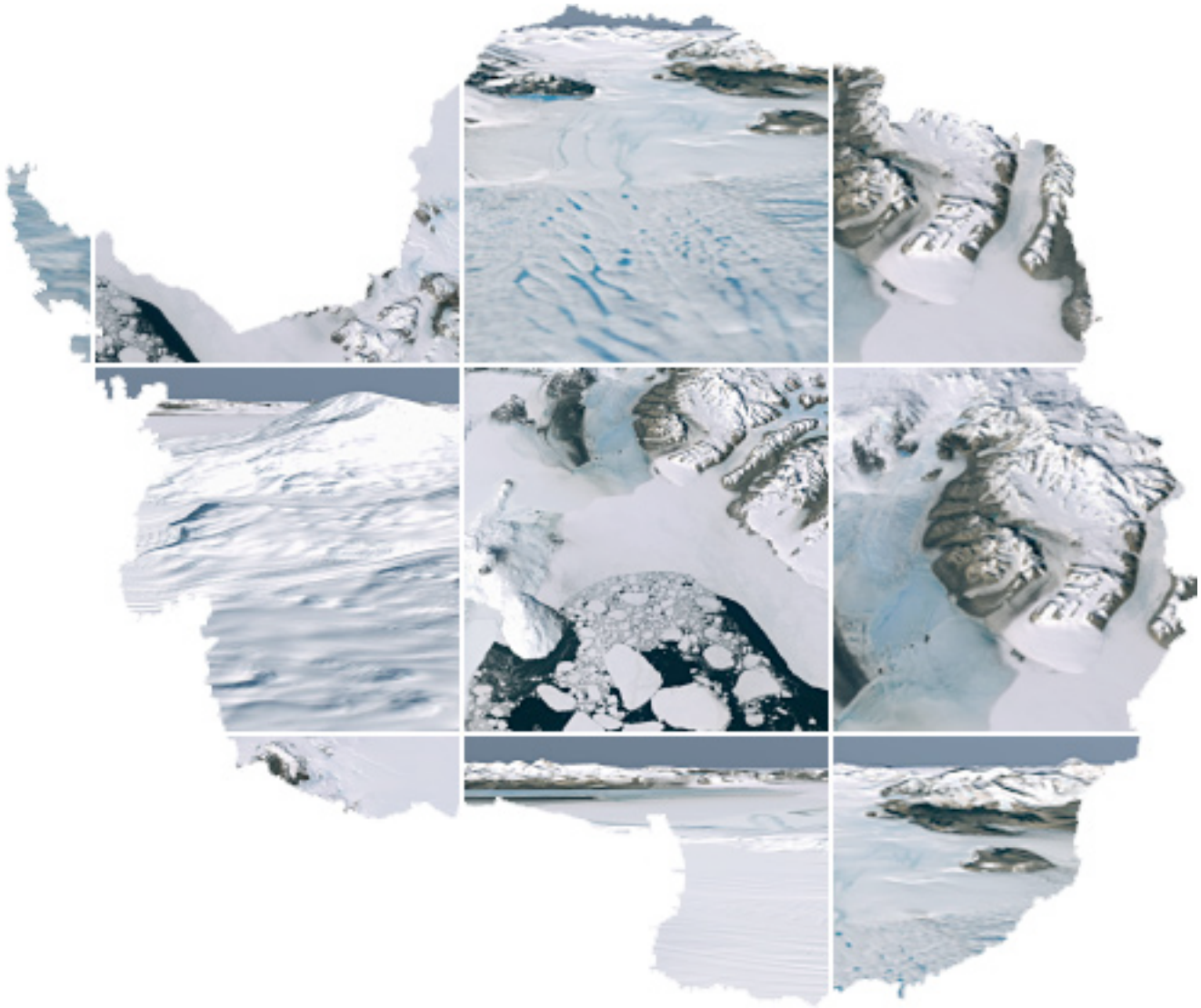
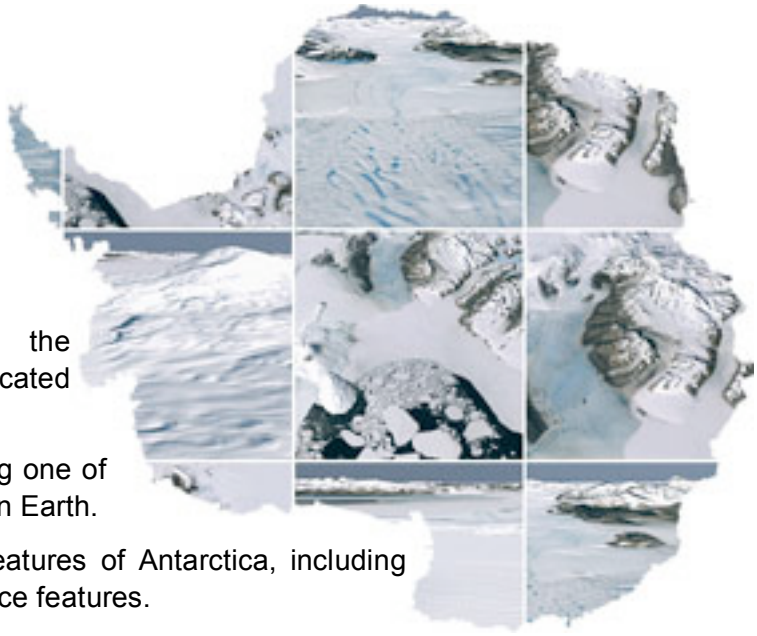
Landsat Image Mosaic of Antarctica

NASA Quest Challenge Educator Guide



Spring 2008

LIMA Landsat Image Mosaic of Antarctica
Faces of Antarctica



Target Audience: Grades 4–8

Estimated Time: 1–2 hours per week
(~ 4 weeks)

Objectives:

- Students will identify Antarctica as the southernmost continent geographically located over the Earth's south pole.
- Students will describe Antarctica as having one of the coldest, driest, and windiest climates on Earth.
- Students will identify major geographic features of Antarctica, including mountains, volcanoes, lakes, and various ice features.
- Students will understand that ice has many forms, including glaciers and ice shelves, crevasses and rifts, icebergs, mega dunes, ice rises and ice rumples, and blue ice.
- Students will recognize that the various ice formations are the result of geologic processes related to tectonic movement, volcanism, weather patterns, seasonal changes, and climate changes.
- Students will observe how scientists can use satellite imagery to investigate Antarctic ice formations and learn about the geologic and ice flow processes that create them.
- Students will work as a team to select a specific geographic feature and write a proposal as to why they think this feature deserves further exploration.

Materials:

- Computer with Internet access for:
  - Pre- and post-challenge surveys*
  - Challenge main page: http://quest.nasa.gov/challenges/lima
  - LIMA site research: http://lima.nasa.gov/
  - Web chat and web cast participation*
- Word processor for writing proposal
- Email access for submitting proposal*

* *These materials are only needed for real-time Challenge participants in Spring 2008.*

Background Information

Antarctica is the highest, driest, coldest, windiest, and brightest of the seven continents. It is the southernmost continent, located primarily south of the Antarctic Circle and positioned over the South Pole. Antarctica is roughly the size of the United States and Mexico combined and is almost completely covered by an ice sheet—a layer of ice that averages more than one mile in thickness and is nearly three miles thick in places. This ice sheet has accumulated over millions of years through snowfall and presently contains 90% of the ice on Earth and would raise sea levels worldwide by over 200 feet were it to melt. Despite its massive ice sheet, Antarctica receives very little precipitation in its interior, making it the largest desert in the world.

The ground beneath the Antarctic ice sheet is a mixture of mountains, volcanoes, plains, sub-glacial lakes, and ocean basins. The tallest mountains on Antarctica extend above the ice sheet, with the highest mountain summit being Vinson Massif, which towers 16,062 feet above sea level. The longest mountain range is the Transantarctic Mountains that conveniently divide the continent into a large sector in the eastern hemisphere, called East Antarctica, and a smaller sector in the western hemisphere, called West Antarctica. The Antarctic Peninsula is primarily a second mountain range. (*Pictured below: Mount Erebus, a volcano on Antarctica's Ross Island*)

Due to various geological and meteorological processes such as plate tectonics, volcanism, weather, and climate change, Antarctica's ice exists in many forms. These forms include deep crevasses and wide rifts, massive glaciers, fast-moving ice streams and expansive floating ice shelves, mega dunes, ice rises, ice rumples, towering ice chimneys, and countless icebergs. Gravity exerts sufficient force on the massive Antarctic ice sheet, causing it to move. The highest elevation ice is in the interior of the continent despite precipitation rates of less than one inch per year. This interior ice is very cold and slow. Flow rates, however, increase toward the coast as glaciers are formed. Some glaciers calve icebergs directly into the ocean while others join to form large, thick floating ice shelves. The Pine Island Glacier, flowing at over 10,000 feet per year, is believed to be the fastest Antarctic glacier. Antarctica's largest ice shelf is the Ross Ice Shelf, which is roughly the size of Texas. Semi-permanent sea ice, called fast ice and formed by freezing ocean water, remains on the ocean surface and is sculpted by the strong katabatic winds.

Pictured above: Lake Fryxell in the Transantarctic Mountains. The blue ice comes from glacial meltwater; the freshwater stays on top of the lake and freezes, sealing in briny (salty) water below.

Antarctica's ice sheet makes it very difficult to study the continent's geologic features; however, new uses of satellite imagery have allowed scientists to learn more about the structures beneath the ice. Landsat Image Mosaic of Antarctica (LIMA) provides a geographically accurate, true-color, high-resolution map of Antarctica that provides scientists a realistic look at the continent in 10 times greater detail than ever before.

Notes to Teacher

- If you are conducting this lesson in conjunction with the Spring 2008 LIMA Quest Challenge, then please limit the number of proposals that your class of students submits to NASA. In order to accommodate all participating classes, ***NASA can only accept 1–2 proposals per class***. For your own purposes may choose to have your students work in several small teams; however, upon completing their Challenge assignments, students should unite as a class and choose 1 or 2 proposals to submit to NASA for scientific review.

- Before you instruct students to explore the USGS/LIMA web site, first introduce them to the "Antarctic Mysteries" portion of the NASA/LIMA web site: http://lima.nasa.gov/mysteries/q1/index.php

  There are two sections to explore:

  – "What is it?" → features 17 mystery images

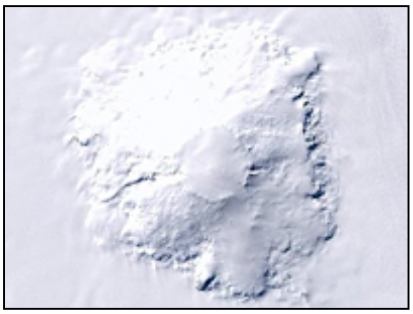
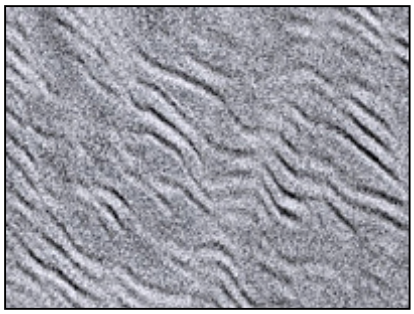
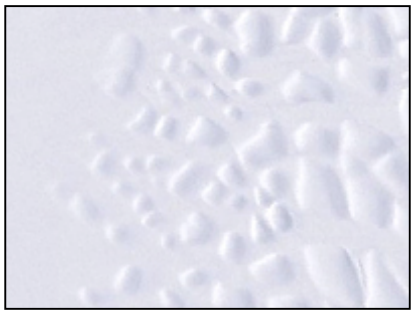
  – "Is the ice moving?" → features 5 topics (including videos) and additional resources (PDFs and web links)

- Introduce students to the key terminology listed on pages 10–11 of this guide, and encourage students to find supporting images for each of the terms.

The Challenge

SITUATION

As Earth scientists, you and your team have been closely studying the various ice formations revealed by the LIMA imagery, and you have identified one specific ice feature that is of particular interest to you. In hopes of gaining research funding to allow you to learn more about this feature and the geologic processes that have helped to create it, you and your team are going to submit a proposal to NASA explaining 1) why you think this geologic feature is interesting enough to warrant further research and investigation and 2) what processes you think are occurring in connection to this ice feature.

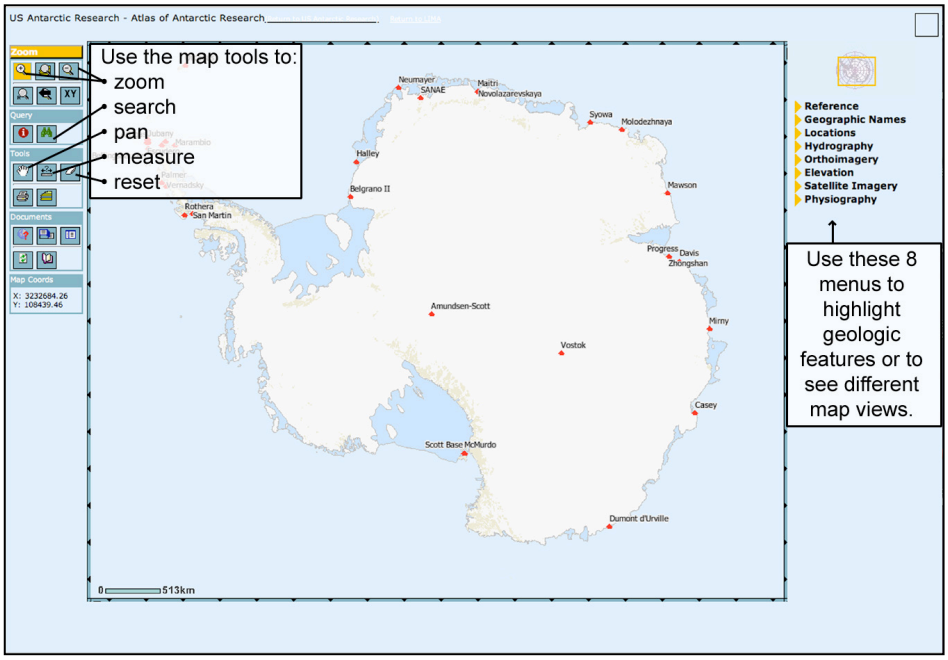
PROPOSAL CRITERIA

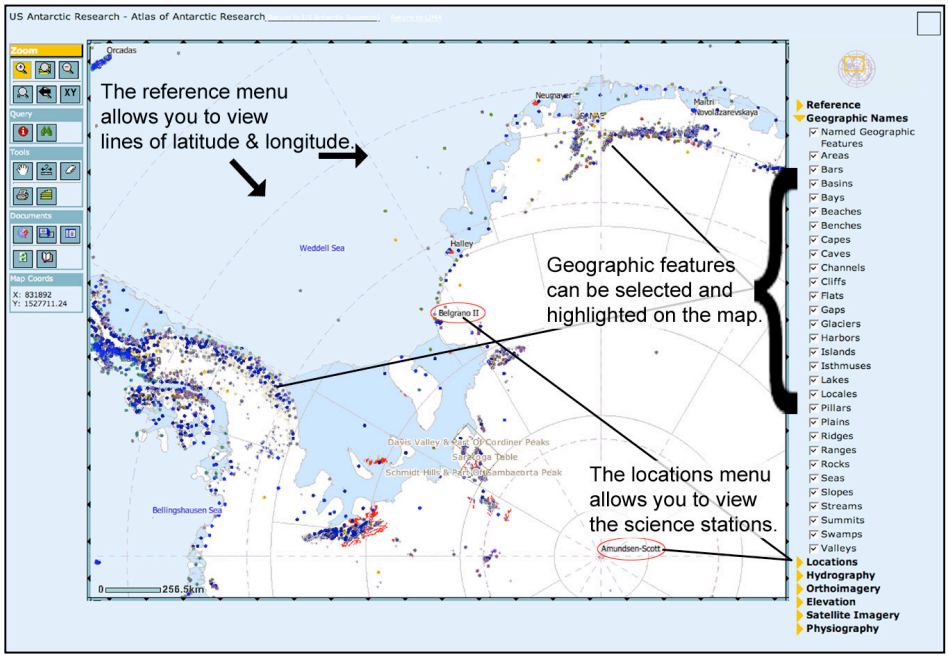
In order to receive full consideration, your team's proposal should not exceed two pages and must include the following:

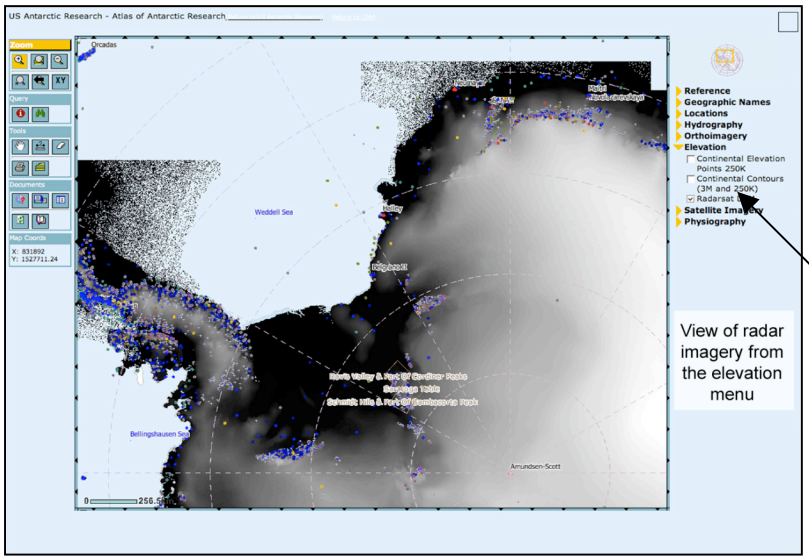
- The name and/or description of your chosen ice feature
- An image of your chosen ice feature
- The location of your selected feature in terms of its longitude and latitude as well as the region of Antarctica in which it exists. (Teams are encouraged to include a map of Antarctica with a mark pinpointing the location of their selected feature.)
- A paragraph explaining why your chosen ice feature is scientifically interesting.
- A paragraph hypothesizing what geologic processes you think are occurring to create this ice feature.
- A paragraph asserting why you and your team should be funded to further investigate this area of Antarctica. (In other words, what are the potential benefits of exploring this feature?)

Exploring LIMA

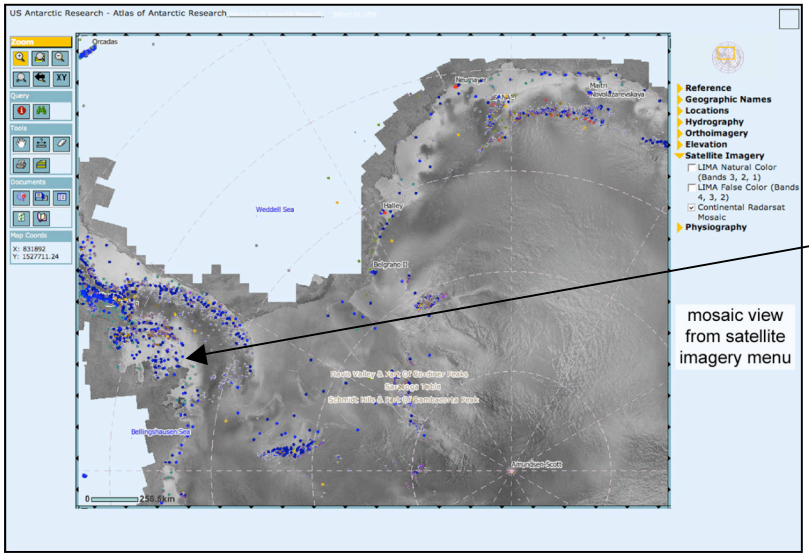
- Access the LIMA-USGS web site: http://lima.usgs.gov/index.php
- Select “Use the Interactive Atlas of Antarctic Research” and then select “Launch Viewer.”
- Use the map tools to navigate the map (zoom in/out, pan, measure, etc).
- Click on the gold arrows next to the 8 menus to highlight various geologic features (glaciers, peaks, lakes, etc) or to see different map views (radar, mosaic, etc).



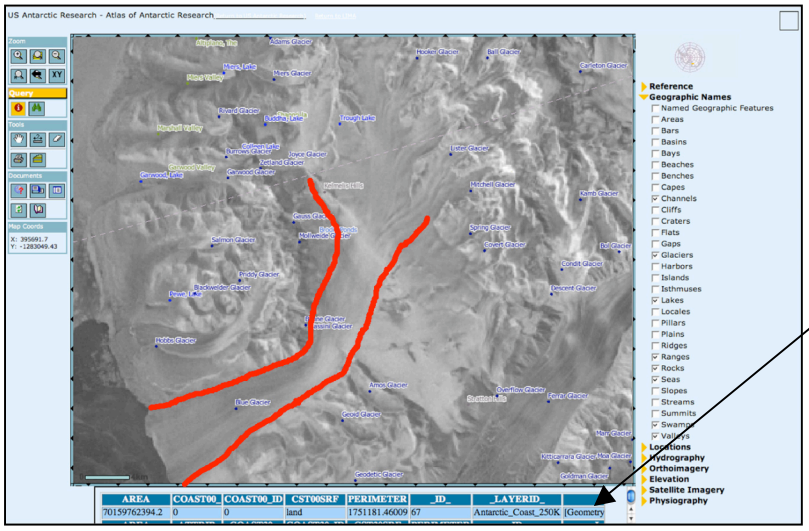




Once a feature is selected, you can examine it under different views using the side menus.



As you identify an interesting region, you can zoom in and select different geographic features.



Once you select a particular feature, you can click on the map to reveal a data table about that feature.

Assessment

The key objectives of this Challenge are to:

- Educate students about Antarctica's geography and geology.
- Introduce students to the concept that ice has many forms and that these forms are a reflection of various geologic processes.
- Demonstrate how satellite imagery is one tool that scientists can use to study and investigate a region of our planet that is difficult to physically explore.

Sample questions that you may use to assess your students' learning include:

- Which 3 choices best describe Antarctica's climate? ***(Antarctica is the coldest, windiest, and driest continent on Earth.)***

polar	savanna	oceanic
tropical	moderate	**windy**
steppe	humid	**desert**

- Crevasse, berg, mega dune, shelf, and rift are terms that are used to describe what kind of formations?

  Ice

- Name some processes that have affected (or changed) the landmass of Antarctica?

  Plate tectonics (volcanism, earthquakes)

  Erosion

  Weather / seasonal patterns

  Climate change (past and present)

- Describe one tool or method that scientists can use to study the continent of Antarctica.

  Satellite imagery

Terminology

Blue ice—ice exposed at the surface without a covering of snow

Crevasse—a fracture (deep, open crack) in a glacier

Fast ice—seasonal sea ice that has frozen along coasts and extends out from shore to sea

Fumarole—opening in or near a volcano through which hot steam and sulfurous gases emerge

Glacier—a large, slowly moving river of ice formed by the accumulation and compaction of snow on mountains or near the poles that flows in response to gravity

Iceberg—a large piece of freshwater ice that has detached from a glacier or ice sheet and is floating in open water (i.e. the ocean)

Ice chimney—an ice tower that forms around a fumarole as escaping steam freezes as soon as it hits the air and accumulates into a “chimney” formation

Ice rise—slow moving ice grounded on the sea floor but surrounded by a floating ice shelf

Ice rumple—undulated (wavy) ice shelf formed by an ice shelf barely contacting the sea floor

Ice sheet—a permanent layer of ice formed by gradual accumulation of snow covering an extensive tract of land such as Antarctica or Greenland

Ice shelf—a thick, floating sheet (platform) of ice formed by flow of an ice sheet or glacier

Ice stream—a region of an ice sheet that flows significantly faster (hundreds of meters per year) than the surrounding ice

Katabatic wind—wind caused by local downward motion of cool, dense air that blows outward from the cold interior of an ice sheet toward the relatively warmer lower altitude coast

Mega dune—large snow dunes formed by persistent katabatic winds that migrate more as a result of evaporation processes than by moving snow

Meteorite—a meteor (consisting of rock, iron, and/or nickel) that survives passage through the atmosphere and strikes the Earth’s surface

Rift— a gaping void produced by the widening of weak ice surrounding a crevasse

Sea ice—frozen seawater

Sublimation—a transition from the solid to gas phase with no intermediate liquid stage (as in ice transitioning directly to water vapor)

Extension

Now that students have learned about some of the geography of Antarctica and have identified a geological feature that is of particular interest to them, they should plan an expedition to conduct further exploration. Task students to plan a trip to Antarctica for a *two-week* expedition. Their plans should include:

- Specific destination
- Means of traveling to/from their destination.
- Means of communication
- List of supplies (food, shelter, clothing, fuel…)
- List of scientific instrumentation
- List of team members and their expertise
- Description of the type of research/experimentation they will conduct
- Estimated cost

Note: This extension activity is for the classroom only; therefore, student work associated with this assignment should not be submitted to NASA.

Additional Resources

Visit the following sites to access additional information regarding Antarctica, including blogs, videos, imagery, current projects/expeditions, articles, and educational materials.

- Antarctic Search for Meteorites: http://geology.cwru.edu/%7Eansmet/
- National U.S. Antarctic Program: http://www.usap.gov/scienceAndEducation.cfm
- Discovering Antarctica: http://www.discoveringantarctica.org.uk/
- British Antarctic Survey: http://www.antarctica.ac.uk/about_antarctica/index.php
- Pine Island Glacier Ice Shelf Project: http://pigiceshelf.nasa.gov/index.php
- Antarctic Geological Drilling Project: http://www.andrill.org/education
- "Antarctica Erupts:" http://www.smithsonianmag.com/science-nature/antarctica.html#
- "Huge Antarctic Ice Chunk Collapses:" http://www.cnn.com/2008/TECH/science/03/25/antartica.collapse.ap/index.html
- Wikipedia: Antarctica: http://en.wikipedia.org/wiki/Antarctica
- Children's story of Ernest Shackleton's 1912 expedition: http://www.salariya.com/web_books/explorer/index.html

Education Standards

National Science Education Standards: Grades K–4

NS.K–4.1 Content Standard A: Science as Inquiry

• *Abilities necessary to do scientific inquiry*

• *Understanding about scientific inquiry*

NS.K–4.2 Content Standard B: Physical Science

• *Properties of objects and materials*

NS.K–4.4 Content Standard D: Earth and Space Science

• *Properties of earth materials*

• *Changes in earth and sky*

NS.K–4.5 Content Standard E: Science and Technology

∫• *Abilities of technological design*

• *Understanding about science and technology*

NS.K–4.6 Content Standard F: Personal and Social Perspectives

• *Changes in Environments*

NS.K–4.7 Content Standard G: History of Nature and Science

• *Science as a human endeavor*

National Science Education Standards: Grades 5–8

NS.5–8.1 Content Standard A: Science as Inquiry

• *Abilities necessary to do scientific inquiry*

• *Understanding about scientific inquiry*

NS.5–8.2 Content Standard B: Physical Science

• *Properties and changes of properties in matter*

NS.5–8.4 Content Standard D: Earth and Space Science

• *Structure of the Earth system*

• *Earth's history*

NS.5–8.5 Content Standard E: Science and Technology

- *Abilities of technological design*
- *Understandings about science and technology*

NS.5–8.6 Content Standard F: Science in Personal and Social Perspectives

- *Natural hazards*
- *Science and technology in society*

NS.5–8.7 Content Standard G: History and Nature of Science

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

National Social Science Education Standards: Grades K–12

NSS–G.K–12.1: The World in Spatial Terms

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

NSS–G.K–12.2: Places and Regions

- *Understand the physical and human characteristics of places.*
- *Understand that people create regions to interpret Earth's complexity.*
- *Understand how culture and experience influence people's perceptions of places and regions.*

NSS–G.K–12.3: Physical Systems

- *Understand the physical processes that shape the patterns of Earth's surface.*

NSS–G.K–12.5: Environment and Society

- *Understand how human actions modify the physical environment.*

NSS–G.K–12.6: The Uses of Geography

- *Understand how to apply geography to interpret the past.*
- *Understand how to apply geography to interpret the present and plan for the future.*

National Technology Education Standards: Grades K–12

NT.K–12.3: Technology Productivity Tools

- *Students use technology tools to enhance learning, increase productivity, and promote creativity.*
- *Students use productivity tools to collaborate in constructing technology-enhanced models, prepare publications, and produce other creative works.*

NT.K–12.4: Technology Communication Tools

- *Students use telecommunications to collaborate, publish, and interact with peers, experts, and other audiences.*
- *Students use a variety of media and formats to communicate information and ideas effectively to multiple audiences.*

National Language Arts Education Standards: Grades K–12

NL–ENG.K–12.4: Communication Skills

Students adjust their use of spoken, written, and visual language (e.g., conventions, style, vocabulary) to communicate effectively with a variety of audiences and for different purposes.

NL–ENG.K–12.5: Communication Strategies

Students employ a wide range of strategies as they write and use different writing process elements appropriately to communicate with different audiences for a variety of purposes.

NL–ENG.K–12.7: Evaluating Data

Students conduct research on issues and interests by generating ideas and questions and by posing problems. They gather, evaluate, and synthesize data from a variety of sources (e.g., print and non-print texts, artifacts, people) to communicate their discoveries in ways that suit their purpose and audience.

NL–ENG.K–12.8: Developing Research Skills

Students use a variety of technological and information resources (e.g., libraries, databases, computer networks, video) to gather and synthesize information and to create and communicate knowledge.

NL–ENG.K–12.12: Applying Language Skills

Students use spoken, written, and visual language to accomplish their own purposes (e.g., for learning, enjoyment, persuasion, and the exchange of information).