagery that can be used to study a planetary surface. Satellite images, aerial photography and geological surveys are used to study Earth. For other planetary bodies, satellite images using a variety of instruments are used. The two activities will focus on using images to create unit maps, including a geologic features unit map of an area on Earth.

In the first activity students will create a unit map of a school campus or a local area by starting with an image showing a high school campus. An image is provided in the accompanying Slide Show for students to use as the initial information or image base. You can use Google Maps to obtain an image to use as the base information of your local area, if desired.

By carefully studying an image you can determine many different features that you can group or classify. Then you can depict those groups or features on a unit map. In this activity, the base information for the unit map is an image that provides the foundation information about an area. The unit map might delineate which areas have vegetation or which areas are public versus private land. Other information might include street names, buildings, and contour lines to show topography or symbols to indicate different objects or features on a map. Students should understand that scientists and others make maps for specific purposes.

In the second activity, students will create geologic features unit maps using a satellite image of an interesting terrain in northern Arizona. Students do not need a thorough understanding of the specific details of an area – just good observation skills. A geologic feature unit map allows you to depict visible geologic features such as different rock colors, land textures or shapes in categories or classifications that will be useful. As they develop the geologic features unit map, students will be able to classify

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features, even if they do not completely understand the features they are observing. A geologic features unit map can allow students to interpret the geologic history of an area in a general manner. Geologic maps (as opposed to geologic features unit maps) show the distribution of more detailed geologic features such as surface rock types. Creating a geologic map generally requires a greater understanding of an area, usually obtained by studies at the site, called ground truthing, or by aerial or satellite data. Since students will not go out into the field to ground truth their data, this activity will have them create a geologic features unit map using background knowledge and their observation skills. For more information on geologic maps, go to:
http://www.nature.nps.gov/geology/usgsnps/gmap/gmap1.html#what Note: additional map skills, resources, and other NASA activities may be found on page 6.

Key Terms:

- **Image for use as Base Information –** an image used as the basis for additional map layers of information, such as unit maps, topographic maps, or geologic maps.
- **Unit Map –** shows where things are - buildings, vegetation, different colored or textured items, land features
- **Geologic Features Unit Map –** shows where types of rock, textures, shapes or other types of land features are located. Key colors or symbols allow for comparisons of different features.
- **Geologic Map –** Geologic maps use color and symbols to identify distinct geologic units, faults, and other geologic features.
- **Map Scale –**The scale of a map is the ratio of a distance on the map to the corresponding distance on the ground. Example: a scale of 1:100 means 1 centimeter measured on the map would equal 100 cm on the ground.

MANAGEMENT

This activity can be conducted in a classroom with tables and chairs or individual student desks. Students should work independently or in pairs to produce their geologic maps and then work in collaborative groups to compare and contrast their maps with the maps produces by their peers. The provided images work well if printed in color or in black and white. Laminate the images or place them in plastic sleeves for use in multiples classes. The Satellite Imagery and Mapping Slide Show includes the images for base information and sample unit maps for you to use with your students as you see fit.

ACTIVITY PROCEDURES There are two parts of this activity.

Part One – *Creating a Unit Map* will give students practice in:

- making observations of an area using an aerial view,
- classifying or categorizing objects or features they see in the image,
- making a unit map based on their observations and classifications.

Students will use an aerial view of a school campus to create a unit map using what they have observed. Students will compare maps created by different student groups to see other classifications.

Part Two – *Creating a Geologic Features Unit Map* will allow students to make observations of an area in northern Arizona in order to classify or categorize geologic features visible in an image and interpret some of the basic geologic history of the area. Students will follow the same steps as they did in Part One in order to create a geologic features unit map. They will make observations followed by classifying or categorizing features visible in the image. Students will create their geologic features unit maps, compare maps made by other student groups, and interpret the geologic history of the area.

Part One – *Creating a Unit Map*

Materials Needed:

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- Image for base information of School Campus (provided on Slide Show– slide #1)
  Print one image per student or one image per 2 students. Color prints are preferable but black and white will work if students can also view the image on the slide.
  (Laminate printed images or place them in a plastic sleeve to preserve them for multiple uses.)

  Local Image Alternative
  To develop an image of your local area use:
  Google Maps
  http://maps.google.com/maps?ftr=earth.promo&hl=en&utm_campaign=en&utm_medium=van&utm_source=en-van-na-us-gns-erth&utm_term=evl

  Or USGS Earth Explorer (http://edcsns17.cr.usgs.gov/NewEarthExplorer/) to create your own image.
- Tracing paper for each image
- Colored pencils
- Tape or paper clips

1. Display the "Image for base information of School Campus" in the front of the room for all students to observe.
2. Have pairs of students list (or discuss) their observations of the map.
3. After students have listed their observations, discuss student observations as a class.
4. After the discussion, ask students how they can classify or categorize objects or features observed in the image. Have students create a list of classifications or categories of objects/features observed. Let them know there is no right or wrong answer to how they classify their objects/features, as long as items listed within a category all have something in common. Students can categorize objects/features by *type of object* (natural versus man-made sports grounds versus buildings, etc.), *texture, shape, size, or color* of objects/features.
5. As a class, discuss the different categories and the features/objects students placed in those categories. Let students know that by categorizing the objects/features in the image, they can now create a unit map of the area.
6. Using individual or team images of school or other, students should do the following to create unit maps:
   a. Look carefully at the image.
   b. Decide how they will categorize objects/features they can identify in the image.
   c. Create a list of category topics and list each object/feature that is associated with that classification.
   d. Discuss what the purpose of their map might be. Maybe they won't discover the usefulness until they have made the map and see the information.
   e. Choose colors to represent each of their categories. This will be the map legend or key.
   f. Cover the image with tracing paper to begin creating the unit map. Students should use the tape or paper clips to secure the tracing paper in place.
   g. Color each feature according to the map legend.
   h. Each map should include a title as well as a map legend.

   Optional Additions:
   a. If students can estimate any measurement, use that information to create a scale bar.
   b. If possible, use a labeled arrow to indicate which way is north.
7. After student groups have created their unit map, have them share their maps with other groups. Students should discuss how their maps are similar or different. Students should also discuss the information gained from their maps and how that information could be used.

Once students have created and discussed their unit maps, they will now apply their mapping skills to

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create a geologic features unit map. Students will follow the same procedures, however, depending on their background knowledge, they may or may not know what the geologic features are that they are observing. Students can still categorize features they observe based on shape, color, texture, or type of geologic feature (With low resolution satellite images, early mapping of planetary objects were and still are mapped that way).

Part Two – *Creating a Geologic Features Unit Map*

Materials Needed:

- Image for base information of SP Crater - one per student or team (provided on Slide Show slide #8)
  (Laminate printed images or place them in a plastic sleeve to preserve them for multiple uses.)
- Tracing paper
- Colored pencils
- Tape or paper clips

1. Display the "Image for base Information of SP Crater" in the front of the room for all students to observe.
2. Have pairs of students list (or discuss) their observations of the map.
3. After students have listed their observations, discuss student observations as a class.
4. After the discussion, ask students how they can classify or categorize the features observed in the image. Have students create a list of classifications or categories of features observed. Let them know there is <u>no right or wrong answer to how they classify their features</u>, as long as items listed within a category all have something in common. Students can categorize features by *color, shape, texture, size, by geologic feature*, etc.
5. As a class, discuss the different categories and the features students placed in those categories. Let students know that by categorizing the features in the image, they are now able to create a geologic features unit map of the area. They will use the same techniques they used to create their unit map earlier. Students should:
   a. Decide how they will classify/categorize features they can identify in the image.
   b. Create a list of category topics and list each feature that is associated with that classification.
   c. Choose colors to represent each of their categories. This will be the map legend or key.
   d. Cover the image with tracing paper to begin creating the unit map.
   e. Color each feature according to the map legend.
   f. Each map should include a title as well as a map legend.

   Optional Additions:
   a. If students can estimate any measurement, use that information to create a scale bar.
   b. If possible, use a labeled arrow to indicate which way is north.

6. After student groups have created their unit map, have them share their maps with other groups. Student should discuss how their maps are similar or different. Students should also discuss the different purposes or uses of the maps created.

Once students have created and discussed their geologic features unit maps, they should now take some time to think about what they can figure out about the geologic history of the area they just mapped. In groups, have students discuss the following questions:

a. What are the different geologic features visible in this area?
b. What does that tell you about the geologic events that have likely affected this area?
c. Can you tell what features are older or younger? Be prepared to explain how you make these determinations.
d. If you were to explore this area, what area would you visit and why?

After the students have discussed the interpretations of their maps, let them know that the image is of an area in northern Arizona where NASA conducts field tests for new equipment and procedures, for

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future exploration. The Desert Research and Technology Studies (Desert RATS) field tests allow NASA scientists, engineers, and astronauts to test how they would explore an area on the surface of another planetary body, such as the Moon, Mars, or an asteroid. The first step in getting ready to explore an area, is to create maps so you can better understand features in an area and with some additional knowledge, begin to understand the geologic history of an area so you can make informed decisions on where best to explore. By completing this activity, your students will have modeled one of the first steps in planning for human or robotic planetary exploration.

In their science journals, have students write about the following:

1. How was your geologic features unit map the same or different from other students' maps? What, if anything, made one map better than another?
2. What are the important elements of creating a good geologic features unit map?
3. How do you think the process you went through to create your geologic features unit map is the same or different from how NASA scientists and engineers create a geologic features unit map?

If you were going to be part of a team preparing for the exploration of the surface of another world, would you rather be on the team as a map maker or as an explorer (astronaut). Explain your answer.

RESOURCES AND ADDITIONAL ACTIVITIES

- **NASA Educator Guide – Destination Mars**
  http://ares.jsc.nasa.gov/ares/education/program/destinationmars.cfm

- **NASA Mission Geography**
  http://www.missiongeography.org

- **Expedition Earth and Beyond**
  http://ares.jsc.nasa.gov/ares/eeab/index.cfm

- **EarthKAM (Earth Knowledge Acquired by Middle School Students)**
  https://earthkam.ucsd.edu

- **Mars Student Imaging Project**
  http://marsed.mars.asu.edu/msip-home

- **MoonKAM**
  https://moonkam.ucsd.edu/

- **Lunar and Planetary Institute (LPI) –** http://www.lpi.usra.edu
  - Information and images about the Black Point Lava Flows
    http://www.lpi.usra.edu/lunar/analogs/blackpoint/
  - http://www.lpi.usra.edu/lunar/analogs/blackpoint/shuttleiss.shtml

- **U.S. Geological Survey**
  - Geologic Maps
    http://www.nature.nps.gov/geology/usgsnps/gmap/gmap1.html#what
  - What Do Maps Show?
    http://egsc.usgs.gov/isb/pubs/teachers-packets/mapshow/
  - Topographic Map Symbols
    http://edc2.usgs.gov/pubslists/booklets/symbols/topomapsymbols.pdf

- **NASA's Mission Geography** – www.missiongeography.org
  The following modules may be useful:
  1) K-4 Module 1:
  - Investigation 1: Does What You See Depend on Where You Are?
  - Investigation 2: Comparing Maps and Images From Space

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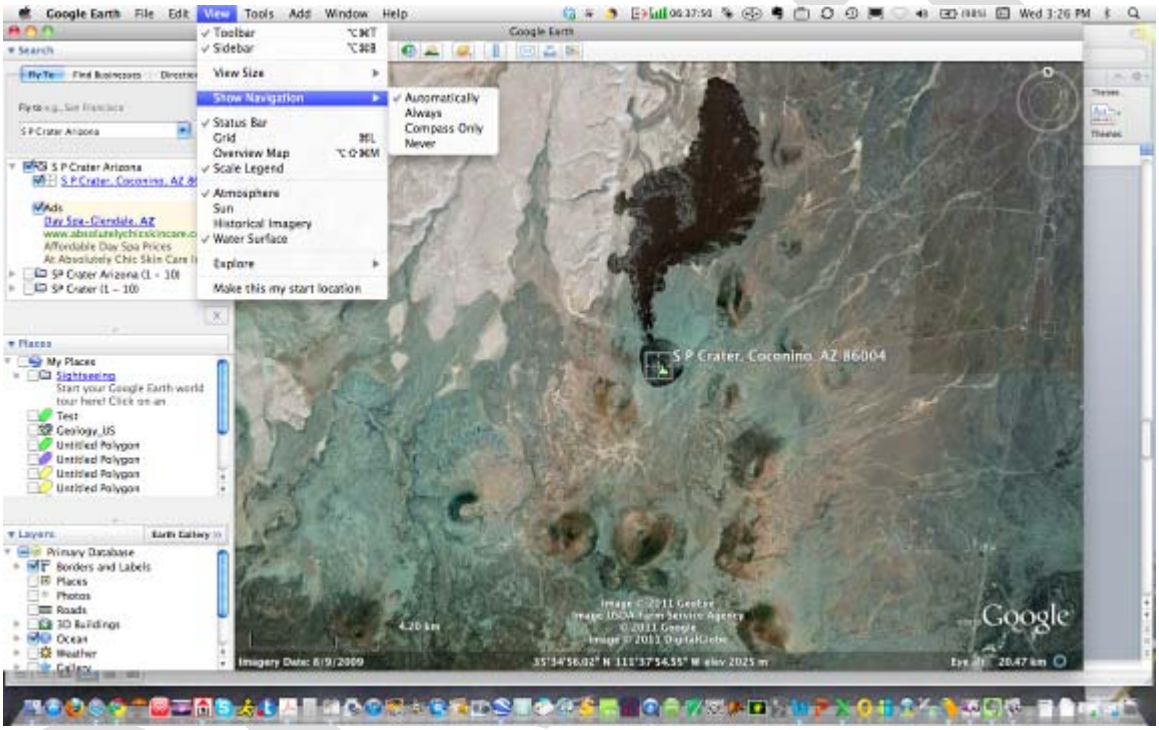
- Investigation 3: What Can Satellites Tell Us About Earth?
- How Does Color Help Us Understand Images From Space?

2) K-4 Module 3:
- Module Overview and What Are Physical and Human Made Features?
- How Do Images Help Us Learn About Our Planet, Earth?

Google Earth Option for Geologic Features Unit Mapping of Desert RATS Area

1. Open Google Earth.
2. In the toolbar, under the 'View' menu, be sure to check 'Toolbar' and 'Sidebar', check 'Status Bar' and 'Scale Legend', and under the 'Show Navigation' menu check 'Automatically'. See image below for details.



(Alternative: Google Earth View access with URL below.)
http://maps.google.com/maps?ftr=earth.promo&hl=en&utm_campaign=en&utm_medium=van&utm_source=en-van-na-us-gns-erth&utm_term=evl

3. In the 'Fly To' tab, enter "S P Crater Arizona" into the search box. Press enter. Make sure that the region you see in Google Earth is similar to the image above.
4. Use the 'zoom' feature to zoom in until the scale is close to 4.0km. Please note that the image does not have to be exactly at a scale of 4.0km, just close.

TEACHERS NOTE:
Have students review the tutorial on how to use the polygon tool in Google Earth. This can be a homework assignment preceding the class or as a classroom activity. The tutorial (both a written and video format) can be found at:
http://earth.google.com/support/bin/static.py?page=guide.cs&guide=22365&topic=23729&answer=148072&printable=1

5. Using the polygon tool, select one color and one geologic feature to highlight.
6. Repeat step five until all geologic features have been highlighted.

Satellite Imagery and Mapping Slide Show is available in PPT and PDF versions on our website.

Image for Base Information of School Campus

(Image from Google/USGS Earth Explorer)

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