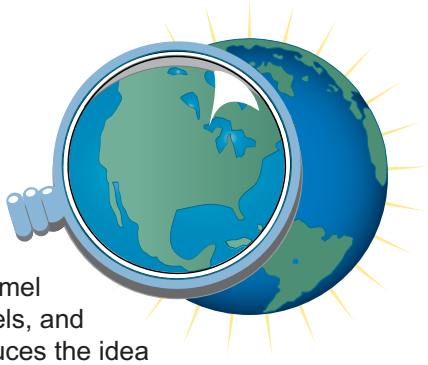
Paths—Usual or unusual?



Investigation Overview

NASA images can introduce students to some unusual natural and human-made paths. These include ancient camel caravan tracks, lava flows, ship channels, and smoke paths. The investigation introduces the idea of one-way and two-way paths. It provides an opportunity for students to work together to study images and to pose and answer many questions about paths. They record their observations and draw conclusions about the origins and nature of these pathways. They also match the images with descriptions of the paths and use maps to gather more information about the environments illustrated in the images.

Time required: One 45-minute session

Materials/Resources

NASA images (make overhead transparencies and one copy for each group of students):

- Figure 1: Mozambique
- Figure 2: Ubar
- Figure 3: Teide volcano, Canary Islands
- Figure 4: Mississippi River delta

Log 1: Looking at new paths
Log 2: Reading about the images
Atlases (or wall maps showing world vegetation and landform patterns)

Content Preview

Paths come and paths go. Some paths are visible from space but not from the ground. Geographers and other scientists use remote sensing to learn about different paths because they affect people and their activities. Paths also give clues about past places and peoples. This technology is especially useful in remote regions of the world or to see paths that extend over long distances. Detailed descriptions of images of Mozambique, Ubar, the Teide volcano, and the Mississippi River delta show paths that are significant for a variety of human endeavors.

Classroom Procedures

Beginning the Investigation

1. If the class has done **Investigation 1**, review the list of paths that students developed in **Log 1**. If they have not done **Investigation 1**, begin this investigation by talking about the various kinds of paths and making such a list on the chalkboard. (See **Investigation 1, *Beginning the Investigation***.)

2. Look at the list of paths and ask the following questions:
   - Can paths disappear, and what would make them disappear? (*Rivers change courses, rainwater or snow may cover paths, natural*

Geography Standards

Standard 1: 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

- Identify and describe the characteristics and purposes of geographic representations, tools, and technologies.

Standard 15: Environment and Society

How physical systems affect human systems

- Identify ways in which human activities are constrained by physical environment.

Geography Skills

Skill Set 2: Acquiring Geographic Information

- Make and record observations about the physical and human characteristics of places.

Skill Set 4: Analyzing Geographic Information

- Use texts, photographs, and documents to observe and interpret geographic trends and relationships.

Skill Set 5: Answering Geographic Questions

- Use methods of geographic inquiry to acquire geographic information, draw conclusions, and make generalizations.

disasters can obliterate paths, people may no longer use pathways and they may become overgrown, etc.)

- Can images from space tell us what happened to pathways that existed long ago? (*Yes, pathways that seem obscure on the ground can be more apparent from a distance.*)
- Why would we be interested in knowing about these pathways? (*To learn about people and their movements in the past and how they have changed.*)
- What kinds of pathways could more easily be studied in images from space than on the ground? (*Paths that are in remote places or extend over long distances.*)

Developing the Investigation

3. Tell students that they will work in small groups to look for some unusual paths in images taken from the Space Shuttle.

4. Form groups of three or four students. Give each group a copy of **Log 1**. Go over the directions. Project transparencies of **Figures 1-4** and give each group a copy of each image. Note that the number of each image should correspond to the numbers on the worksheet.

   Use information in **Background** to tell the class enough about each image so that they will be able to figure out the answers. When showing **Figure 1**, explain that this is a photograph taken by an astronaut. Explain that **Figures 2-4** were produced by radar signals from a sensor on the Space Shuttle. Explain that radar signals can go through clouds and darkness. The signals give information about the ground to computers that use it to create images. These images can look like photographs. Scientists determine the colors shown in the image according to what will help them interpret it.

5. Have students work together in their groups after completing the first image together as a class.

6. After the groups have completed the task, show each image again and have the groups report what they have observed.

7. Distribute **Log 2** and have the groups decide which description in **Log 2** goes with each image, in **Figures 1 to 4**. Have students read the descriptions that match the images. Share additional information in the **Background** section with the students. Ask students to point out the pathways and features that are mentioned.

8. Find the locations of the images on a world map or in atlases. Describe the physical features of the locations.

Concluding the Investigation

9. Show the images again and discuss the significance of the pathways in each image.

   - Smoke paths: *People downwind may be affected by the smoke in adverse ways*.
   - Camel tracks: *Old caravan tracks show the movement of people across the desert in ancient times. They can lead archeologists to ancient settlement sites that might otherwise be difficult to find.*
   - Lava flow path: *Historic flow patterns may help predict future volcanic activity, indicating areas of danger to human settlements.*
   - Mississippi River delta paths: *Sediment deposits change the delta and affect river traffic.*

Background: Images

Figure 1: Mozambique <http://eol.jsc.nasa.gov/newsletter/smoke/page1.htm>. The image STS070-717-027 shows bush fires in southern Mozambique in Africa. The easterly winds from the Mozambique Channel blow the smoke from many large fires into the country of Zimbabwe on the African plateau. This image shows winter, the dry season in southern Africa. People set fires to hasten the greening of the grass shoots for cattle grazing.

Figure 2: Ubar <http://observe.ivv.nasa.gov/nasa/exhibits/ubar/ubar_3.html> This is a radar image of the region around the site of the lost city of Ubar in southern Oman, on the Arabian Peninsula. The ancient city was discovered in 1992 with the aid of remotely sensed data. Archeologists believe Ubar existed from about 2800 B.C. to about 300 A.D. It was a remote desert outpost where caravans assembled to transport frankincense across the desert. Frankincense is a sweet-smelling incense used as a fragrance, for medicinal purposes, and for embalming. This image was acquired by the Space Shuttle *Endeavour* on April 13, 1994. The image covers an area about 50 by 100 kilometers. The prominent magenta-colored area is a region of large sand dunes. The prominent green areas are rough limestone rocks, which form a rocky desert floor. A major wadi, or dry stream bed, runs across the middle of the image and is shown largely in white. The actual site of the fortress of the lost city of Ubar, currently under excavation, is near the wadi close to the center of the image. The fortress is too small to be detected in this image. However,

tracks leading to the site, and surrounding tracks, appear as prominent, but diffuse, reddish streaks. These tracks have been used in modern times, but field investigations show many of these tracks were in use in ancient times as well. Mapping of these tracks on regional remote sensing images was a key to recognizing the site as Ubar in 1992. This image, and ongoing field investigations, will help shed light on a little-known early civilization.

Figure 3: Teide volcano, Canary Islands <http://southport.jpl.nasa.gov/volcanopic.html> This radar image shows the Teide volcano on the island of Tenerife in the Canary Islands. The Canary Islands, part of Spain, are located in the eastern Atlantic Ocean off the coast of Morocco. Teide is the third highest volcano on Earth. Teide erupted only once in the 20th century, in 1909, but is considered potentially threatening due to its proximity to the city of Santa Cruz de Tenerife, shown in this image as the purple and white area on the lower right edge of the island. The summit crater of Teide, clearly visible in the left center of the image, contains lava flows of various ages and roughnesses that appear in shades of green and brown. Color enhancement of the image makes it easier to see the lava flows and the vegetation. Different vegetation zones, both natural and agricultural, are shown as areas of purple, green, and yellow on the volcano's flanks. Scientists are using images such as this to understand the evolution of the structure of Teide, especially the formation of the summit caldera and the potential for collapse of the flanks. The volcano is one of 15 identified by scientists as potentially hazardous to local populations, as part of the international "Decade Volcano" program. The image was acquired onboard the Space Shuttle *Endeavour* on October 11, 1994.

Figure 4: Mississippi River delta <http://southport.jpl.nasa.gov/pio/srl2/sirc/srl2-delta.gif> This is a radar image of the Mississippi River delta where the river enters into the Gulf of Mexico along the coast of Louisiana. The main shipping channel of the Mississippi River is the broad red stripe running northwest to southeast down the left side of the image. The bright spots within the channel are ships. This image was acquired aboard the Space Shuttle *Endeavour* on October 2, 1995. The image is centered on latitude 29.3 degrees North latitude and 89.28 degrees West longitude. The area shown is approximately 63 kilometers by 43 kilometers. North is towards the upper right of the image. As the river enters the Gulf of Mexico, the water slows down and dumps the sediment that it has eroded from the land. This sediment accumulates over the years and forms new land in the delta. Most of the delta in the image consists of mud flats and marsh lands. There is little human settlement in this area due to the instability of the sediment.

Background: One- and Two-Way Paths

One-way paths are ones in which movement is overwhelmingly in one direction. For example, rivers and glaciers flow downhill, and prevailing or constant winds and currents such as the jet stream and gulf stream flow in a consistent direction. Movement on two-way paths can be in either direction. There are many human examples such as roads and railroads. Animal paths, bird flyways, and some environmental flows (for instance land breeze/sea breeze patterns), or flows in tidal channels, are examples of two-way paths.

Evaluation

***Log 1**

What are the paths in the image?	Made by natural forces, people, or animals?	One-way or two-way path?	Can it change? How/why?
1. smoke	natural/ people	1	yes, wind changes
2. caravan routes	people/ animals	2	yes, people change routes
3. lava flows	natural	1	yes, lava erupts elsewhere
4. river channel	natural	1	yes, channels change course

***Log 2**

1. Ubar
2. Teide volcano
3. Mozambique
4. Mississippi River delta

Related Resources

http://observe.ivv.nasa.gov/nasa/ootw/1999/ootw_990512/ob990512_more7.html Japan, good images of lava flows

Module 4, Investigation 3: Log 1

Looking at new paths

Directions: Scientists use images from space to study events on Earth. You can do the same thing. Work in your group to answer the following questions about each image in Figures 1, 2, 3, and 4. Be sure to match the image with the number on your sheet.

What kind of path is in the image?	Is the path made by natural forces, people, or animals?	Is the path a one-way or two-way one? Explain your thinking.	Can the pathway change? How and why?
1.			
2.			
3.			
4.			

Module 4, Investigation 3: Log 2

Reading about the images

1. This is an image of ancient camel caravan paths. The paths lead to a place where there was once a city called Ubar. The ancient city was discovered in 1992 with the aid of images from space. For years, archaeologists have looked for the lost city of Ubar. Ubar is believed to have been in southern Oman, on the Arabian Peninsula. Archaeologists believe Ubar disappeared about 1700 years ago. Ubar probably was a desert outpost where caravans met while they were carrying goods across the desert. Frankincense was an important trade item. Frankincense was used as a medicine, as perfume, and in preserving dead bodies.

   The fortress is too small to be seen in this image. However, ancient camel tracks leading to the site, and surrounding tracks, appear as reddish streaks. This image and field investigations will help us to learn more about this little-known early civilization.

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2. This is an image of the pathways of lava. This volcano is called Teide and is located on the island of Tenerife in the Canary Islands. The Canary Islands, part of Spain, are located in the eastern Atlantic Ocean off the coast of Morocco. This is the third highest volcano on Earth. Teide last erupted in 1909. The city of Santa Cruz de Tenerife may be damaged by lava flows.

   Scientists are using images like this one to understand how Teide developed and what paths future lava flows might take. The volcano is one of fifteen that scientists have listed as possibly dangerous for local populations.

Module 4, Investigation 3: Log 2

Reading about the images

3. This is an image of the pathway of smoke. The image is from Mozambique in Africa. Winter is the dry season in southern Africa. Many cattle are raised in this area. Fires are set to speed up the greening of the grass shoots for cattle grazing.

   The easterly winds from the Mozambique Channel blow the smoke from these many large fires. The smoke is carried by the wind to the southern part of this island. The wind carries the smoke into the country of Zimbabwe.

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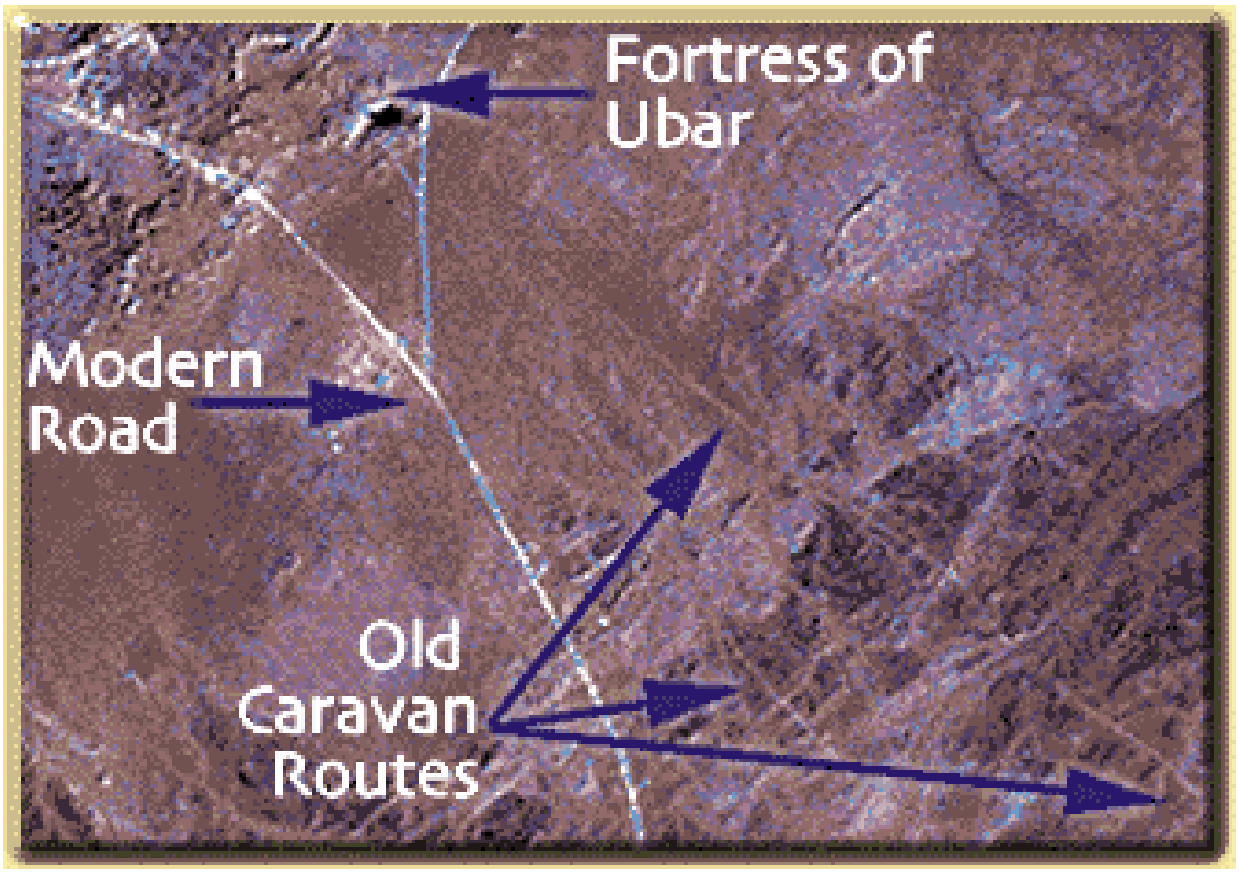
4. This is an image of the Mississippi River Delta on the Louisiana coast. It shows the channels that ships take through the delta as they enter or leave the river. The main shipping channel of the Mississippi River is the broad red stripe.

   As the river enters the Gulf of Mexico, it dumps most of the sediment (mainly mud, clay, and sand) that it has eroded from the land. This sediment can pile up over the years, adding new land to the delta and making the channels find new paths as the old ones become clogged.

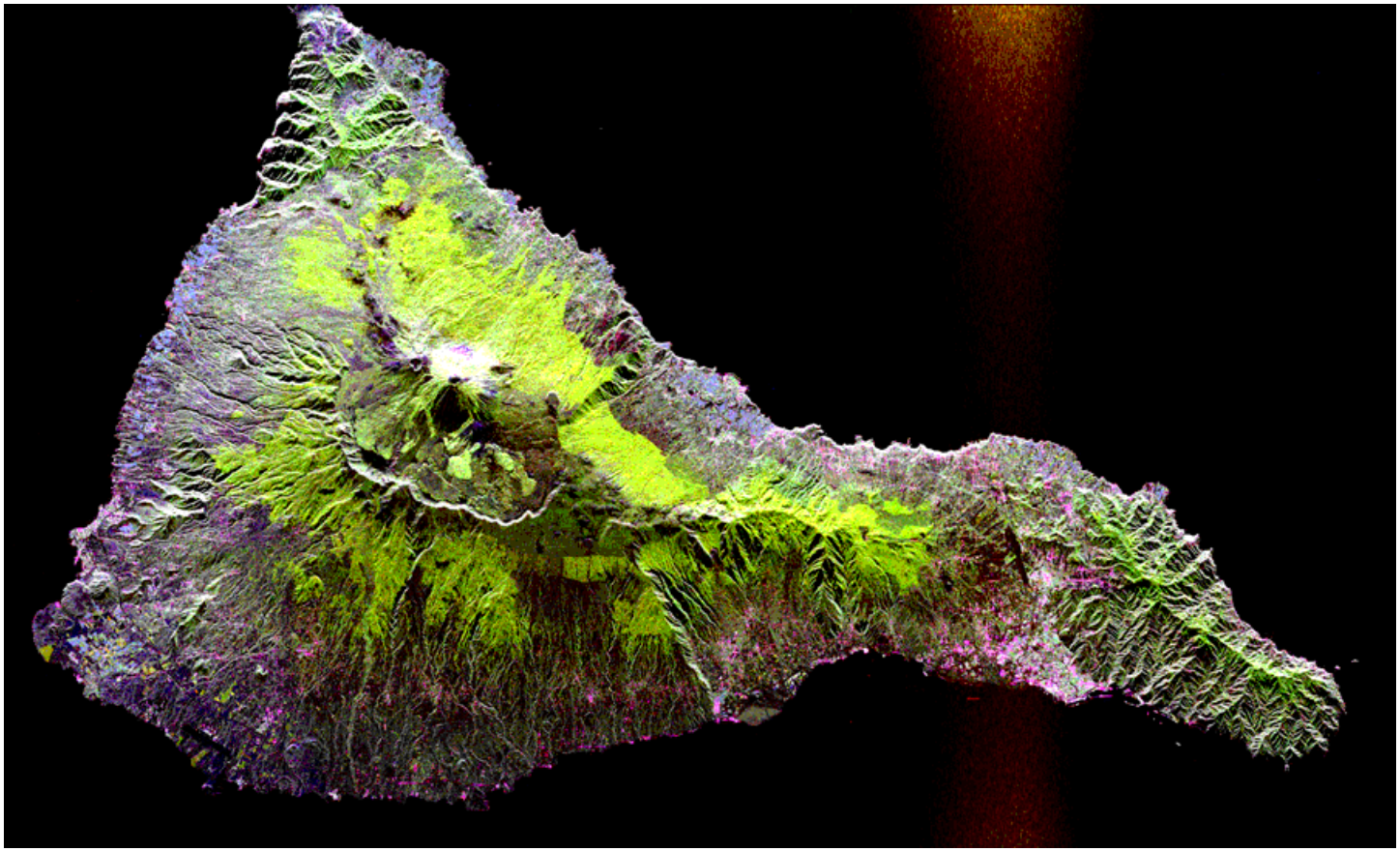
   Most of the land in the delta is made up of mud flats and marsh lands. There is little human settlement in this area because it is not safe to build on sediment that keeps shifting.

Module 4, Investigation 3: Figure 1

Module 4, Investigation 3: Figure 2



Module 4, Investigation 3: Figure 3



Module 4, Investigation 3: Figure 4